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Production, Development and Innovation in Inter-Firm Networks

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Thesis submitted in partial fulfillment of the requirements for the degree of Licentiate of Science in Technology

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ABSTRACT

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Inter-firm network relationships, knowledge intensiveness and regional competitiveness are fashionable subjects in management science today because of globalization, advancement in IT and firms' increasing focus on their core competencies. There is a need for clarifying the models and concepts to make sense of the phenomena of inter-firm network dynamics. A model of three typical network types is built in this study. The network types are labeled as production network, development network and innovation network. The model is based on the concept of three knowledge environments of an organization by Ståhle. The objective of the study is to find out how Ståhle's concept of mechanic, organic and dynamic knowledge environments are related to the inter-firm networks in a region, and what are the roles of brokering intermediary organizations in inter-firm networks.

The study consists of four individual papers that concentrate on different aspects of inter-firm networks and the roles of brokering organizations in them. In the first two papers, the three-dimensional model of networks is put to action in describing the tangible and intangible flows in a cluster of small firms. In the third paper the roles of the intermediaries are described according to the model. In the fourth paper the roles of a certain type of an intermediary organization, knowledge intensive business services (KIBS) are defined accordingly.

The findings of the study suggest that firms use inter-firm network relationships as strategic assets in order to benefit from them in their businesses. Production, development and innovation networks constitute basic tasks that a firm needs to engage in order to survive. According to the case study presented here, it was possible to discern these three networks in a regional cluster of small firms. It was found out that each of the networks has their unique functioning logic and effectiveness criteria. It was also found out that the regional intermediary organizations and KIBS are important actors to facilitate the network dynamics in a region.

In this study, it is argued that Ståhle's concept of mechanic, organic and dynamic knowledge environments can be used as a background framework in the context of inter-firm networks. However, according to the case study, Ståhle's dynamic knowledge environment is not as chaotic in inter-firm networks as Ståhle claims. Based on the organization theory literature reviewed in the introduction part of the study, it can be suggested that Ståhle's dynamic knowledge environment is often a transient phenomenon: its role is to be utilized as a vehicle for transformation when an organization is converted from a mechanic, exploitation mode towards an organic, exploration mode without external pressure.

This study contributes to the field of Knowledge Management, and especially its Finnish line of thought. Practically, this study helps managers to think about their inter-firm network relationships differently, and states that there is no one right way to arrange network relationships. Instead, managers of organizations and decision makers in regions will have to consider innovation functions, production functions, and development functions separately.

Keywords: Knowledge Management, Inter-firm networks, Intermediaries	Language: English

TEKNILLINEN KORKEAKOULU **LISENSIAATINTYÖN TIIVISTELMÄ**
Informaatio- ja luonnontieteiden tiedekunta
Tuotantotalouden laitos

Tekijä: Anssi Juhani Smedlund		
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Työn ohjaaja: Dosentti Marja Toivonen		

Yritystenväliset verkostot, tietointensiivisyys ja alueiden kilpailukyky ovat trendikkäitä aiheita johtamisen kirjallisuudessa globalisaation, tietotekniikan kehityksen ja yritysten ydinosaamiseen keskittymisen takia. Tämän vuoksi tarvitaan malleja ja konsepteja, joiden avulla yritystenvälisten verkostojen toimintaa voidaan tarkastella paremmin. Tässä tutkimuksessa esitellään malli kolmesta tyypillisestä verkostosta. Verkostotyypit on nimetty tuotantoverkostoksi, kehitysverkostoksi ja innovaatioverkostoksi. Malli perustuu Ståhlen konseptiin organisaation tietoympäristöistä. Tämän tutkimuksen tarkoituksena on selvittää, soveltuvatko Ståhlen mekaaninen, orgaaninen ja dynaaminen tietoympäristö yritystenvälisten verkostojen kuvaamiseen maantieteellisellä alueella ja mitkä ovat välittäjinä toimivien organisaatioiden roolit näissä verkostoissa.

Tutkimus koostuu neljästä itsenäisestä julkaisusta, jotka keskittyvät verkostoitumiseen ja välittäjäorganisaatioiden rooleihin verkostoissa. Kahdessa ensimmäisessä julkaisussa kolmiulotteista verkostomallia sovelletaan aineellisten ja aineettomien virtojen kuvaamiseen alueellisessa pienten yritysten klusterissa. Kolmannessa julkaisussa selvitetään välittäjäorganisaatioiden rooleja verkostomallin mukaisesti. Neljäs julkaisu keskittyy erityisesti osaamisintensiivisten palveluyritysten (KIBS) roolien selvittämiseen alueellisissa yritystenvälisissä verkostoissa.

Tutkimuksen löydösten perusteella voidaan sanoa, että yritykset käyttävät verkostosuhteita strategisesti ja pyrkivät hyötymään verkostosuhteista liiketoiminnassaan. Tuotanto-, kehitys- ja innovaatioverkostot ovat verkostosuhteiden kolme päätyyppiä, ja yritys tarvitsee näitä kaikkia verkostoja selviytyäkseen. Tutkimuksessa esitellyn casen perusteella alueellisesta klusterista voidaan erotella nämä verkostot. Jokaisella verkostotyypillä on oma toimintalogiikkansa ja tehokkuuskriteerinsä. Tutkimuksen perusteella voidaan myös todeta, että alueelliset välittäjäorganisaatiot ja KIBS –yritykset ovat tärkeitä toimijoita yritystenvälisten verkostojen rakentajina.

Ståhlen mekaaninen, orgaaninen ja dynaaminen tietoympäristö sopii lähtökohdaksi yritystenvälisiä verkostoja tarkasteltaessa. Tapaustutkimuksen perusteella voidaan kuitenkin sanoa, että Ståhlen dynaaminen tietoympäristö ei ole niin kaoottinen yritystenvälisten verkostojen yhteydessä kuin mitä Ståhle väittää. Tutkimuksen teoriaosuudessa esiteltyjen organisaatioteorioiden valossa voidaan sanoa, että Ståhlen dynaaminen tietoympäristö toimii usein siirtymävaiheen ilmiönä: sen rooli on saada aikaan muutos organisaatiossa, kun organisaatiota muutetaan mekanistisesta, eksploitatiivisesta toimintatavasta kohti orgaanista, eksploratiivista toimintatapaa ilman yrityksen toimintaympäristöstä lähtöisin olevaa ulkoista muutospainetta.

Tutkimus liittyy tietojohtamisen alaan ja erityisesti sen suomalaiseen tutkimussuuntaukseen. Käytännön tasolla tutkimus auttaa yritysten johtajia ajattelemaan yritystenvälisiä verkostoja uudella tavalla väittäen, että ei ole olemassa yhtä oikeaa tapaa verkostoitua. Tämän sijasta yritysjohdon ja alueellisten päättäjien tulee ajatella innovaatiotoiminnan, kehitystoiminnan ja tuotannon verkostoja kutakin erikseen.

Avainsanat: Tietojohtaminen, yritystenväliset verkostot, välittäjäorganisaatiot	Julkaisukieli: Englanti

Acknowledgements

This study is a part of my PhD dissertation project. Because of the fortunate abundance of published research papers, I decided to include the papers concentrating on regional inter-firm networks in this licentiate study. My forthcoming PhD dissertation will include papers on intra-firm networks, where I apply the three-dimensional model of production, development and innovation networks presented in this study in the intra-firm context.

I wish to address my biggest gratitude to Professor Pirjo Ståhle for providing the framework used as the starting point in this study. She has also supported me greatly throughout my scholarly career so far, which I am grateful for, especially at Lappeenranta University of Technology during the years 2001 - 2005.

I wish to thank Professor Aino Kianto (née Pöyhönen) for acting as the thesis supervisor in my master's thesis project during the research process for papers I and II in this study with Professor Ståhle, and taking responsibility for polishing up the award winning paper also included in this study "Assessing Intellectual Capital in Regional Clusters". This paper provided motivation for the rest of the papers and my scientific endeavors generally.

During the research process for the third paper included in this study, Mr. Lassi Köppä was irreplaceable as a research partner and in providing ideas and comments to the paper along with Professor Ståhle, which I am grateful for.

In the fourth paper, I wish to thank Docent Marja Toivonen for bringing in important insights from the KIBS sector. Marja Toivonen provided also important feedback in the final phases of the introduction part of the study along with Professor Eila Järvenpää, without whom this effort would not have been possible. I owe gratitude to Professor Järvenpää for her support to include this study in my PhD project at Helsinki University of Technology, where I have been privileged to do my research at the BIT Research Centre in Innovation Management Institute since 2005.

Further extremely important individuals include the professors and PhD students at the classes and seminars at UC Berkeley Haas School of Business, where I wrote most of the raw text for the theory part of this study during my visiting scholar year 2006. At Haas School of Business, I wish to especially thank Professor David Teece and Assistant Director Patricia Murphy for supporting my visit. I also wish to thank Professor Kalevi Kyläheiko for helping to arrange my visit at Haas.

Despite of the growing interest towards research paper-based theses, there are not many outstanding examples of them. Dr. Sami Sarpola provided me an excellent example and general advice on how to structure a paper-based thesis, which was valuable for me. Furthermore, I wish to thank Docent Antti Hautamäki for acting as the examiner of this study. He also supported me during the year 2006 in Berkeley, which I am grateful for. Finally, I would like to thank the financiers for providing monetary support in my research projects. These institutions are: the Academy of Finland, the Finnish Funding Agency for Technology and Innovation (TEKES), Finland's Ministry of Trade and Industry, the Finnish Work Environment Fund, the Finnish Association of Graduate Engineers TEK, Helsingin Sanomat Foundation, Snellman Foundation and the Support Foundation of Lappeenranta University of Technology.

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Anssi Smedlund

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II. Smedlund, A. and Pöyhönen, A. (2005). “Intellectual Capital Creation in Regions: A Knowledge System Approach.” In A. Bounfour and L. Edvinsson (Eds.), Intellectual Capital for Communities: Nations, Regions and Cities. Butterworth-Heinemann, New York, NY.

III. Smedlund, A. (2006). "The Roles of Intermediaries in a Regional Knowledge System". Journal of Intellectual Capital 7(2). 204-220.

IV. Smedlund A. and Toivonen M. (2007). “The Role of KIBS in the IC Development of Regional Clusters”. Journal of Intellectual Capital 8(1). 159-170.

1 INTRODUCTION

Inter-organizational networks are a very popular issue in contemporary management science. Depending on the theoretical background, networks can be thought of as being a hybrid -type of organizing between markets and hierarchies (Williamson, 1975), or a totally new organization form of their own (Powell, 1990). Castells defines a network simply as a "set of interconnected nodes" (Castells, 1996, 470). Actors form nodes in any network structures, and transmit various types of flows to other actors in the network. Economists Shapiro and Varian (1999) see networks as a prerequisite for succeeding in competition.

According to Teece (1998), the knowledge-based economy of today is based on the growing importance of increasing returns. This means that the markets are dominated by firms that enjoy some kind of lead compared to other firms. The leading position is not necessarily based on the first-mover advantage, or superiority of the offering of the firm, but networks. In the markets dominated by alliances of firms and networks of end users, the value of many products and services is dependent on the amount of other users of the product. According to this phenomenon, which is also called the network externality (Shapiro and Varian, 1999), it is better to be connected to a bigger network than a smaller one. Typical examples of this effect are communication technologies, such as telephone, email and fax (Shapiro and Varian, 1999).

Networking for strategic competitive advantage differs from other forms of cooperation. According to Hyötyläinen & Simons (1998), other forms of cooperation are 1) bidding contest for subcontractors, 2) subcontracting cooperation, and 3) partner-type cooperation. All the three other forms of cooperation are dyadic

by nature, but in strategic networking dyadic relationships are expanded to the level of multilateral cooperation.

Networking has been claimed to have numerous benefits for a firm. Firstly, from the strategic alliance point of view and according to the theory of the firm and the transaction cost theory, network ties lower the transaction costs of the participating actors by allowing them to concentrate on their core competencies, making the production of a product more efficient (Coase, 1937, ; Williamson, 1975, ; Williamson, 1981, ; Williamson, 1985, ; Jarillo, 1988). Secondly, according to social capital theories, inter-firm networks initiate learning from other actors with trustworthy and communicative relationships (i.e. Uzzi, 1997, ; Yli-Renko, Autio and Sapienza, 2001). Thirdly, according to the research on innovation processes, networks give an opportunity to improve products, production methods and processes continuously by providing conditions for combining different resources and knowledge (Powell, 1998, ; Miettinen, Lehenkari et al., 1999).

Another remarkable phenomenon in the management of a firm today is the ever-increasing emphasis on the role of knowledge in the creation of economic wealth. Knowledge is seen as the dominant source of competitive advantage (Drucker, 1995, ; Marr, 2005). The special attributes of knowledge, especially its characteristic as a 'public good' and the endless replication possibilities included in it, make knowledge a key economic resource, and change the value creation logic of firms towards more knowledge-based value creation. Related to the notion of increasing returns, knowledge resources accumulate in use (Teece, 2000), a mechanism that is opposite to traditional, tangible resources.

In order to manage a knowledge-based organization better, Ståhle (Ståhle and Grönroos, 2000, ; Ståhle, Ståhle and Pöyhönen, 2003) has developed a concept

of three different "knowledge environments" of an organization. This concept has been considered as an important contribution to the Knowledge Management field in Finland, and it has been in the curricula of some Finnish business schools since 2000, and given motivation to numerous graduate and post graduate theses, especially at Lappeenranta University of Technology (i.e. Parviainen, 2003, ; Smedlund, 2003, ; Luukkonen, 2004, ; Pöyhönen, 2004, ; Tikkanen, 2004, ; Lempiäinen, 2005, ; Mattila, 2006, ; Montonen, 2006, ; Parviainen, 2007, ; Hyrkäs, 2008).

Regardless of its popularity in Finland, Ståhle's concept of knowledge environments has not gained notable attention in other countries despite the fact that some publications about the concept have been published in English (Ståhle and Grönroos, 2000, ; Ståhle, Ståhle and Pöyhönen, 2003). The concept is originally based on conceptual analysis of systems theories published in Ståhle's PhD dissertation (Ståhle, 1998), where organizations are seen as systems functioning with the logics of open, closed or natural systems. This approach connects Ståhle's work to organization theory scholars, such as Hatch (1997) and Scott (2003), who have presented quite similar groupings.

Ståhle has labeled her knowledge environments as 1) mechanic, 2) organic and 3) dynamic knowledge environments (Table 1). Besides the type of knowledge, Ståhle uses also relationships, information flow and the mode of leadership as criteria and distinguishing categories in her concept, although it is not explained in the publications why specifically these criteria are used as distinguishing factors. In a mechanic environment, where the dominating type of knowledge is explicit, relationships are determined by the organizational hierarchy, the information flow is one-way and top down, and the leadership method is orders and direct use of power.

In an organic environment, where the type of knowledge is tacit, the relationships are reciprocal, the information flow is multi-way and horizontal, and the leadership method is dialogue and delegation of power. Finally, in a dynamic knowledge environment, where the type of knowledge is potential, the relationships are spontaneous, the information flow is chaotic and disorganized, and the leadership method is relinquishing power (Ståhle, Ståhle and Pöyhönen, 2003, 70).

Table 1: The three knowledge environments of an organization (Ståhle, Ståhle and Pöyhönen 2003, 70)

Organization as a three-dimensional system	**Mechanic**	**Organic**	**Dynamic**
Knowledge	Defined, explicit	Experiential, hidden, tacit	Intuitive, potential
Relationships	Determined by organizational hierarchy	Reciprocal, seeking consensus	Spontaneous, networked
Information flow	One-way	Multi-way	Chaotic
Management and leadership method	Orders, direct use of power	Dialogue, self-assessment, delegation of power	Networking skills, visions, relinquishing power

Ståhle's concept of the different knowledge environments was first developed in context of teams (Ståhle, 1998) and then later expanded to the organizational level (Ståhle and Grönroos, 2000). Later, a diagnostic measuring method (Dynamic Intellectual Capital or DIC index as a result) called the "KM-factor®" was developed to identify mechanic, organic and dynamic knowledge environments in teams, units and subsystems in organizations, through a survey aimed at the management and employees of a firm. The method and the DIC index method are proprietary of Ståhle's consulting firm, and the specific survey questions or the methodology of calculating "DIC –index" have not been revealed in scientific publications (for a cursory overview of the method, see Ståhle, Ståhle and Pöyhönen, 2003, ; Pöyhönen, 2004).

1.1 Objectives of the study

Ståhle's concept of knowledge environments have gained notable attention in Finland, and it is an intuitively compelling framework to make sense of different kinds of preconditions of organizations that create value with knowledge assets and. The objective of this study is to find out how Ståhle's concept of mechanic, organic and dynamic knowledge environments are related to the inter-firm networks in a region, and also position these knowledge environments in the organization theory literature. The primary research questions are formulated accordingly, to answer the question of whether it is possible to categorize inter-firm network relationships according to Ståhle's model, and what are the characteristics of these networks. The secondary research question seeks answers to what are the roles of brokering organizations in regional inter-firm networks.

This study explores the nature of inter-firm networks from mechanic, organic and dynamic angles, and also clarifies the roles of different actors in networks. The research questions give a perspective on the different aspects of networking between firms. They complement each other and make it possible to gain better understanding of the nature and role of networks between firms in regions. The research questions are discussed in more detail in chapter 3.

1.2 Outline of the study

This licentiate study consists of four original papers and an introductory part. The papers are enclosed at the end of the study, and the introductory part provides a summary of the papers. The introductory part is structured as follows. In chapter two, the theoretical background based on Ståhle's knowledge environment concept is presented. The background of Ståhle's work is briefly introduced, and then it is

positioned in the body of organization theory literature by seeking out similar concepts that have been presented in the past by other authors. The nature of the theory part in this study is not to provide an exhaustive literature review summarizing all existing knowledge in organization theory related to knowledge environments, but to develop convincing arguments of connections between different theories that are related to the knowledge environment concept.

In chapter three, the research problem and objectives of the study are presented and discussed in detail. After this, the collection of empirical data used in the papers is described, and the methodology of the data gathering and the validity of the material and methods are discussed.

Chapter four presents the main results of the papers included in this study. First, the results of a theme-based interview study conducted in a regional cluster are presented; this introduces a model of regional production, development and innovation networks. Second, based on the same interviews as in the first paper, a model of regional knowledge system is presented, and the inter-firm networks in the region are elaborated in depth. Third, the roles of intermediary organizations in the networks of production, development and innovation are described, founding on theme-based interviews and discussions with individuals in another region, where the future competitive advantage is based on knowledge assets. Fourth, the roles of knowledge-intensive business services (KIBS) are described at a conceptual level, reflecting the regional knowledge system model on the existing KIBS –literature.

In the fifth and final chapter, the main findings of the study are discussed, and the main contributions for research and practice are reviewed. In this chapter, also the limitations of the study are discussed, and suggestions and directions for future research are provided.

The first of the four papers included in this study (Paper I), "Assessing intellectual capital creation in regional clusters", written by Aino Pöyhönen and Anssi Smedlund, has been published in the Journal of Intellectual Capital 2004, 5 (3). The paper is based on Smedlund's Master's Thesis at Lappeenranta University of Technology during 2002-2003. Aino Pöyhönen contributed 60% to the paper and Anssi Smedlund 40%. The second paper (Paper II), "Intellectual Capital Creation in Regions: A Knowledge System Approach", written by Anssi Smedlund (60%), and Aino Pöyhönen (40%), is based on the same empirical material as the first one. The second paper has been published in a book titled "Intellectual Capital for Communities: Nations, Regions and Cities", edited by Ahmed Bounfour and Leif Edvinsson, and published by Butterworth-Heinemann in 2005.

The third paper (Paper III), "The roles of intermediaries in a regional knowledge system" written by Anssi Smedlund, has been published in the Journal of Intellectual Capital 2006, 7 (2). The fourth paper (Paper IV), "The role of KIBS in the IC development of regional clusters", written by Anssi Smedlund (70%) and Marja Toivonen (30%), has been published in the Journal of Intellectual Capital, 2007, Volume 8, Issue 1.

2 THEORETICAL BACKGROUND

In this theory chapter, Ståhle's concept of knowledge environments is described in more detail and reviewed in contrast to the organization theory. As shown below, Ståhle's concept combines elements from many existing organization theories, particularly those related to the contingency theory, postmodern organization theories, systems theory and writings in knowledge management. This chapter concludes that Ståhle's concept of mechanic and organic knowledge environments is widely supported by the existing organization theory and also empirical research, but the dynamic knowledge environment seems to be problematic in terms of empirical evidence.

Ståhle developed her model of mechanic, organic and dynamic knowledge environments of an organization by interpreting different systems theories in her dissertation in education science at the University of Helsinki (Ståhle, 1998), and later in her book on knowledge management published in 2000 (Ståhle and Grönroos, 2000). According to Ståhle (2003), the mechanic knowledge environment functions with a logic of cybernetics, as a machine with a closed system logic, the organic environment resembles the logic of the general systems theory of Bertalanffy (1968) , and the dynamic environment has similarities with self-organizing systems (Prigogine, 1976), the chaos theory (Lorenz, 1993), and the autopoietic systems view (Maturana and Varela, 1980, ; Maturana and Varela, 1987).

In the field of organization theory, systems theory has been successfully used to describe the relationships between different organizational theory paradigms (i.e. Hatch, 1997, ; Baum and Rowley, 2002, ; Scott, 2003). In organization theory,

systems theories help to describe the fundamental origins of different theories (Baum and Rowley, 2002), and function as underlying root metaphors to illustrate the fundamentally different ways of representing organizations (Hatch, 1997).

Scott (2003) divides the theories on organizations into three categories: 1) rational systems, 2) natural systems, and 3) open systems. In this division, according to Baum and Rowley (2002), the rational view presents a machine-like perspective, the natural systems present an organic view, and the open systems view presents a metaphor of adaptive and interdependent systems of various subsystems, aiming to meet the dynamic needs of the environment. The underlying difference between the three system perspectives is that the perspectives of rational and natural systems see the environment and the organization as separate entities with clear boundaries, whereas in the open systems perspective, the distinction is not so clear. In the open systems perspective the focus is on the relationships and interdependencies between the organization and the environment (Baum and Rowley, 2002).

Ståhle's interpretation of systems theories is different. Instead of using systems theories as a tool to position and categorize other organization theories (Scott, 2003), she states that an organization has three environments of knowledge systems present at the same time. In other words, there are mechanic, organic and dynamic knowledge environments present in the same organization at the same time, which makes the organization both open and closed simultaneously. Furthermore, Ståhle states that all the organizational modes, which she calls "knowledge environments" are needed in order for the firm to survive (Ståhle, Ståhle and Pöyhönen, 2003).

The idea of different social and physical environments as a precondition for knowledge is also a key in the concept of "BA" coined by Nonaka (Nonaka and

Konno, 1998). Knowledge environment is defined in Ståhle's writings as a similar organizational space in time as in the notion of BA: it allows individuals to interact in a way that results in the desired outcome of knowledge creation, transfer or adapting. Scharmer (2001) uses the concept of knowledge environment to describe the organizational structure that supports either explicit, embodied tacit, or not-yet embodied tacit knowledge. Ståhle states that the mechanic knowledge environment uses explicit knowledge, the organic tacit knowledge, and the dynamic potential knowledge (c.f. self-transcending knowledge in Nonaka and Konno, 1998, ; Scharmer, 2001) to create value (Ståhle, Ståhle and Pöyhönen, 2003).

The idea that an organization is actually a mixture of many different systems is compelling; pure examples of each are quite hard to find, and most contemporary organization theories tend to combine elements of rational, natural and open systems (Baum and Rowley, 2002, ; Scott, 2003). Hatch (1997) states that the classical view where the organization was seen as a closed, machine-like system belongs to the pre-history of organization theories. Therefore it is obsolete to begin with; the theories nowadays must include the organization's interaction with its environment. According to Baum and Rowley (2002), examples of contemporary organization theories that cross the system borders are, for example, institutional theories and power and resource dependency theories, in addition to network, learning and complexity theories.

Ståhle's view of three knowledge environments can be clearly stated as being a part of the postmodern view of organizations. Postmodern views in the organization theory include critical, feminist and neomarxist viewpoints. According to Hatch (1997), the definition of postmodernism starts from the notion that an organization is not one unified concept, but a mixture of many – a collage that is

made from bits and pieces of knowledge and understanding brought together. Ståhle's original research on the self-organizing work groups was conducted among teams inside a relatively large organization (Ståhle, 1998). In that research, work groups were observed, and it was found out that some of the groups functioned with self-organizing logic that was later labeled as a dynamic knowledge environment (Ståhle and Grönroos, 2000).

A good example of teams functioning with different ways is provided by executive board meetings and brainstorming sessions in R&D. The different ways of functioning have been extended from the group level to constitute also organization structures as a whole, to portray the simultaneous existence of mechanic, organic and dynamic knowledge environments (Ståhle and Grönroos, 2000, ; Ståhle, Ståhle and Pöyhönen, 2003).

According to postmodern views of the organization theory, and in the open system view (Scott, 2003), the idea of an organization consisting of many different types of groups is quite common. In these studies the organization is seen as comprising various interrelated, possibly conflicting subsystems (Hatch, 1997) - in Ståhle's (2000) terms, some functioning in a mechanistic way, some in organic and some in dynamic ways.

Theories exist of how organizations are structured to reach efficiency in production in a mechanistic system, but also gain benefits of innovation with open systems. Parson's (1960) solution is to divide an organization into interrelated systems consisting of three layers: the layer in the middle is the technical "core" that produces products. Around the technical core is the managerial system that mediates between the organization and the task environment and administers the internal

affairs. Around the managerial system is the institutional system that relates the organization to the outside world (Thompson, 1967).

Weick's (1976) theorizing around "loosely coupled systems" provides another example of describing how an organization is structured in layers – an organization maintains routine production through its technical core and innovativeness through relationships with the environment at the same time. According to the idea of loose coupling, "organizations appear to be both determinate, closed systems searching for certainty and indeterminate, open systems expecting uncertainty" (Orton and Weick, 1990, 204).

Among the postmodern views, the feminist school of thought has similar features as Ståhle's dynamic knowledge environment. Martin, Knopoff and Beckman (1998) build a model in their research concerning organizational culture in a retail organization and claim that there are three organizational types: the traditional bureaucratic, a normative, and a feminist organization. The feminist organization type by Martin, Knopoff and Beckman is illustrated with similar characteristics as Ståhle's dynamic knowledge environment (Table 2). According to Martin, Knopoff and Beckman, the feminist organization challenges the traditional forms of organizations, by emphasizing employees' emotions and well-being rather than efficiency or performance concerns.

Table 2: Feminist organization type and Ståhle's dynamic knowledge environment

	Dynamic (Ståhle, Ståhle and Pöyhönen 2003, 70)	**Feminist** (Martin, Knopoff and Beckman 1998, 431)
Skills	Intuitive, potential	Low level of division of labor; informal; nonspecialized
Relationships	Spontaneuos, networked	Low level of hierarchy; egalitarian; authority dispersed throughout organization
Information flows	Chaotic	N/A
Management and leadership method	Networking skills, visions, relinquishing power	Low level of control; unobtrusive; through internalized values reflecting feminist ideology

Ståhle uses skills, relationships, information flows and the management/leadership method as distinguishing categories when describing the characteristics of the three knowledge environments (Table 2). The most important distinguishing factor between the dynamic/feminist organization type and other organization types is the lack of hierarchy. According to feminist ideology in general, the level of control over individuals must be kept to minimum, and the authority must be dispersed through the organization. This is also the essence of Ståhle's dynamic knowledge environment, where the relinquishing of power and chaotic information flow create an environment that is able to react spontaneously to occurring events and self-organize itself rapidly. The ability to self-organize is the essence of Ståhle's dynamic knowledge environment. According to Ståhle, the critical factors for self-organizing systems are a far-from-equilibrium –state, entropy, iteration and bifurcation, and these processes should be possible in the dynamic knowledge environment (Prigogine, 1980, ; Ståhle, 2004).

Issues related to power in the dynamic knowledge environment are similar to Perrow's (1986, 129-131) description of fully unobtrusive control, where employees know by nature how to behave in different situations. Other types of control that Perrow describes are direct and bureaucratic types of control mechanisms that are more suitable to mechanic and organic management systems (ref. Martin, Knopoff and Beckman, 1998, 430)

In addition to the postmodern, feminist view of the organization, Ståhle's three-dimensional knowledge environment model seems to have a common ground with the contingency theory of the 1960s (Burns and Stalker, 1961, ; Thompson, 1967, ; Ståhle, 1998). The main message in the contingency theory is twofold: 1) there is no one best way to organize; however, 2) any way of organizing is not equally effective (Galbraith, 1973). The early contingency theorists, Burns and Stalker (1961), divided the ways to organize activities inside organizations into two: mechanistic and organic.

The mechanistic management system resembles Taylor's scientific management (Taylor, 1972 [c1947]) and Weber's bureaucratic organization (REF: Weber, 1947, ; Scott, 2003, 155). Scott cites Weber (Weber, 1947, ; REF: Scott, 2003, 155) "bureaucratic organization is superior to any other form in precision, in stability, in the stringency of its discipline, and its reliability". Hierarchical bureaucracy is a human machine that thrives for "precision", "stability" and "reliability" (Giddens, 1983, ; REF: Scott, 2003, 155). Therefore, hierarchical bureaucracy functions with an unambiguous flow of information – with clear rules and regulations – to get the job done as efficiently as possible. Mechanistic forms are employed by firms carrying out routine tasks (Scott, 2003, 162). Organic

management systems, according to Burns and Stalker (1961), are more decentralized, and likely to be utilized in firms engaged in innovative tasks.

Mechanistic and organic management systems (Burns and Stalker, 1961, 119) represent "two polar extremities of the forms which such systems can take when they are adapted to a specific rate of technical and commercial change". In Table 3, Ståhle's mechanic and organic knowledge environments are compared with the mechanistic and organic management system definitions in Burns and Stalker's (1961) original work. The mechanistic management system represents hierarchy and specialized functional tasks and is designed for stable conditions. The organic management system is designed for changing conditions and functions with the logic of continuous adjustment and re-definition of individual tasks through interaction with others (Burns & Stalker, 1961, 121).

Table 3: Similarities between Ståhle's mechanic and organic knowledge environments and the contingency theory

	Mechanic (Ståhle et. al., 2003)	**Mechanistic** (Burns & Stalker, 1961)	**Organic** (Ståhle et. al., 2003)	**Organic** (Burns & Stalker, 1961)
Skills	Defined, explicit	Skills are well known and specified by the task. Techniques and purposes to perform small parts of tasks better are emphasized	Experiential, hidden, tacit	Skills are professional competencies, experiences of the task as a whole instead of just a one piece. Holistic approach to the work
Relationships	Determined by the organizational hierarchy	Strict superior – subordinate relationships. The superior knows what the subordinates are doing and assesses the work of the subordinates	Reciprocal, seeking consensus	Relationships are based on commitment to the "concern beyond any technical definition". There are no superiors and subordinates, the knowledge about the task may be located anywhere in the social network
Information flows	One-way	Superiors issue instructions to subordinates. Information that resides inside the organizational hierarchy is emphasized. Interaction between people is vertical, between the superior and the subordinate	Multi-way	Continuing adjustment, information and advice to others, not instructions and decisions. Affiliations external to organization are emphasized as long as they are valid from the own point of view. Communication is lateral rather than vertical, resembling consultation rather than command
Management and leadership method	Orders, direct use of power	To be a member of the organization, one must show loyalty and obedience to the superior. Each functional role has specified rights and obligations. Control and authority are hierarchical	Dialogue, self-assessment, delegation of power	Commitment to the "technological ethos" is valued higher than loyalty and obedience. People can not post problems away from themselves. Possible sanctions are of the social kind and derive from the network of co-workers more than from the contractual relationship between a worker and the corporation or the immediate supervisor

Both Burns and Stalker (1961) from the contingency theory perspective and Weick (1990) more from the resource dependency school of thought suggest that a successful organization has to be rational and indeterminate simultaneously. However, in Burns and Stalker's work, there is more a sense that an organization will fall into the organic management system when facing a turbulent environment

and then organize back to mechanistic logic, which is seen as the best way to arrange activities and also as the most desired stage of operation in the early writings of the contingency theory. The exploration-exploitation paradox (March, 1991) in the management of an organization is argued stronger in Weick's work - a successful organization has to be rational and indeterminate simultaneously, not interchangeably. This means that in any part of a firm, the system functions both at a technical level, which is closed, and at an institutional level, which is open to outside forces (Orton and Weick, 1990).

Research into the existence of mechanistic and organic management systems is convincing among contingency theorists. After the original work of Burns and Stalker (1961) about the rayon mills and electric industry in the UK during the 1950's, also Lawrence and Lorsch (1967), Galbraith (1973), Blau and Scott (1962), and Aiken and Hage (1968) have presented evidence of how the environmental contingencies affect the internal structures of an organization by transforming them to structures equivalent to Burns and Stalker's (1961) mechanistic and organic systems. The message in all the above studies is similar to that of Blau and Scott's (1962), who conclude that vertical hierarchies are good for tasks requiring efficient coordination of information and routine decision making. If the task presents complex or ambiguous problems, such centralized hierarchies impede the problem solving.

When contrasting Ståhle's knowledge environment idea with the research based on the contingency theory, the mechanic and organic knowledge environments seem reasonable, but the dynamic knowledge environment is somewhat detached from the other two. If an organization can take either a mechanic or an organic form, depending on the external contingencies, there is not really room for a dynamic

knowledge environment. The dynamic knowledge environment seems, at least from the contingency theorists' point of view, a utopia, an organizational structure that according to some ideologies (i.e. the feminist one) other than economic efficiency concerns, is the most desirable.

Besides the postmodern organization theory, there are writings in knowledge management literature that speak for the existence of a third, dynamic knowledge environment in addition to the mechanic and organic ones. Snowden (2002) argues that knowledge management has gone through three separate generations from storage and handling of information with IT, through conversions of tacit and explicit knowledge (Nonaka and Takeuchi, 1995) to more radical innovation. Scharmer (2001) points out that Nonaka & Takeuchi's SECI model misses a component that allows radical change and explains why the transformation of tacit knowledge and back started in the first place. Furthermore, it can be argued that the complexity and chaos theories, postmodern as such, in the knowledge management literature, can be positioned as supporting the dynamic knowledge environment as an existing organizational structure.

Arguments towards the third, self organizing knowledge environment that allows radical change seem intuitively appealing, but not as a structures of organizations. If a feminist-like, postmodern organization structure without any kind of power structure (hierarchical or social), similar to what Martin, Knopoff and Beckman (1998) suggest, existed, it would redefine the word "organization", because in organizing, there is always a power component required. The organization, by definition, always forms a hierarchy (vertical or horizontal), otherwise it cannot be called an organization (Fairtlough, 2005). Maybe an organizational structure that Ståhle labels dynamic and some postmodern

organization scholars as feminist, cannot be called an organization to begin with - in these kinds of structures the boundaries of formal organizations will get blurred, and the locus of power is undefined. Individuals will start working in collaboration with others in different networked environments in multiple projects simultaneously. One example of such behavior are for example the open source communities that are a rising phenomenon today.

3 RESEARCH OBJECTIVES AND METHODOLOGY

Despite of the obvious concerns presented above on the existence of the dynamic knowledge environment in the organization theory, this study starts from the clean slate and investigates how Ståhle's concept of three-dimensional knowledge environments could be applied in the context of inter-firm networks. The results presented below and discussed in the discussion part of this study show that the critique is in some parts supportable, but the dynamic knowledge environment metaphor is still useful. The results show that in the context of inter-firm network relationships, the concept of knowledge environments should be interpreted differently than inside an organization. This chapter presents and discusses the objectives of the study in detail. Then the collection of empirical data used in the original papers is described. Finally, the methodology of the papers is described.

3.1 Objectives of the study

The objective of this study is to find out, how Ståhle's concept of mechanic, organic and dynamic knowledge environments is related to inter-firm networks, and also position these knowledge environments in the organization theory literature.

Despite the vast amount of research related to networks, there seems to be very few knowledge management -related empirical studies on inter-firm networks. There is a need for a conceptual model to provide help for managers in directing their attention to the right mechanisms to solve the timeless paradox how to balance between efficiency and innovativeness – exploration and exploitation (March, 1991).

The flows of knowledge and the intellectual capital assets are crucial in this balancing act, at least in countries like Finland, where it is commonly acknowledged

that the competitive advantage of firms in the future will be based on knowledge-intensive industries rather than physical capital and manual labor-intensive business. The context of the empirical research presented in this study is a region, and inter-firm networks are important from the regional point of view as well. There are writings about regional networks between firms, but there has not been much empirical evidence to support the concepts developed by the authors (see also: Jacobs and Mann, 1996, ; Mannermaa and Alqvist, 1998, ; Koivisto and Ahmaniemi, 2001, ; O'Donnell, Gilmore et al., 2001). The more specific research questions that this study seeks to answer are presented and discussed next.

Q1: Is it possible to categorize networks – particularly in regional contexts – using the three-dimensional concept of knowledge environments to differentiate between networks functioning with the logics of mechanic, organic and dynamic knowledge environments, and what are the characteristics of these networks?

Ståhle's systems theory-based concept of a mechanic, organic and dynamic knowledge environment is intuitively a good way to make sense of organizational environments. As presented above, the systems theory-based reasoning of discerning different structures and functioning logics in organizations has also been popular in organization theory since the 1960's, and quite similar suggestions as Ståhle's concept have been made (see Hatch, 1997, ; O'Donnell, Gilmore, Cummins and Carson, 2001, ; Scott, 2003). Yet, while this topic has been widely discussed, the prior research in clarifying these structures has been at the team or organizational level, and the theory lacks empirical evidence on similar structures in the context of inter-firm networks. Papers I and II included in this study address this issue. More

specifically, Paper I presents an application of mechanic, organic and dynamic knowledge environments in inter-firm setting, whereas Paper II describes the three network types in more detail, and presents a model of the mutual dynamics of these networks in a regional cluster of small firms.

Q2: What is the role of brokering organizations – intermediaries and KIBS – in regional production, development and innovation networks ?

In the network theory, the importance of brokers or hubs has been highlighted. These actors are more connected than others, and they gain information benefits and control the relationships between otherwise unconnected others (Burt, 2000).

One group of regional intermediaries are professional service firms (PSF's), also known as KIBS (Knowledge-Intensive Business Services). It has been noted that the role of KIBS for national economies is growing rapidly, which increases the importance of understanding their roles in regional economies, as well. In all western economies, the KIBS sector is growing faster than any other industry when measured with GVA and employment (Toivonen, 2004). Papers III and IV included in this study address the second research question. Paper III describes the roles of intermediaries in general in production, development and innovation networks in local, regional and national levels of examination. Paper IV describes the roles of KIBS in production, development and innovation networks.

In this study, networks are seen as an institutional form of coordinating, or governing, economic exchange relations between the actors. Therefore, the networks are considered as a particular organizational form that can be studied (Powell and Smith-Doerr, 1994, ; REF: Ebers, 1997). In other words socio-centric network

perspective is used as the research perspective (cf. Adler and Kwon, 2002). The type of approach varies in the papers of this study. The first paper introduces the model of three network types mostly in a theoretical sense, using only one network example from the case regional cluster. The second paper brings in the concept of the regional knowledge system and elaborates the dynamics of the networks more empirically. Paper III takes a policy-oriented stand by distinguishing critical challenges of a region from the network perspective, and the fourth paper describes the roles of KIBS in a region more from the value creation of a single firm – perspective (Table 4).

Table 4: Positioning of individual papers in the context of a region

Context:	Region			
Network perspective:	Socio-centric, networks as an institutional form of governance			
Paper:	Paper I: Assessing IC creation in regions	Paper II: IC Creation in Regions : A Knowledge System Approach	Paper III: The Roles of Intermediaries in a Regional Knowledge System	Paper IV: The Role of KIBS in the IC Development of Regional Clusters
Focus:	Theoretical, regional cluster	Regional cluster	Policy oriented	Firm strategy oriented

3.2 Data collection

In papers I, II and III the primary data was gathered with theme-based interviews. The fourth paper is conceptual. It is, however, based on earlier empirical studies made by the authors in Finnish regions and companies. In the data gathering process in papers I, II, and III, the interviews were tape-recorded and then transcribed. The transcribed data was classified according to themes. The data in papers I and II is the same, and the data in paper III was gathered from a different region than in the first

two papers. In the theme-based interviews in papers I and II, the interview themes are constructed according to the basic determinants of Ståhle´s knowledge environments (knowledge, relationships, information flow and mode of leadership) (Ståhle, Ståhle and Pöyhönen, 2003). In the third paper, the interview themes were grouped to cover issues that described the characteristics of the region's economics, the role, vision and mission of the interviewee's organization in the region, and opinions of the interviewees related to the political environment, family life and living conditions in the region. The implementation of the interviews and the two sets of case studies are described next.

3.2.1 Theme based interviews in a regional cluster

Theme-based interviews on the regional networks of small firms in an industrial cluster were conducted as a part of a research project financed by the Finnish Association of Graduate Engineers (TEK) during the years 2002-2003. The implementation and the results of the research have been reported in detail in Smedlund's Master's thesis in economic science (Smedlund, 2003) and in a book published by TEK (Smedlund, Pöyhönen and Ståhle, 2003). The goal of the theme-based interviews was to map all the actors in the regional cluster, model the relationships between the actors, identify strengths and weaknesses in the network dynamics in the region, and develop a tool to asses and manage the region's inter-firm networks.

The case region was chosen because it formed a tightly knit, relatively small and well observable regional cluster of small firms, geographically isolated from the main industrial agglomerations in Finland. The case region was also an interesting subject of research because in its industry, which is mechanical wood processing,

inter-firm networking between small firms was unusual in Finland, and the few regional cluster experiments done in the 1990's had not been successful (Passila, 1998). Furthermore, the region represented the largest public investment in its industry at the time.

The theme-based interview method is a discussion-based form of interview where the themes are defined beforehand. In the interview situation, the questions do not follow a certain pattern or order, but the interviewer ensures that all the pre-defined themes are covered during the discussion. In research papers I and II in this study, the themes were built according to the basic determinants of Ståhle's knowledge environment concept. These are knowledge, relationships, information flow and leadership methods. By finding out the nature of these determinants, it is possible to determine the nature of the knowledge environment (Ståhle, Ståhle and Pöyhönen, 2003).

In the context of the research, in papers I and II these themes were defined as follows: 1) what kinds of knowledge and competencies there are in the network, 2) what kinds of relationships there are between the actors, 3) how knowledge is transferred between the actors, and 4) how the above mentioned processes are coordinated and managed.

There were a total of 11 interviews with the CEO's of the companies in the case region between December 2002 and March 2003. The goal to interview every actor in the region was successful, except for one firm, whose CEO refused to participate in the research. Each interview lasted about one hour. Most of the interviews were conducted by two researchers, where one of the researchers asked most of the questions while the other one took notes and kept track of the questions asked. All the interviews were transcribed. In order to increase the validity of the

research, to ensure that the theme-based interviews would cover all the relevant issues, some of the interviews were specified with short telephone conversations with the interviewees after the face-to-face interview.

3.2.2 Theme-based interviews of regional intermediaries

The theme-based interviews in the regional intermediary research reported in paper III were conducted as a part of a research project coordinated by the Finnish Funding Agency for Technology and Innovation (TEKES) and financed by the Finnish Ministry of Trade and Industry during the summer 2004. The research and the results have also been reported in detail in a publication by TEKES (Koskenlinna, Smedlund et al., 2005), and as an electronic research report published by the Finnish Ministry of Trade and Industry (Ståhle, Smedlund and Köppä, 2004). The goal of the theme-based interviews in the regional intermediary research was to map challenges that the intermediate organizations face in the facilitation of inter-firm production, development and innovation networks.

The case region in this research was the Kuopio region, which has 117,000 inhabitants (Valovirta and Virtanen, 2004). This region was chosen as the case region largely because it was one of the options that the project coordinator gave to the researchers. The town of Kuopio is located in the eastern part of Finland far away from the growth areas of Finland and is the biggest town in its region. The main reason to choose the Kuopio region was because of its special characteristics in knowledge-intensive businesses. The Kuopio region has gone through major changes in its economic structure during the past 30 years. Up to the beginning of the 1990s the main industries were agriculture and labor-intensive factory work. After the Soviet Union collapsed in the early 1990s, and after Finland joined the EU

in 1995, both factories and farms vanished from the region and the inhabitants in the area have been left with only public sector, the University and the University hospital, which were the biggest employers in the region. During the times of the interviews, the unemployment rate of the region was around 15 percent (Statistics Finland).

In Kuopio, a lot of economic activities have evolved around the University and the University hospital. Some domestic and foreign pharmaceutics and medical firms have founded research laboratories close to the University to benefit from the supply of highly educated and relatively inexpensive workforce. Also numerous privately or publicly owned start-ups have started their business in the city. The case study in the regional intermediary research that is reported in paper III in this study concentrated on the network dynamics, particularly in the medical technology cluster of the Kuopio region. The themes of the theme-based interviews in this study were generally the missions, roles and network relationships of the interviewees' organizations. Personal opinions of the interviewees covering issues in their region and organization were also included.

In total 8 interviews were conducted in the Kuopio region in June 2004. The interviewees were selected on the basis of a preliminary understanding of the intermediary organizations in the region to include key individuals from the region's technology centre, university, university hospital, venture capital firm and municipal government (Ståhle, Smedlund and Köppä, 2004). Each of the interviews lasted around one hour, and the interviews were recorded and transcribed. The interviews were conducted by two researchers in a similar fashion as in Papers I and II, where one researcher asked most of the questions while the other researcher took notes and

kept track on the questions asked. Also some previous research reports were used as background material and referred to in the research paper.

3.3 Methodology and positioning of the individual papers

In this part the progress of the research of this study is first described. Then, the research designs of the individual papers are discussed and the implementation of the data analysis reported in the papers is described.

3.3.1 Progress of the research

The research reported in this study has been a process where the model of production, development and innovation networks was deepened to cover the mutual dynamics of three networks in a region. The roles and challenges of the intermediate organizations in these networks, and finally the specific roles of KIBS in these networks were also included. Paper I (Pöyhönen and Smedlund, 2004) can be considered as a starting point for the research leading to this study. This paper introduced the concept of production, development and innovation networks in a regional cluster from the knowledge management perspective. The network model was further clarified in paper II, including more reporting on the empirical data gathered in Smedlund's Master's thesis project (Smedlund, 2003), and also the model of a regional knowledge system was presented for the first time.

In the research process of papers I and II, there were already some signals of the importance of professional services in a regional cluster, because the consulting firm had a very strong role in the regional case cluster. This consulting firm was an actor in the regional cluster, and it functioned as a knowledge intermediary in the innovation network discovered in the region during the theme-based interviews. The insights built during the research process of the first two papers resulted in a

research setting that was used in paper III, where the content of the paper was to define the roles and challenges of intermediary organizations in a regional knowledge system, from the point of view of production, development and innovation networks. The fourth paper then summed up conceptually the role of KIBS in a region and provided understanding of and discussed the concept of KIBS in conjunction with the knowledge environments of a regional cluster. The timeline of the progress of the research and the relationships between the individual papers are presented in Figure 1.

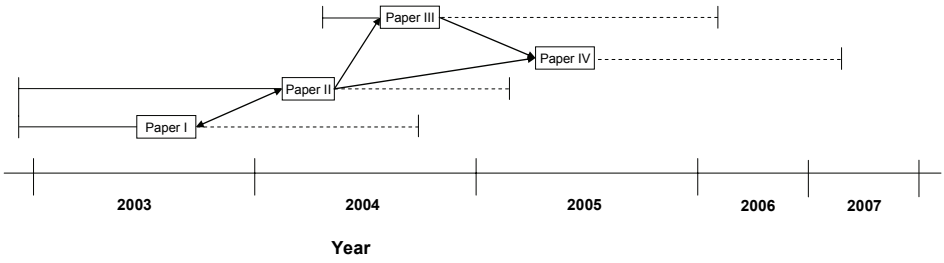


Figure 1: Progress of the research, publication times, and relationships between the individual papers

The timeline in Figure 1 provides an illustration of when the individual papers included in this study were written, when the data was gathered, and when the papers were published in a scientific, peer-reviewed journal or book. The boxes in Figure 1 represent roughly the time spent in actual writing of the papers, the solid lines represent the time period when the data was gathered and analyzed, and the dotted lines represent the time period between the first draft of the paper and the actual publication date. Papers III and IV were slightly revised during the review process according to the feedback received, but Papers I and II were accepted for publication in the form they were submitted. It should be noted that Papers I, III and IV were presented in a scientific conference before the journal submission, papers I

and III in the annual McMaster World Congress, Hamilton, ON, Canada in 2004 (I) and 2005 (III), and paper IV in the European Conference on Knowledge Management, Limerick, Ireland in 2005. Paper II was written on an author invitation after the presentation of Paper I at the McMaster World Congress 2004.

3.3.2 Methodology and conduct of the data analyses

This study includes papers that represent the case study methodology in management science. The case study research method was chosen as the methodology for the study mainly for two reasons: 1) the case study method is best suited in situations where the studied phenomenon is new, and 2) as a method, case study allows in-depth analysis of a certain phenomenon and lets new issues emerge from the research data (Yin, 1994). In case study research, it is important to define the research questions carefully, as they "provide a well-defined focus to collect specific kinds of data systematically" (Eisenhardt, 1989, 536). However, the questions are often loosely and broadly defined and they require continuous redefining along the progress of the case study (Eisenhardt, 1989). In management science, the role of case studies is to form a single picture of the studied phenomenon based on triangulation of different sources of data. As described above, the main method of data gathering in this study has been a theme-based interview.

Despite of the overall research methodology being quite holistic and inductive – new issues emerging from the cases - the background theories have a big role in this study. Ståhle´s model of knowledge environments was the background framework in papers I and II. In papers III and IV, however, the background frame of reference was the three-dimensional network model and the regional knowledge system model created in papers I and II and based on the empirical data gathered

from the industrial case cluster. Preliminary understanding on the service innovation processes of KIBS also formed a background against which the analysis of literature was reflected in paper IV. In the first paper, there was also a sense of deductive analysis, where the ideal types of the four basic determinants of Ståhle's knowledge environments (knowledge, relationships, information flow and leadership method) were contrasted with the perceived state in the region in these determinants and presented as a Table in the paper.

Next, the data analysis in the individual papers is discussed in detail, and also the research designs of the individual papers are presented. A summary of the research methods, data collection methods, sample size and validity concerns are presented in Table 5.

Table 5: Research methods and data collection methods of the individual papers

Paper	Research method	Data Collection methods	Sample	Means of improving validity
I	Case study	Theme-based interviews	11 interviewees	Multiple interviewees; multiple interviewers; transcribing of the interviews; review of relevant secondary data (i.e. Web pages); phone discussions with the interviewees during the data analysis
II				
III	Conceptual paper with case examples	Theme-based interviews / discussions	8 interviewees	Multiple interviewees; multiple interviewers; review of other relevant research reports; interviewees commented on the paper before it was submitted to a journal
IV	Conceptual study	No empirical data used	None	No empirical data used

The empirical data in papers I and II was analyzed as follows, to model the inter-firm network dynamics in the region. Each of the transcribed interviews was

analyzed with a profiling technique, where the identified actors and activities were sought afterwards from the data. This made it possible to draw network illustrations of the production, development and innovation networks in the region. The illustrations were presented according to the value network methodology developed by Allee (2002).

In Allee's value network methodology, the goal is to map all the actors to the same picture and then illustrate the flows between the actors. Internal actors are illustrated as circles and external actors as ellipses. Flows between the actors are divided into tangible and intangible flows (Allee, 2002, ; Smedlund and Pöyhönen, 2005). Allee's value network model was described thoroughly in Paper II. After the profiling and drawing the network illustrations, the interview data was analyzed according to the themes of the interviews. More in-depth analysis of the data made it possible to spot the strengths and weaknesses in the functioning of the different network types (see Table 1 in Pöyhönen and Smedlund, 2004).

In empirical paper III, the roles of the intermediaries in production, development and innovation networks were constructed on the basis of insights gathered during the interviews. The transcriptions of interviews were analyzed in a similar manner as in papers I and II, first by creating an overall image of the position of the particular organization in the network and then arranging the transcriptions according to themes. Based on the interviews, three intermediary cases were briefly described in paper III to support the conceptual model of the regional knowledge system and the roles of the intermediaries in the knowledge system at local, regional and national levels. A draft of paper III was sent to the selected interviewees to ensure the validity of the facts presented about the three intermediary organizations

in the paper. Also, some existing reports on the Kuopio region were reviewed during the data analyzing phase (Ståhle, Smedlund and Köppä, 2004).

4 RESULTS

This chapter reviews the results of the study by presenting the main findings of each paper. In the first chapter, the results of the theme-based interviews conducted in the case region are summarized, and the model of production, development and innovation networks is introduced (Paper I). Second, based on the same data with the first paper, the model of regional knowledge system is introduced, and the description of the case region is elaborated in greater detail (Paper II). Third, the results of the theme-based interviews of the regional intermediary study in the Kuopio region are presented to the extent that the case is reported in this study (Paper III). Also the roles and challenges of regional intermediaries are described here, based on the regional knowledge system model. Finally, the last sub-chapter presents the main insights of the conceptual study on the roles of KIBS in the regional knowledge system.

4.1 Paper I: Assessing Intellectual Capital Creation in Regional Clusters

According to this paper, a regional cluster of small firms consists of several overlapping networks of production, development, and innovation. The networks were identified according to Ståhle's concept of mechanic, organic and dynamic knowledge environments. As a conclusion it was stated that when all the types of networks are present in the region, new innovations will be implemented and new innovation ideas will emerge simultaneously, making it possible to combine innovativeness and effectiveness inside the region. An individual actor in a region can be a member of several types of networks at the same time, and the networks may have actors from outside the region as well (Table 6).

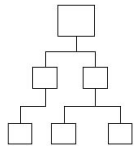
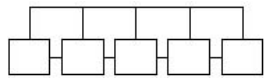
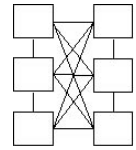
	Production network	Development network	Innovation network
Illustration			
Structure	Vertical - The actors belong to the same order-supply chain	Horizontal - The actors are similar to each other	Diagonal - The actors are heterogeneous with each other – from different fields of business, and private or public organizations
Strategic goal of the network	Efficiency - Lower transaction costs of production by letting the actors concentrate their core competencies	Gradual development - Increase reciprocal learning from other actors with the mechanisms of communication and trust	Innovation - Make possible the innovation of new products, processes or production methods with a combination of different actors, diverse knowledge and resources
Knowledge function	Implement existing knowledge to practice	Share firm-specific best practice and tacit knowledge	Create new knowledge

Table 6: Three ideal types of knowledge networks (Based on Pöyhönen and Smedlund, 2004)

The most important distinguishing characteristic between the three network types is the structure of the networks (Table 6). The production network is a hierarchical buyer-supply chain, governed with legal contracts between the actors. The development network is a horizontal network, meaning that the actors are similar each other, but not direct competitors. In this network, the communication is reciprocal and the relationships are based more on inter-personal trust than formal contracts. Finally, the innovation network is a diagonal network with heterogeneous actors and a structurally sparse network, where the relationships are based on acquaintances and the links are formed across hierarchical boundaries.

The strategic goals of the networks differ from each other substantially. The goal of the production network is to produce the basic products of the company in a

pre-defined manner, and increase efficiency in production by lowering the transaction costs of the members of the chain by letting the actors focus in their core competencies. The goal of the development network is gradual development of existing products, services, processes or production methods in a long term partnership, with the mechanisms of trust and reciprocal communication. The goal of the innovation network is to make possible the innovation of totally new products, services, processes or production methods for the market by combining the diverse and non-redundant knowledge and resources of the participating actors.

The functions of the three networks can be simply summarized as follows: a production network implements existing knowledge into practice, a development network shares existing knowledge, and an innovation network creates new knowledge.

The production, development and innovation networks can be further evaluated according to 1) knowledge, 2) relationships, 3) information flows, and 4) the mode of leadership of the network types, separately. Ståhle uses the same labels of factors when distinguishing between mechanic, organic and dynamic knowledge environments (Ståhle, Ståhle and Pöyhönen, 2003). This provides a tool for the decision makers in a region to define the roles of different actors from the network dynamics point of view. In Table 7, the strengths and weaknesses in innovation, development and production activities in a case regional cluster are evaluated. In the Table, the ideal stage of each of the network type is contrasted with the perceived current stage to identify the strengths and weaknesses in the networks of production, development and innovation.

Table 7: Strengths and weaknesses in the operation of three identified network types within the case cluster (Pöyhönen & Smedlund, 2004)

		Production network	Development network	Innovation network
Knowledge and competence	CRITERIA	Defined, explicit	Experiental, hidden, tacit	Intuitive, potential
	CASE	Actors' core competencies have not been clarified and internal production processes are not as efficient as possible.	Formation of mutual experience-based tacit knowledge has not begun.	Tacit knowledge of diverse actors is combined with theoretical research knowledge to create innovations.
Relationships	CRITERIA	Determined by hierarchy	Reciprocal, seeking consensus	Spontaneous, abundant
	CASE	Agreements between the focal company and subcontractors are unclear.	Lack of trust between some actors hinders collaboration.	Plenty of personal and casual relationships between almost everyone. Researchers are highly appreciated by other actors.
Information flow	CRITERIA	One-way, top-down	Multi-way, horizontal	Chaotic, sporadic
	CASE	Information about stock levels is not circulated to all relevant parties.	There are two separate cliques in the area, which do not communicate directly.	A lot of real-time communication and problem-solving. Quick reaction time to problems arising from entrepreneurs.
Management and leadership method	CRITERIA	Orders, direct use of power	Dialogue, empowerment	Personal networking skills, relinquishing power
	CASE	The raw material acquisition firm has too much power over the manufacturing firms' processes, even though it is not the focal company of the network.	The institutional actor has the leading position. The other actors are not empowered and active enough.	The university's research laboratory coordinates the innovation process in a manner that respects the needs of the other actors.

As presented in Table 7, the production network in the case region had insufficient and poorly structured information flows between the material acquisition firm and the manufacturing firms. In the innovation network, the university's research lab coordinated the innovation process in a way that respected the interests of the private firms in the case region. It was clear that the innovation network functioned best, but the most important network type for this particular cluster was

the development network. Here, the actors shared best practices in production with each other and built social capital, i.e. personal networks, trust and shared norms within the cluster.

4.2 Paper II: Intellectual Capital Creation in Regions: A Knowledge System Approach

In the first paper, the main result was the distinction between production, development and innovation functions in the network context. According to this paper, each network type is suitable for creating a certain type of knowledge-based competitive advantage, and has its own operational logic and effectiveness criteria. The concept and model of a regional knowledge system introduced in the second paper is illustrated in Figure 2. The main argument included in this model is that innovation, development and production networks are not separate in a region, but interlinked. This is due to the fact that a single actor in the region has a role in many networks at the same time.

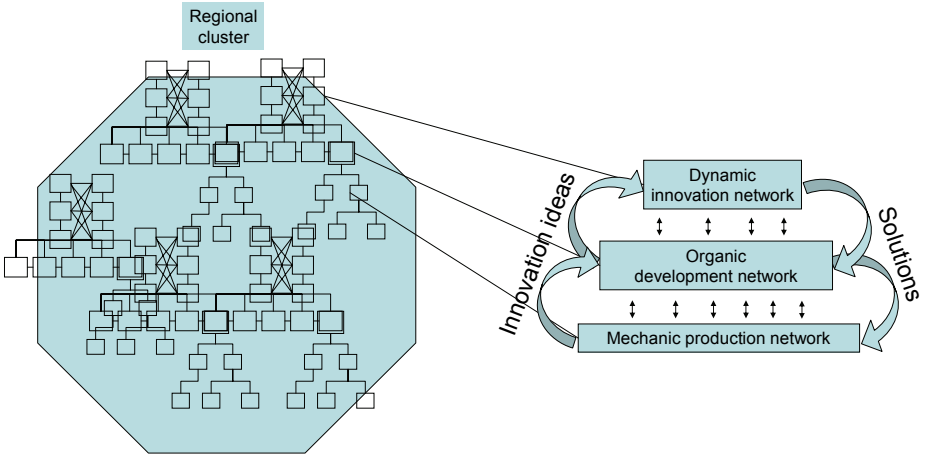


Figure 2: A regional knowledge system (Smedlund and Pöyhönen, 2005, ; Smedlund, 2006)

The regional knowledge system (Figure 2) illustrates the dynamics that exist between innovation, development and production networks in a region. During the interviews in the case region, it was quickly realized that many of the actors had a double or even triple role in the activities in the region. This resulted in redundancies between the networks of innovation, development and production, and allowed the innovation ideas to emerge from the production level to the innovation level – a firm that presented a problem in production that needed to be solved, was not necessarily involved in the innovation process that solved the actual problem. Due to the horizontal nature of the development network, the innovation ideas and also solutions for problems were quickly diffused in the region.

4.3 Paper III: The Roles of Intermediaries in a Regional Knowledge System

According to the view presented in this study, intellectual capital consists of intangible assets that create value, besides tangible assets. Intellectual capital creation includes a whole variety of knowledge processes from replication of existing knowledge and competencies in the production network to radical innovations in the innovation network. In the regional knowledge system, certain actors play an essential role as hubs and nodes; these actors are called intermediaries. The actors in the intermediary role function as hubs of knowledge flows in the region, thus connecting different kinds of actors together and transferring knowledge between the actors.

The third paper identifies the regional intermediaries in a regional cluster. The main contribution of this paper is the creation of a framework to define the roles of intermediaries in a region. Dividing the regional networks according to their intellectual capital functions (~knowledge function), similarly to the first paper – knowledge creation in the innovation network, knowledge transfer in the development network and knowledge implementation in the production network – and combining this with macro, meso and micro perspectives, provides a tool for the decision makers of a region to understand the critical roles of the intermediaries.

The regional intermediaries link local and national levels together with mutual strategy formation and visioning processes. With the functioning of the "triple helix" (Etzkowitz and Leydesdorff, 2000) of public, private and science worlds, the overall strategy of a region can be steered towards the right fields of business. The novel approach introduced in the third paper helps to define the concept of an intermediary in the regional context. It also shows that intermediaries

have a much broader role in a region than just knowledge transfer, and it claims that the roles of the intermediaries differ in national, regional and local levels. The roles of the intermediaries in the regional knowledge system are summarized in Table 9.

Table 8: The roles of intermediaries in the dynamics of a regional knowledge system (Smedlund, 2006)

	National/macro level intermediaries	Regional/meso level intermediaries	Local/micro level intermediaries
Innovation networks	Supporting joint projects of science and private sectors	Keeping the innovation strategies coherent between the actors. Promoting the "triple helix" -type of cooperation.	Trusted third parties. Selection of innovation ideas. Hubs in the transfer of information.
Development networks	Providing national forums to encourage firms in building national and international links.	Forming national and international relations. Forming regional forums for knowledge sharing.	Coordinating forums of knowledge sharing and learning among entrepreneurs. Creating trust and communication.
Production networks	Influencing the laws, taxation and other institutions for a better environment for production.	Attracting anchor tenants to the region.	Knowledge intensive business services to small firms.

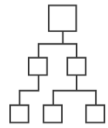
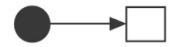
The macro, meso and micro perspectives are a widely used method of categorizing different mechanisms related to a certain phenomenon, particularly by political scientists. The framework created in this paper examines how national, regional and local intermediaries can improve the dynamics of a region, and ultimately improve the competitive capability of a private company located in the region. The empirical findings from the Kuopio region suggest that the roles of regional/meso level intermediaries are highlighted in the creation of dynamics of production, development and innovation. The regional intermediaries link micro-level actors with national, macro-level politics and create strategies and visions for the region that take into account both these aspects. The intermediaries briefly

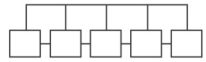
described in the paper were the national Finwell program, the regional Health-Kuopio project, and the local Teknia technology center.

4.4 Paper IV: The Role of KIBS in the IC Development of Regional Clusters

In the fourth and final paper included in this study, production, development and innovation networks are discussed from the perspective of knowledge-intensive business services (KIBS). This paper argues more explicitly than the earlier ones that in each network type, a specific type of knowledge is dominant, although other kinds of knowledge are also needed. In order to produce products efficiently, production networks need first and foremost directly applicable explicit knowledge. Tacit forms of knowledge and conversions between tacit and explicit knowledge are characteristic of development networks, where firms concentrate on step-by-step learning from each others' experiences. In innovation networks knowledge is still to a great extent in a potential form.

The fourth paper highlights the importance of KIBS in the knowledge processes of a regional cluster. Based on the literature reviewed in the paper, it is argued that KIBS convey explicit knowledge to help their clients manage their existing business efficiently. They ensure the growth of their clients' business by transferring best practices, which abundantly involve tacit knowledge. Finally, they help their clients develop new business by acting as sources of potential knowledge and by facilitating the innovation processes. The results of the fourth paper, the roles of KIBS in a regional knowledge system, are summarized in Figure 3.

	Production network	
Illustration	 Nature of the network	 Position of KIBS
Role of KIBS	Providing explicit and timely knowledge. Performing a specified phase in clients' business processes, diagnosing and clarifying clients' problems, providing advice, acting as a change agent	

	Development network	
Illustration	 Nature of the network	 Position of KIBS
Role of KIBS	Intermediating tacit knowledge by sharing experiences and by benchmarking. Helping clients to convert tacit knowledge to explicit and vice versa	

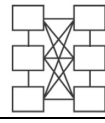
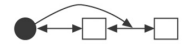
	Innovation network	
Illustration	 Nature of the network	 Position of KIBS
Role of KIBS	Functioning as sources of potential knowledge, as facilitators of the complex process typical of innovation and as brokers between actors	

Figure 3: KIBS and their roles in a regional knowledge system (Smedlund and Toivonen, 2007)

The concluding insight of the fourth paper is that KIBS are important intermediaries in the knowledge processes of a region. When the roles of KIBS are examined in the framework of production, development and innovation networks, further analysis of their functions for regional development can be done.

5 DISCUSSION AND CONCLUSIONS

In this chapter, the main findings of the study are first summarized and discussed, after which the contribution for theory and practice is presented. In the end of this chapter, the limitations of the study are discussed, and finally, suggestions for future research are presented.

5.1 Summary and discussion of the results

The objective of this study was to find out how Ståhle's concept of mechanic, organic and dynamic knowledge environments are related to inter-firm networks in regions, and also to position the concept in the organization theory literature. The research questions were formulated accordingly, to find out whether it is possible to categorize inter-firm networks according to Ståhle's knowledge environments, and to describe the characteristics of these networks on the basis of her model. A separate research question was posed concerning the role of brokering organizations – intermediaries, and KIBS in particular – in the regional production, development and innovation networks.

The first paper laid ground for the analysis of the research topic. Here Ståhle's concept of the knowledge environments of an organization was applied into a network of multiple actors in a regional cluster. In the research process for the first paper, there were already some signals of the importance of KIBS in a regional cluster: a consulting firm had a very strong role in the case cluster. This consulting firm was an actor in the cluster, and functioned as a brokering intermediary in many of the regional networks, as explained in the second paper. Paper number three, which was written to describe the roles of different knowledge intermediaries in a region, further highlighted the role of KIBS as active actors in flows of knowledge

in a region. The fourth paper summed up conceptually the role of KIBS in a region and provided understanding of and discussed the concept of KIBS in conjunction with the knowledge environments of a regional cluster.

It has been argued that in the new knowledge-based economy, the importance of attractive regions is becoming more and more emphasized (i.e. Castells, 1996). Regions and the industrial clusters within them are the main building blocks of successful states. The message brought forth in this study is that a region has to be able to maintain its critical mass of constant innovation, development and effective production in order to prevent slow decay. Only a region that masters these three functions simultaneously is capable of attracting flows of capital, competent employees and multinational companies, and compete against other regions in the world. More concretely, in the second paper it was stated that a regional cluster of small firms has to be able to form a united market force, share knowledge, produce products efficiently and innovate new strengths for the future.

In the research papers included in this study, Ståhle's concept of knowledge environments was applied as a starting point in the context of inter-firm networks. It was found out, however, that even though Ståhle's model functioned as a guiding background concept for production, development and innovation networks, the networks are somewhat different from Ståhle's original idea. The production network can be seen to function with a similar logic as Ståhle's mechanic knowledge environment, but in a development network, the relationships are not necessarily based on consensus seeking, but learning from others. Furthermore, the innovation network seems to have a formal leader, who "owns" the innovation project and manages the network accordingly.

The three-dimensional model of inter-firm networks presented in this study supports the idea that firms use network relationships as strategic assets in order to benefit from them in their business. Production, development and innovation constitute basic tasks that a firm needs to engage in order to survive.

Intentional network building for strategic advantage is the core idea also in the works of Möller et al. (Möller and Svahn, 2003, ; Möller and Rajala, 2007), where they introduce three ideal business "nets" that a focal company can aim to build in order to create value with the current business of the firm, with renewing current business, or with creating new business. The three-dimensional model of inter-firm networks presented in this study provides one framework on how to think about network relationships. To connect the models created in this study with the works of Möller et al., it can be stated that the current business of the firm requires production networks, renewing the current business requires development networks, and creating new businesses needs innovation networks.

This study contributes first and foremost to the research of the Finnish line of Knowledge Management, research into regional clusters and research into KIBS. From the regional point of view, inter-organizational networks have a significant role. This study has shown that the networks of production, development and innovation can be distinguished in the regional cluster of small firms. Together, the three network types form a regional knowledge system, where the role of the intermediaries is to support the networks of production, development and innovation at local, regional and national levels. The highlighted role of KIBS in the regional knowledge system is to intermediate the flows of explicit, tacit and potential knowledge. In the following parts of this discussion chapter, the theoretical contribution and managerial implications of the study are presented in more detail.

5.2 Theoretical contribution

In order not to produce only practical value for managers and policy makers struggling to make sense and manage their firms' or region's network relationships, also theoretical viewpoints were taken into account in this study.

In the theory part of the study, Ståhle's concept of mechanic, organic and dynamic knowledge environments was reflected with the mainstream of organization theory. It was noted that the approach Ståhle has used is important, and it has much in common with the views of knowledge management, the contingency theory, the postmodern theory and systems theories. In the empirical part of the study, Ståhle's concept of knowledge environments was applied in a new context, in inter-firm networks. The networks were then modeled similarly to Ståhle's idea.

Extending Ståhle's view on knowledge environments to inter-organizational networks was possible, because systems theory, which is the starting point in Ståhle's knowledge environments suits well for the inter-firm network context. Systems theories and network theories have much in common and they are both quite different from other organization theories. Both in systems theories and in the network approach, phenomena are studied as wholes, and the focus is on the relationships between actors in the original environment (Johannessen, 1998). Both systems theories and network theories aim to provide a comprehensive explanation of the studied phenomena, not just a single testable hypothesis. It has been said that criticism towards positivism in science during the 1940's was the reason why systems theory was developed in the first place (Mulej, Potocan et al., 2004).

A textbook in strategic management states that a fundamental management challenge of the firms is threefold: 1) to produce existing products or services as

efficiently as possible, 2) to develop the existing products or services, and 3) to create new products or services (Fitzroy and Hulbert, 2005). These management challenges are quite similar to the ones that Ståhle seeks to answer with her knowledge environment concept (Ståhle, Ståhle and Pöyhönen, 2003), and what Möller et al. present as ideal business net types (Möller and Svahn, 2003, ; Möller and Rajala, 2007). The above mentioned management challenges are also in the essence with the main idea of the model of production, development and innovation networks presented in this study.

Table 9 presents the fundamental management challenges of a firm and the empirical evidence of them in team, organization and network levels in the light of this study. Here Ståhle's work on teams from 1998 serves as empirical evidence towards the existence of a dynamic knowledge environment in the creation of new products and services. In her dissertation in 1998, Ståhle concentrated only on exploring the nature of the dynamic knowledge environment, and there is no empirical evidence presented on the existence of Ståhle's mechanic or organic knowledge environments at team levels, despite the fact that the idea is intuitively compelling.

Burns and Stalker's (1961) view of mechanistic and organic management systems gives an answer to the organizational level of examination of how efficient production, development and innovation are carried out. Burns and Stalker (1961) state that the whole spectrum of a firm's actions is managed with either mechanistic or organic management systems. Furthermore, the contingency theory scholars in the 1960s and 1970s (Blau and Scott, 1962, ; Lawrence and Lorsch, 1967, ; Aiken and Hage, 1968, ; Galbraith, 1973) presented convincing evidence of both management structures.

At the organizational level, the contingency theorists' mechanistic-organic dichotomy remains the most plausible theory, despite of some suggestions towards a third, more chaotic system (Scharmer, 2001, ; Snowden, 2002). It seems that the dynamic-type knowledge environment is hard to capture in empirical studies. This might be because there are still quite few dynamic management structures in organizations, or then the empirical non-existence of a dynamic management structure can be due to the research methods used in these studies.

At the inter-organizational level, the framework of the production network, development network and innovation network presented in this study describes the features of relationships between organizations in fundamental management tasks. Ståhle's model of mechanic, organic and dynamic knowledge environment seems to be a good starting point to distinguish corresponding network structures between firms. The concept of current business nets, business renewal nets and emerging new business nets by Möller et al. (Möller and Svahn, 2003, ; Möller and Rajala, 2007) also describe how firms should arrange their network relationships in production, development and innovation (Table 9).

Table 9: The fundamental management challenge of a firm and empirical evidence of management structures at team, organizational and inter-organizational levels of examination in the light of the present study

Fundamental management challenge	***Efficient production of existing products and services***	***Development of existing products and services***	***Creation of new products and services***
Team level	Not Studied	Not Studied	Dynamic *(Ståhle, 1998)*
Organizational level	Mechanistic (*Burns and Stalker, 1961)*	Organic (*Burns and Stalker, 1961)*	
Inter- organizational network level	Production network (this study); Current business net *(Möller and Rajala, 2007)*	Development network (this study); Business renewal net *(Möller and Rajala, 2007)*	Innovation network (this study); Emerging new business net *(Möller and Rajala, 2007)*

The model of inter-organizational production, development and innovation networks is not totally similar with Ståhle's original idea of three knowledge environments, although there is considerable consistency between the functioning

logics of the two. It can be stated that production network functions like the mechanic knowledge environment, with hierarchical roles and well-defined flows of information. Also the development network and organic knowledge environment can be seen as uniform, but the main function of the relationships in the development network is not to seek consensus among the actors, but to share firm-specific business –related knowledge.

The regional innovation network and the dynamic knowledge environment have much in common in terms of knowledge and information flows – in both, the information flow is non-organized, even chaotic. However, in the power dimension, the inter-firm innovation network still has to have a leader, who "owns" the innovation project, and orchestrates the network ties related to this innovation. Therefore, the innovation network differs from the dynamic knowledge environment in the way that the innovation network is intentionally built from the perspective of the focal company (c.f. The emerging value net by: Möller and Rajala, 2007), but the dynamic knowledge environment, by definition, lacks any kind of control, as stated in the theory part of this study.

Theoretically, this study has shown that it is possible to discern three inter-organizational networks in a region by thinking about production functions, development functions and innovation functions separately and illustrating that these networks are fundamentally different from each other.

The main theoretical contribution of this study is that Ståhle's idea of a dynamic knowledge environment that functions similar to the terms of a feminist organization in a "power vacuum" without a formal leader did not prove to be a reasonable way to arrange inter-firm network relationships. Instead, the inter-firm networks seem to be managed and intentionally built by actors that share a common

interest in a goal (see also innovation network case studies by Miettinen, Lehenkari, Hasu and Hyvönen, 1999).

5.3 Managerial and policy implications

The model of three networks - production, development and innovation networks - developed in this study was applied in practice from three perspectives in the research papers. First, the model was applied in the description of the tangible and intangible flows between firms in a regional cluster of small firms in mechanical wood processing industry. Secondly, the model was applied in the policy development of a knowledge-based region to further clarify the roles of intermediaries in the three networks. The third perspective in applying the developed model was a conceptual analysis on the role of KIBS, knowledge-intensive business services, in a regional knowledge system.

The results of the papers increase the understanding of regional clusters and of the knowledge-intensive business service (KIBS) industry from the network point of view, and provide incentives for managers working in these industries. Many managerial challenges can be solved and many dilemmas avoided, when managers are guided to think of their firms' production, innovation and development functions separately, and arrange the network relationships accordingly. The models generated in this study can be used to realize a firm's position and roles in a complex network better and also to orchestrate the network relationships around the firm. In this way, it can be made clear that managing existing business effectively, ensuring growth with existing businesses and developing new businesses all involve a different value creation logic and require different kinds of management tools in terms of network relationships, competencies, information flow and the mode of leadership.

Regional network dynamics are emphasized especially in the peripherial regions of Finland, where agriculture and traditional factory work have become unprofitable due to structural changes in the national economies and globalization. This study, particularly the models presented in the third and the fourth paper, give suggestions to managers and policy makers on how knowledge-based competitive advantage is created and sustained in regions where the future competitive advantage depends on knowledge assets.

From the managerial perspective, the three-dimensional model of inter-firm networks can be used to reduce the inherent complexity of inter-organizational networks into a more manageable level. The overall idea behind the logic of the three-dimensional networks is that there is no one right way to arrange network relationships. Instead, managers in organizations and decision makers in regions should consider the innovation functions, production functions, and development functions separately.

Christensen (1997) considers maintaining the balance between exploitation and exploration as a fundamental dilemma that innovators face (see also March, 1991). Therefore, apparatus to transform an organization from the exploitation mode to the exploration mode are needed. The sense in the classical contingency theory of Burns and Stalker (1961), and also in the evolutionary view of the firm (Nelson and Winter, 1982) is that an organization will become routinized, mechanic and bureaucratic over time, and organic only when facing pressure from the external environment.

As described above, the contingency theory explanation for balancing between exploration and exploitation is to align the management system of the firm according to the level of uncertainty in the firm's environment. There, the organic

management system is good for exploration of new innovations, and the mechanic management system for exploiting existing strengths. It was also noted that there are traces in the knowledge management literature of the third management system in addition to mechanic and organic - Ståhle labels this third management system a dynamic knowledge environment, and the postmodern organization theorists label it as a feminist organization. There is, however, a well articulated inconsistency in the reasoning logic of whether this third management system exists or not, because in order to be called an "organization" there must be a power component present, whether the power is hierarchical in a mechanic, or peer pressure in an organic management system. This is contradictory to Ståhle and the postmodern organization theory, which state that the third management system is an unobtrusive "power vacuum".

Although the dynamic knowledge environment may be non-existent as an organizational structure, there is evidence of such systems in R&D teams, as Ståhle states in her dissertation (1998). A good example of a dynamic team where a kind of "power vacuum" is created purposefully, is a brainstorming session where people forget the hierarchical positions of others. In the Finnish culture, a similar thing happens in pre-Christmas parties, and in Japan the power vacuum is institutionalized when bosses go drinking with their subordinates regularly after work.

The managerial conclusion of this study is that there is no such thing as a dynamic knowledge environment as an organizational structure. The role of the dynamic knowledge environment that functions with a postmodern, power relinquishing logic is being an ideology. This ideology is a vehicle for transformation when the organizational structure needs to be changed from a mechanistic structure towards a more organic structure without external turbulence.

Therefore, dynamic knowledge environments, and consequently innovation networks should be purposefully created and encouraged by the management of a firm to steer the organization away from a routinized and mechanistic operation logic (Figure 4).

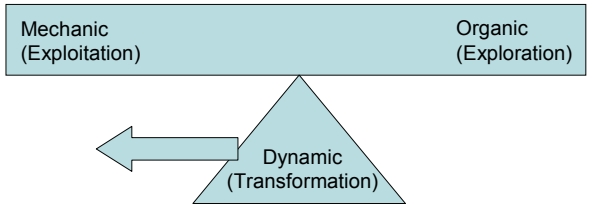


Figure 4: Dynamic knowledge environment as a vehicle for transformation[1]

Figure 4 illustrates the role of the dynamic knowledge environment as an internal apparatus to force the organization away from its routines. By purposefully creating an environment of spontaneous relationships, chaotic information flow and relinquishing of power, it is possible to tip the organizational structure more from a mechanistic, exploitative mode towards an organic, innovative and exploration mode. Supposedly, after creating purposeful turbulence with management efforts, the organization will find its previous inertia and routines, and organize back to its equilibrium between mechanic and organic.

The concept of the three knowledge environments and production, development and innovation networks can also be linked to the analysis of innovation processes, particularly if these processes proceed in clear stages (Figure 5). The innovation network functioning in the sense of a dynamic knowledge

1 Idea adapted from Mr. Thomas Hill, Genentech, Inc., a presentation at a service innovation seminar at UC Berkeley, School of Information Systems, November 9, 2006.

environment can be used purposefully in the innovation process to create input for a more systematic R&D process. The "rate of failure" in terms of ideas presented and actual products innovated can be purposefully increased. It is not uncommon to have thousands of ideas that actually only produce tens of products for the market - therefore, the more ideas produced in the invention phase of the innovation, the better. This is the functioning logic of the funnel-type of product innovation process, where innovation ideas enter the funnel and are then terminated in the beginning or developed further (Figure 5).

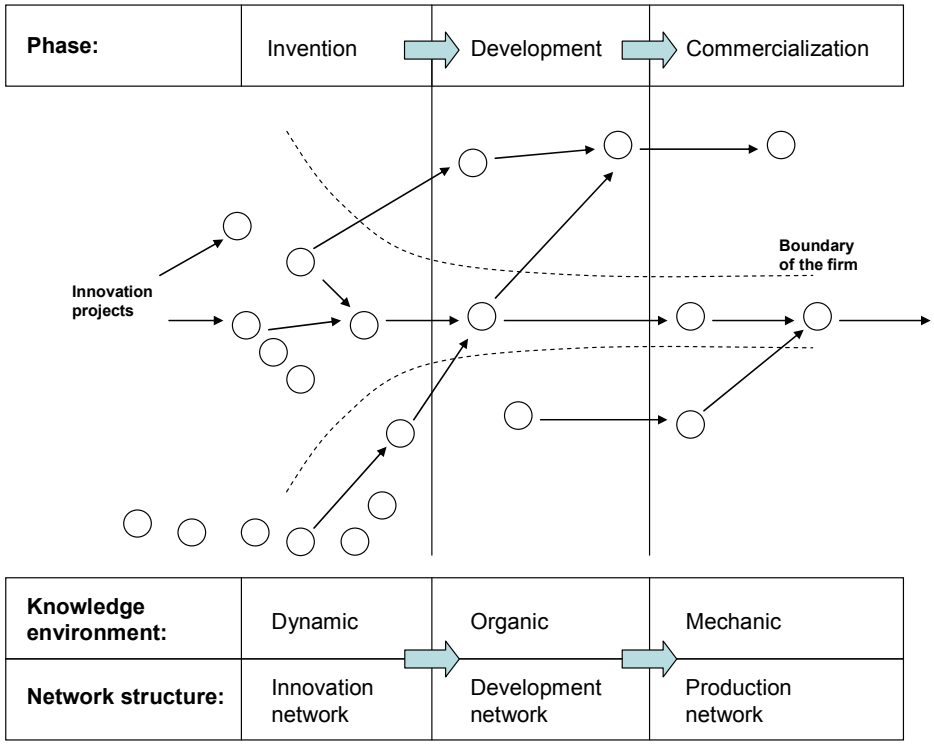


Figure 5: The roles of knowledge environments and production, development and innovation networks in conjunction with the management of a product innovation process in the Open Innovation paradigm (Chesbrough, 2003)

After producing a vast amount of ideas, the development network, resembling the organic knowledge environment can be used in the R&D phase of the

innovation process. There, according to the idea of open innovation (Chesbrough, 2003), the R&D organization must be able to not only work on the innovation project, but also be open to the environment in case of possible innovation project spin-offs and take-ins. Finally, in the commercialization phase, the production network that functions with the logic of the mechanic knowledge environment can be used to produce the pre-defined product as efficiently as possible, according to the industrial organization logic.

In the inter-organizational context, which was the main concern of this study, the main managerial implication is that a firm that simultaneously masters all three networks - production, development and innovation - is more likely to reach a sustainable competitive advantage compared to a firm that masters only one or two tasks. This could explain why so many excellent companies are actually performing quite poorly. In the case of commercial airlines, for example, an established airliner can be excellent in efficiently moving people and goods between locations, still making minus profit and losing competition to low cost carriers. This kind of "cost trap" is common also in industrial products, especially among small and medium sized businesses, where the rise in material costs can bankrupt the company, even though the books of orders are full for the next couple of years. In the light of this study, these kinds of companies fail to build successful innovation networks and concentrate only on optimizing production systems, which leads to critical failures in sensing the changes in their business environments.

5.4 Limitations

The research method in the empirical parts of this study was an inductive case study. The primary data was gathered with theme-based interviews. Previous written

material, i.e. earlier research reports, newspaper articles, internal memos and internet sources about the cases were used to make sense of the cases, but were not all fully referenced in the research papers.

The limitations of this study are related to the case study methodology, and particularly to the data gathering and generalizability of the results. In Papers I and II, the data was gathered rigorously to include every actor in the regional cluster of small firms. It must be noted, however, that the case region in Papers I and II had some special characteristics. It was an intentionally built agglomeration of small firms located relatively far away from the main places of economic activities in Finland. On one hand, this was a good thing because the region was easily accessible and observable for researchers, but on the other hand, the network dynamics in this particular case could differ significantly from those regions that involve more actors and are born with evolutionary mechanics without government intervention.

The Kuopio region that was used as empirics in Paper III is also special in the sense that it is located in a sparsely inhabited, peripherial region of the EU, and as described above, it also has strong government involvement, the public sector being the biggest employer in the region. Furthermore, besides the geographical and political characteristics of the Kuopio region, which might influence the generalizability of the case study in Paper III, there were some inconsistencies in the process of data gathering for Paper III. Due to the small scale of the research project, the researchers had a limited time to interview actors in the region (two days), and it was possible to conduct only 8 interviews. Also, the theme-based interview questionnaire was not fully followed in every interview, and some of the interviews remained at the level of informal discussions. Because of these limitations, the

empirical part in Paper III was chosen to be presented as case examples of regional intermediaries that would enrich the conceptual insights presented, rather than constitute an inductive, data driven research. However, even this small scale empirical research in Paper III showed that the concept of a regional intermediary is viable, and it is possible to distinguish the different roles of intermediaries with a relatively small set of empirics.

5.5 Further research

The main result of this study, as described above, is a new perspective into inter-organizational networks in a region. Based on the case examples in the study, it is possible to argue that there definitely is no one, right network model that could be used to create and sustain competitive advantage. Instead, there are many different network types that contribute differently to the value creation, which all require different managerial initiatives. The three-dimensional network model presented in this study reduces the complexity of the concept of networks into a more understandable and manageable level. This builds ground for a novel framework for future research on inter-organizational networks and their management.

A natural path of future research would be to take the concept of production, development and innovation networks to a larger region and replicate the research done at a bigger scale. The research process and the results would bring forth the knowledge dynamics of a region and benefit the decision makers who have the power to influence the regional structures of production, development and innovation.

A second possible topic of future research comes from the third paper presented in this study. The framework of the roles of regional intermediaries at

local, regional and national levels is clearly applicable, and gives a ready-made framework to clarify the roles, challenges and tasks of the regional knowledge intermediaries further. As this specific study in the present work was not as rigorous as one could desire, new studies are especially welcome.

As discussed above, the three tasks – production, development and innovation - are fairly easy to discern at the network level, but the organizational level is more problematic due to the strong evidence towards the dichotomous mechanistic versus organic paradigm in the contingency theory (Burns and Stalker, 1961). Contingency theories were developed during the industrial era, but they are still considered as viable theories of management systems and structures of organizations. More research should be conducted to find out whether organizational structures similar to Ståhle's dynamic knowledge environment exist or not. On the basis of the present study, a hypothesis can be made that they do exist, but only in situations when the organization is in transition from mechanistic to organic.

One more natural step of future research would be to test the concepts of production, development and innovation networks at the intra-organizational level. This kind of research could make an important contribution scientifically and also practically. It would be particularly interesting to see how the different network manifest themselves in human capital-intensive industries that rely heavily on knowledge both as a resource and as an outcome.

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APPENDIX 1

Paper I. Pöyhönen, A. and Smedlund, A. (2004). "Assessing Intellectual Capital Creation in Regional Clusters." Journal of Intellectual Capital 5(3): 351-365.

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Assessing intellectual capital creation in regional clusters

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Keywords *Intellectual capital, Knowledge management, Information networks, Systems theory*

Abstract *To provide a theoretical model of the dynamics of intellectual capital creation in regional clusters and in inter-organizational networks. The model has been constructed on the basis of earlier studies, especially system's theoretical interpretation of organizations as knowledge systems, and then applied to the examination of a regional cluster operating in the mechanical wood processing industry in Eastern Finland. Intellectual capital in regional clusters is created by three main knowledge creation activities, each of which corresponds to a specific type of an inter-organizational network. First, production networks aiming at efficiency and replication should function according to mechanistic system logic, focusing on the enactment of rules and regulations. Development networks aiming at continuous incremental development, on the other hand, are most successful when adhering to an organic mode, which emphasizes participation, tacit knowledge sharing, dialogue and mutual adjustments. Finally, innovation networks seeking to produce new intangible assets benefit from a dynamic systems model, where entropy and spontaneous knowledge flows form the basis for mastering radical change. Model should be applied to more cases to ascertain its validity. Provides means for understanding, assessing and managing creation of knowledge-based value in inter-organizational collaboration. Addresses three gaps in existing research: it focuses on regional intellectual capital; it examines the ways in which intellectual capital is created as a dynamic process; it provides means for understanding the future potential of a region.*

Introduction

There exists a widespread agreement that the differences in the competitiveness of organizations are based first and foremost on their intangible resources and capabilities to extract value from them (Drucker, 1988; Prahalad and Hamel, 1990; Quinn *et al.*, 1997; Teece *et al.*, 1997). Moreover, it has been noted that intellectual capital is a significant source of competitiveness on national level (Bontis, 2003; Edvinsson, 2002; Edvinsson and Stenfelt, 1999). According to the logic of the knowledge-based economy also the success of a region depends essentially on the ability of its actors to employ, circulate and create knowledge. In other words, the ability for intellectual capital creation is a crucial determinant for regional competitiveness.

Nevertheless, most of the research on intellectual capital has focused on individual companies rather than on more macro-level units such as regions or nations (Bontis, 2003). Furthermore, even though there are several theories about the composition of intellectual capital, as well as measurement frameworks for assessing the actualized, already existing intellectual capital (Edvinsson and Malone, 1997; Kaplan and Norton, 1992; Sveiby, 1997; Stewart, 1997; Roos *et al.*, 1998; Sullivan, 1998), there is relatively little knowledge about "the ways in which intellectual capital is created

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and maintained as a dynamic process". Most of the theories of intellectual capital treat organizational knowledge as a static package rather than as a dynamic capability for knowledgeable action (Spender, 1996; Nahapiet and Ghoshal, 1998; Orlikowski, 2002). However, in order to understand and develop the future potential of an organization or a region, it is necessary to look at the ways in which intellectual capital is created (Teece *et al.*, 1997; Edvinsson, 2002). In this paper, we present a model of intellectual capital creation within regions, and demonstrate how it can be used in assessing and developing regional intellectual capital. In our approach, intellectual capital is viewed as an ongoing, emergent process, and the focus is not on the intangible assets *per se*, but on the capability to leverage, develop and change them.

In practice, regional competitive advantage is created in the networks that operate within the region (McDonald and Vertova, 2001). In this paper, we approach regional intellectual capital development by examining inter-organizational networks and their dynamics within a regional cluster. Regional clusters are collaborations of several organizations within the same geographical area and industry (Porter, 1990). By an inter-organizational network we mean the totality of the relatively constant, intentional and goal-directed collaborative arrangements between several organizations. Viewed as a whole, an inter-organizational network contains the actors (individuals and organizations) belonging to the network, the relationships between them, the resources flowing in the relationships, as well as the coordinating and steering mechanisms of the network (Seufert *et al.*, 1999).

Inter-organizational networks and collaboration between organizations have become important and widely spread phenomena in the modern society. Manuel Castells, a Sociologist, (1996) calls the currently emerging societal structure network society, while according to the Economists Shapiro and Varian (1998), we live in a network economy, where success is based on understanding the logic of relational networks and the ability to use them for creating value. The globalization of competition, advances in technology, and the increasing rapidity and nonlinearity of change have made it necessary for all types of organizations to engage in collaborative arrangements that complement their own core competences (Powell *et al.*, 1996; Inkpen, 1996). In a large part of industries, organizations nowadays use collaborative arrangements in all phases of the production process from research and development to manufacturing and marketing. In fact, collaboration has been called the metacapability of the 21st century (Miles *et al.*, 2000). This poses new challenges and requirements for the management and the development of both organizations and regions. In this paper, we present a framework that can support regional competitiveness by providing means to meet these challenges.

Intellectual capital creation in inter-organizational networks

With the dawn of the knowledge era, new determinants for competitive advantage have been proposed. In the current discussion of intellectual resources, three main themes have been brought up: intangible assets, the dynamic capabilities to create and modify these assets, and the social relationships in which the knowledge processes take place. Each of the approaches implies a different conception of knowledge in organizational contexts. When knowledge is framed as an intangible asset, it is understood as a possession or property of the organization, typically consisting of investments and intellectual property rights or human, structural and customer capital

(Bontis, 1999; Brooking, 1996; Sveiby, 1997). The dynamic capabilities approach, in contrast, views knowledge as an ongoing, emergent process, and focuses not on the intangible assets *per se*, but on the capability to leverage, develop and change them (Edvinsson, 2002; Eisenhardt and Martin, 2000; Ståhle *et al.*, 2004; Teece *et al.*, 1997). Finally, in the relational approach, knowledge is understood as a socially constructed and shared resource, and the focus is on the characteristics of the social relationships connecting the various actors and the social capital embedded in them (Brown and Duguid, 1991; Lave and Wenger, 1991; Lesser and Prusak, 1999; Nahapiet and Ghoshal, 1998). Studies on intellectual capital tend to emphasize the intangible assets view of knowledge, while the latter two viewpoints are more common in knowledge management literature. We argue that in order to understand value creation in the knowledge economy, it is necessary to take all the three facets into account.

To understand how intellectual capital is created, the dynamic and social facets of knowledge are especially pertinent. They are particularly important when the focus of interest is not on identifying and evaluating the intangible assets possessed at the moment, but on analyzing how the network is operating as a relational system, where the actors are involved in the exchange and mutual development and innovation efforts, and how this operational mode influences its capability to create intellectual capital.

In this paper, we look at the intellectual capital of regions by differentiating three modes of intellectual capital creation and examining the requirements that each of these pose for the functioning of networks within the region. Our analysis of intellectual capital creation is based on systemic interpretation of the functioning of inter-organizational networks. By a system we mean a complex network of interrelationships, which are demonstrated through communication and actions between the elements of the system. Essentially, the systemic view emphasizes connections between the elements of the system, rather than the attributes of the elements *per se*.

The systemic view has been used to describe a large variety of phenomena, ranging from thermodynamics to human behavior. Accordingly, even the definitions of what constitutes a system tend to vary a great deal depending on the point of departure of the author (Luhmann, 1995; Ståhle, 1998). Based on this lack of coherence in system-based views, Ståhle (1998) and Ståhle *et al.* (2003) have discerned three paradigms underlying system theoretical studies, which can be labeled as mechanistic, organic and dynamic. The three paradigms actually depict different system types, and imply different criteria for the effective functioning of the system. The mechanistic paradigm is based on Newtonian physics and focuses on universal laws, rules and regularities, and considers systems as stable and closed. The organic paradigm, in contrast, regards systems as open and evolving, and emphasizes interaction with the environment and internal regulation via feedback processes. Finally, the dynamic systems paradigm focuses on the non-linear and unpredictable behavior of systems, and on their internal dynamics for producing change. Ståhle and her colleagues (Ståhle and Grönroos, 2000; Ståhle *et al.*, 2003) have applied this idea to organizations and constructed a model of organizations as three-dimensional knowledge systems, consisting of mechanistic, organic and dynamic knowledge environments.

We apply this framework to the level of inter-organizational networks and suggest that networks can be classified according to their tasks in intellectual capital creation,

or, in other words, the basic knowledge creation activity that they conduct. We also claim that each system type represents a distinct mode of intellectual capital creation, has different effectiveness criteria and serves different purposes in the strive of a region towards competitive advantage.

The first way in which intellectual capital is created in inter-organizational networks is through the efficient implementation of the network members' knowledge for the production and stabilization of routines. We propose that the network arrangements aiming at efficiency and replication should function according to a mechanistic system logic, focusing on the enactment of rules and regulations. Second, intellectual capital can be created by mutual learning between the participating organizations. A network whose aim is to transfer knowledge between its members and thus, support their continuous incremental development is most successful when adhering to an organic mode, which emphasizes participation, tacit knowledge sharing, dialogue and mutual adjustments. Finally, intellectual capital can also be created in a network by jointly producing new, previously non-existing knowledge. Networks seeking to produce innovations such as new products benefit from a dynamic systems model, where entropy and spontaneous knowledge flows form the basis for mastering radical change. In sum, intellectual capital is produced by implementing and developing the intangible assets, knowledge and competencies already existing within the network, and by creating totally new intangible assets, knowledge and competencies.

The three modes of intellectual capital creation described above can be connected with distinct network types, which we call production network, development network and innovation network. These will be described in more detail below. Several authors have proposed similar classifications of inter-organizational networks, even though we could not locate any earlier studies categorizing networks based on their system dynamics or knowledge focuses. For example, Nooteboom (1999) describes networks as either vertical, horizontal or diagonal. According to him, vertical structure depicts networks that are based on subcontracting and include both customers and suppliers. Horizontal networks, on the other hand, are co-operative arrangements among firms in the same field of business, and diagonal networks consist of firms from several different lines of business. Also the classification of Koivisto and Ahmaniemi (2001) resembles our model. They identify three network types:

(1) a vertical production network that coordinates and develops network activities;

(2) a horizontal learning network, which aims at sharing knowledge between the participants; and

(3) an innovation network aiming at a combination of diverse resources and knowledge.

Production network

In a production network, the flows between the actors mainly consist of physical products and money. All the information flowing between the actors are related to production, e.g. information about stock levels. The production network can be dominated by a single central actor, or it can be coordinated by a broker outside the actual network setting. The actors in the production network do not necessarily know all the other actors involved. The relations in the network are based on dyadic

relationships between an actor of the network and the dominating actor or the broker. The network structure is hierarchical. An essential characteristic of the production network is that it serves as an effective way to produce a pre-designed product or service.

Ideally, a production network functions as a mechanistic machinery (Ståhle and Grönroos, 2000), which efficiently produces permanent quality and achieves pre-determined goals. In order to do this, the network needs clear and coherent rules and regulations. Thus, the essential knowledge of the production network should be in an explicit form and circulated to all relevant actors. It is enough that the information flows in one direction, mostly top-down, because discussion and elaboration open up the possibility for modifications, which in this type of network are unwanted and mere hindrances to its effectiveness. This kind of operational mode is facilitated by centralized control and a hierarchical structure.

Japanese Keiretsu is an example of a production-based network. Keiretsu is a vertical group of small companies that is dominated by a large firm, and it is structured in a pyramid form. The goal of Keiretsu is to provide regular supply and steady prices for the dominant member. Keiretsu has been used extensively as an example in network literature, and it has even been cited as one of the explanations for the Japanese post-war success (Dennis, 2000). The production network model of western countries is somewhat different from the Keiretsu model. In the west, the dominating actor tends to have dyadic relationships with several subcontractors. The subcontractors are chosen by the dominating firm on the basis of their individual offers rather than on cartel arrangements (Luomala *et al.*, 2001).

The cooperation between the dominating focal company and its network partners can be called strategic, because the networks are used purposefully to achieve competitive advantage (Jarillo, 1988, p. 32). The focal company is likely to maintain long-term relationships with its specialized partners, because long-term relationships create trust and reduce transaction costs (Jarillo, 1988, p. 39). The focal company also tends to transfer some of the risks involved in the production to its partners (Paija, 1999, p. 39). From the supplier's point of view, big customers are strategically essential. Belonging to a production network is especially important for suppliers that have low innovation capabilities, because they have the weakest capacity to keep up with technological and market development (Kautonen *et al.*, 2002, pp. 9-10).

Development network

A development network is a network construct that can be used for joining firms in a regional cluster, even if they do not have cooperation in the production function. The actors in a development network can even be competitors. The goal of a development network is to spread information that benefits all the actors individually. By learning the best practices of others, firms can achieve a higher level of efficiency. In a regional setting, a development-focused network can improve the actors' performance in, for example, marketing or acquisition of venture capital. An essential characteristic of the development network is its knowledge sharing nature.

The development network resembles Ståhle and Grönroos (2000) account of the organic knowledge environment within organizations. The continuous development maintained in the organic environment is based on tacit knowledge, lateral two-way information flows, double contingent relationships, and empowering leadership.

Similarly, in the development network the actors' capabilities develop over time as they learn from each others' experiences. The relations are reciprocal and based on trust rather than on detailed formal agreements. Co-operation is conducted in everyday casual communication between the actors, and active participation is encouraged. There is no single dominant actor in the development network. However, there can be a coordinator that supports knowledge sharing.

A development network is formed horizontally between the actors. In a horizontal network consisting of competing organizations, there is a chance of a "zero-sum game", where one actor's profit is another actor's loss. Collaboration between competing firms cannot usually happen lest the firms are willing for some kind of integration or merging with each other. In contrast, if the products and markets of the actors are different, knowledge sharing can be achieved without the need to unite. (Nooteboom, 1999, p. 6). Besides knowledge sharing, the actors can form a development network around a shared resource that benefits all the participants (Vesalainen, 1996, pp. 19-23).

One example of horizontal networking between competitors is the One World alliance formed by several airlines. The goal of the One World alliance is to provide competitive advantage for the participants by improving the coordination of flights and by providing them a uniform brand, which is then used in marketing. According to Pirnes (2002), this kind of model improves the individual capacities of each actor and provides synergy benefits by combining the diverse knowledge of the actors.

Innovation network

In an innovation network, new solutions for problems are developed consciously in cooperation of the actors involved. The main goal of an innovation network is to create new knowledge. The relationship structure in the innovation network is diagonal. This means that the actors participating in the innovation network are from different production chains and from different industries. An innovation network can also tie together institutional and entrepreneurial actors.

The innovation network should master creation of knowledge that is novel for everyone in the network. This requires that there is room for creativity and that the operational mode of the network is not too structured and formalized. Along the lines of Ståhle's (Ståhle and Grönroos, 2000) description of a dynamic knowledge environment, potential and intuitive knowledge, even self-transcending knowledge (Scharmer, 2001), should be highly valued. The relations are informal and rich and the actors' capabilities are multifaceted. The network is ideally lead by the actor who is most suitable for coordinating the resources and knowledge, i.e. authority migrates according to expertise rather than position in the hierarchy.

The creation of innovations requires highly specialized knowledge from different fields, and thus, networks are a fertile soil for the creation of radically new knowledge. In fact, it has been argued that most of new knowledge creation happens in networks, not within organizations (Powell, 1998; Powell *et al.*, 1996; Miettinen *et al.*, 1999). For example, Miettinen *et al.* (1999) conducted extensive longitudinal studies of several Finnish innovation processes from the network point of view. One of the innovations was the cholesterol-lowering margarine Benecol, which was developed for eight years in collaboration between actors representing such diverse fields as the wood processing industry, public health services, food industry and universities.

Lundvall and Borrás (1998, p. 109) define an innovation network as "an explicit organizational co-operation and exchange arrangement aimed at the development of knowledge, products or services." In their opinion, the regional dimension of the innovation network is crucial for three reasons. First, the creation of human capital requires geographical proximity. Second, geographical proximity increases the possibility for both casual and planned meetings as well as spontaneous and structured information exchange, and thereby increases the emergence of formal and informal networks. Third, synergies can emerge from the shared cultural, psychological or political perspectives of those engaged in the same industry within the same economic space or region.

Summary of the network types

The characteristics describing the different network types in a regional cluster are shown in Figure 1.

One of the classical problems in business economics and organizational theory is how to combine innovativeness and efficiency. Traditionally, these have been perceived as contradictory and mutually excluding (Sutcliffe *et al.*, 2000). For example, March (1991) has portrayed organizations as focusing either on exploration, i.e. search for new knowledge, or exploitation, i.e. application of existing knowledge. According to him, these processes are contradictory, and an organization should not attempt to accomplish both. Our position on this issue is that as the various modes of intellectual

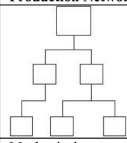
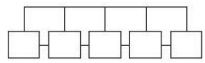
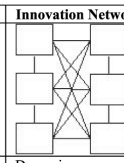
	Production Network	Development network	Innovation Network
Illustration			
Nature of the system	Mechanical	Organic	Dynamic
Aim	Effective production of a pre-designed product for the focal company	Sharing knowledge between actors. Shared knowledge benefits the actors individually	Constant creation of innovations and new knowledge
Structure	Vertical	Horizontal	Diagonal
Relationships	Determined by hierarchy	Reciprocal, seeking consensus	Spontaneous, abundant
Social connections in the network type	Not many. Interaction is restricted to production-related matters	Every organization (actor) is represented by a person. These representatives keep up personal relations with each other	There are a lot of connections between the firms' personnel
Duration of co-operation	Long-term. Dyadic relations are important investments	Can be either long-term or short term	Co-operation sustained until innovation is complete
Knowledge and competence	Defined, explicit	Experiental, hidden, tacit	Intuitive, potential
Information flow	One-way, top-down	Multi-way, horizontal	Chaotic, sporadic
The role of communication in the network	Clear rules and regulations. Possibly a shared ERP system	Casual interaction between people in a specific region	A lot of entropy, i.e. excess communication and information
Importance of location	Subcontractors can be located geographically anywhere as long as logistics and information flows are functioning	Requires face-to-face communication	Regionality is pronounced in the development of innovations, but some actors can still be located geographically elsewhere
Management and leadership method	Orders, direct use of power	Dialogue, empowerment	Personal networking skills, relinquishing power

Figure 1.
Three ideal types of knowledge networks

capital creation operate by different logics, a given network should choose which one to specialize on and then organize its operations accordingly. However, when the regional cluster is viewed as a whole, it should include all types of networks, operating concurrently. Naturally, there can be several networks of each type within the cluster, and an individual firm can be a member in several networks at the same time.

Several authors (Benner and Tushman, 2003; Teece *et al.*, 1997; Weick, 1998) have recently proponed the view that a given organization should be able to engage in many kinds of change processes or knowledge creation activities simultaneously. For example, Teece *et al.* (1997, p. 515) argue that competitive advantage requires both exploitation of existing internal and external firm-specific capabilities and development of new ones. We have taken this thinking to the level of regions and argue that in order to create competitive advantage, a regional cluster is likely to require all three types of networks, because each of them is apt for a particular knowledge-based activity: an innovation network is needed for the creation of new knowledge, a development network for the dissemination of knowledge and best practices, and a production network for implementing knowledge into practice efficiently. Thus, in our view, the intellectual capital creation of regional clusters encompasses the whole spectrum of knowledge-based activities from the execution and replication of the existing knowledge to quantum-leap innovations. With this set of thinking, the capacity of the regional cluster to create intellectual capital can be maximized and its ability for continuous self-renewal secured.

Methods

The empirical case examined in this research is regional and relatively young cluster of small firms that are located in the eastern part of Finland. The firms in the cluster operate in the mechanical wood processing industry, which is a relatively traditional field of business dominated by few large corporations. At least in Finland, there has been very little network-based co-operation in this particular industry, and almost all previous attempts to form network arrangements have failed (Passila, 1998).

The case cluster is a collaboration bringing together several regional actors: local entrepreneurs, venture capitalists and institutional actors. The main institutional actors are several local municipalities and a local university. Compared to their overall budgets, the local municipalities had invested heavily in the formation of the cluster.

In March 2003, there were eight actors involved in the cluster. The number of actors is likely to increase in the following years. All the actors are situated within a couple of hundred yards from each other in the same industrial area provided by local municipalities. Four of the actors are small manufacturing firms that manufacture end products to the market. All the manufacturing firms have slightly different raw material requirements and products, so they are not direct competitors with each other. One of the actors is a service provider that takes care of one phase of the production of the manufacturing firms, and the other actors is owned jointly by all the municipalities in the region, and handles raw material acquisition for the manufacturing firms. Finally, one of the actors rents labor and machinery to all the other actors in the area. There is also a university's research laboratory in this industrial area.

As regional competitive advantage is created in networks operating within the region, we studied the collaborative arrangements within the cluster. The inter-organizational networks were examined according to the socio-centric

perspective, i.e. from the viewpoint of the whole network, not from the actor-centric perspective of an individual organization (Adler and Kwon, 2002).

We made several visits to the industrial area between December 2002 and March 2003, and collected data by theme-based interviews ($N = 11$) which included representatives from all the actors involved in the cluster. The interviews lasted for about one hour each, and were all recorded on tape and transcribed.

The interview themes were constructed on the basis of the knowledge environment theory by Ståhle and Grönroos (2000) and Ståhle *et al.* (2003). In this theory, four basic factors are used for defining the weights between mechanic, organic and dynamic knowledge environments. These factors are:

(1) knowledge and competence;

(2) relationships;

(3) information flow; and

(4) management and leadership method.

The intellectual capital creation process in different network types was thus studied from the viewpoints of:

(1) what kind of knowledge and competence the actors had;

(2) what the nature of relationships between the actors was;

(3) how information was transmitted; and

(4) how these processes were managed and coordinated.

With these themes, we were able to discern the systemic logic according to which the various types of networks within the cluster were functioning.

In addition, the interviewees were asked either to draw a graph of how they perceive the network, and verbally explain the connections and flows between the actors, or to comment on a graph made by the researchers. Based on these graphs and the related explanations, an overall presentation of the cluster and the three network types identified within it were modeled by using Allee's value network approach model (Allee, 2000, 2002).

Results

When the cluster was examined as a whole, three main strategic goals were identified:

(1) decreasing transaction costs;

(2) formation of a single, united market force to compete against big corporations in the industry; and

(3) improving the capacity to continuously innovate new products, technologies and processes.

Based on the interviews and the graphic illustrations, we were then able to identify three distinct inter-organizational networks within the regional cluster, namely production, development and innovation networks. (Larger clusters are likely to include several networks of each type.) Each network type had its own objective in the area. The objective of the production network was to bring cash flow to the area by producing pre-designed products as efficiently as possible. The aim of the development network was to distribute knowledge between the actors, and the goal of the

innovation network was to create new knowledge. Thus, these network types functioned as knowledge implementing, knowledge transferring and (new) knowledge creating levels in the cluster.

In order to achieve its main strategic goals, the cluster needed all three types of networks. The production network was needed to lower transaction costs, the development network for forming a single marketing force, and the innovation network for developing new products and methods. Together the three networks formed a cycle, where the innovations produced in the diagonal innovation network were transferred via the horizontal development network to improve the performance of the vertical production network. On the other hand, when an actor noticed a weakness in their production process, this trigger was passed on to the innovation network by using the development network in between.

Allee's (2000, 2002) value network approach model was used to illustrate the tangible and intangible flows between the actors. With this method it was easy to see that in the different network types the flows between the actors were different and consistent with the hypothesized model. In the production network the flows consisted of products, money and production-related information, whereas in the development network the only flow between the actors was knowledge. In the innovation network the flows were mainly knowledge, but also resources, money and products (Figure 1).

Figure 2 shows an example of the types of tangible and intangible flows in the development of an innovation within the cluster. Along the principles suggested by Allee (2002), internal actors (actors in the same industrial area) are presented by circles, external actors (actors outside the industrial area) by ovals, intangible flows are dashed lines, and tangible flows are solid lines. The direction of the flow is presented with an arrow. In this case one of the manufacturing firms in the cluster noticed problems in the quality of the finished products supplied by the service provider. The manufacturing firm notified the research laboratory about the problems, which then took on the task of solving the problem. The issue was solved in collaboration with the entrepreneurs, with funding from several sources. In the process the research laboratory combined

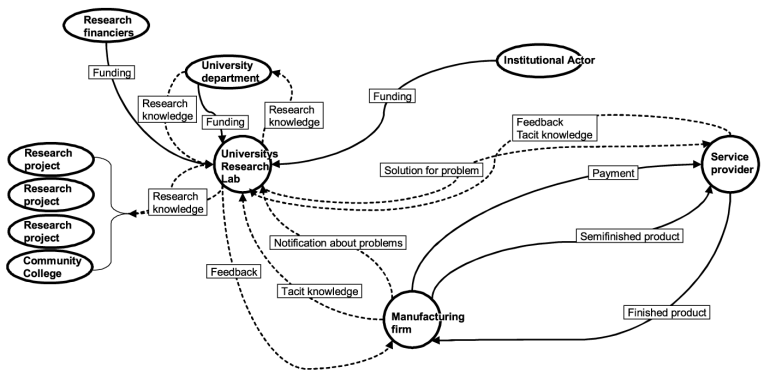


Figure 2.
An illustration of the innovation network

the tacit knowledge of the entrepreneurs with its own research knowledge, and took advantage of the possibility for quick experimentation of possible solutions on-site.

By applying the criteria of systemic functioning of the three network types, it was possible to find the strengths and weaknesses in the operation of the case cluster. Overall, the production network had insufficient and poorly structured information flows between the material acquisition firm and the manufacturing firms. The innovation network functioned best, but the most important network type for this particular cluster was the development network. Within the development network, the actors shared best practices used in production with each other and built social capital, i.e. personal networks, trust and shared norms (Putnam, 1995), within the cluster. The main results of this analysis are summarized in Table I.

Conclusion

This paper examined regional clusters as dynamic knowledge-based systems. On the basis of the literature and the empirical case, it was argued that regional clusters can be

Production network		Development network	Innovation network
Knowledge and competence			
Criteria	Defined, explicit	Experiental, hidden, tacit	Intuitive, potential
Case	Actors' core competencies have not been clarified and internal production processes are not as efficient as possible	Formation of mutual experience-based tacit knowledge has not begun	Tacit knowledge of diverse actors is combined with theoretical research knowledge to create innovations
Relationships			
Criteria	Determined by hierarchy	Reciprocal, seeking consensus	Spontaneous, abundant
Case	Agreements between the focal company and subcontractors are unclear	Lack of trust between some actors hinders collaboration	Plenty of personal and casual relationships between almost everyone. Researchers are highly appreciated by other actors
Information flow			
Criteria	One-way, top-down	Multiway, horizontal	Chaotic, sporadic
Case	Information about stock levels is not circulated to all relevant parties	There are two separate cliques in the area, which do not communicate directly	A lot of real-time communication and problem-solving. Quick reaction time to problems arising from entrepreneurs
Management and leadership method			
Criteria	Orders, direct use of power	Dialogue, empowerment	Personal networking skills, relinquishing power
Case	The raw material acquisition firm has too much power over the manufacturing firms' processes, even though it is not the focal company of the network	The institutional actor has the leading position. The other actors are not empowered and active enough	The university's research laboratory coordinates innovation process in a manner that respects the needs of the other actors

Table I.
Strengths and weaknesses in the operation of three identified network types within the case cluster

perceived as consisting of three types of networks, namely production, development and innovation networks. Each network type is apt for creating a certain type of knowledge-based competitive advantage, and has its own operational logic and effectiveness criteria. Furthermore, it was claimed that in order to effectively implement, develop and innovate intellectual resources, a regional cluster has to include all types of networks. Thus, in our view, intellectual capital creation encompasses the whole spectrum of knowledge processes from replication of existing knowledge and competencies to quantum-leap innovations. Consequently, in order to maximise its potential for intellectual capital creation and leverage, a regional cluster must be able to combine such various features as exploration and exploitation, effectiveness and innovation, routine and non-routine (Weick, 1998).

The ways in which intellectual capital is created has been a neglected subject in the research on intellectual capital. Our construct of the three ways of intellectual capital creation in inter-organizational networks is an attempt to model this important phenomenon, and also to bridge the gap between the two schools examining knowledge in business contexts, namely the intellectual capital and knowledge management approaches. Our interpretation is related to such emerging themes as dynamic capabilities (Eisenhardt and Martin, 2000; Teece *et al.*, 1997), renewal ability (Brown and Eisenhardt, 1997; Leonard-Barton, 1995; Weick, 1996; Pöyhönen, 2004) and dynamic intellectual capital (Ståhle and Grönroos, 2000; Ståhle *et al.*, 2003). Naturally, our model has to be applied to a number of cases to prove its viability in other regional clusters and inter-organizational networks.

From a practitioner's point of view, the framework presented in this paper offers several benefits. By understanding regional clusters as consisting of different types of networks, a more thorough understanding of the complex multi-level processes at work can be achieved. Our model describes how a network should operate to create knowledge-based value, and it can be used for identifying the weaknesses and strengths in the current operational logic of regional clusters and the networks embedded in them. In addition, as the efficient application of knowledge to production processes requires very different kind of steering from that of innovation processes, our model provides a basis for strategically focused intellectual capital management of regions and networks.

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Further reading

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APPENDIX 2

Paper II. Smedlund, A. and Pöyhönen, A. (2005). "Intellectual Capital Creation in Regions: A Knowledge System Approach." In A. Bounfour and L. Edvinsson (Eds.), Intellectual Capital for Communities: Nations, Regions and Cities. Butterworth-Heinemann, New York, NY.

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Chapter 14

Intellectual Capital Creation in Regions: A Knowledge System Approach

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Introduction

In the new economy, firms have to produce and distribute products faster to the market and continuously innovate new products to gain a competitive advantage. To extract value from intangible resources and capabilities are becoming increasingly important factors for the competitive advantage of firms (e.g., Drucker, 1988; Prahalad and Hamel, 1990; Quinn et al., 1997; Teece et al., 1997). In addition, it has even been noted that intellectual capital (IC) is a significant source of competitiveness on the national level (Edvinsson & Stenfelt, 1999; Edvinsson, 2002; Bontis, 2003). This has forced companies to form new kinds of structures. One of the new ways of organizing business is network-type cooperation in a regional cluster of small firms.

When successful, networks have numerous advantages for the participating organizations. Networks let the organizations produce more with lower costs by decreasing transaction and capital costs; organizations are able to learn the best practices and obtain market-related information from their partners; and the actors in a region are able to innovate new products in collaboration with others. In the heart of these processes is the capability to create and transfer new knowledge and use the existing knowledge in the network.

We have earlier conducted a framework for modeling and managing IC creation in regional clusters (Pöyhönen & Smedlund, 2004). In this framework, we argued that in order to maximize its value creation potential, a regional cluster of small firms has to create new knowledge, transfer existing knowledge, and implement knowledge at the same time. In this chapter, we will describe this topic in detail, and define a new

approach for understanding regional knowledge creation and the dynamics of creating IC in a complex collaboration of multiple actors.

Three main themes appear in the different theories of the intellectual resources of organizations. These themes are: 1) intangible assets, 2) competencies and capabilities, and 3) social relationships in which the knowledge processes occur (Table 1). In this chapter, we study inter-firm networks by dividing a complex network of multiple actors into smaller units. This helps in seeing the essential structures behind the value creation on a regional level. We view IC as the capability of an organization to create, transfer, and implement knowledge. A capability approach is crucial to the new economy, where new innovations are an essential way to gain a competitive advantage.

The conception of knowledge is fundamentally different in each of the themes concerning the intellectual resources of organizations. In the intangible asset approach, knowledge is defined as a possession or property of the organization, typically consisting of human, structural, and customer capital (Brooking, 1996; Stewart, 1997; Sveiby, 1997; Bontis, 1999). The capability approach views knowledge as an ongoing and emergent process, where the capability to leverage, develop, and change intangible

Table 1: Three Approaches to the Determinants of Competitive Advantage in Knowledge-Based Economy

	Asset Approach	Cability Approach	Relational Approach
Knowledge understood as	Possession or property of the organization	Ongoing, emergent process	Socially constructed and shared resource
Main interest	Identification and valuation of existing intangibles	Capability to create, develop and modify intangibles	Social relationships and interaction
Focus on	Investments, intellectual property rights, human capital, structural capital, customer/ relational capital	Adaptive and self-generative capability of the unit of analysis	Characteristics of the social relationships connecting the actors and social capital embedded in them
Research trends	Intellectual capital, IPR management, human capital statement	Dynamic capabilities, dynamic IC, organizational renewal ability	Social capital, inter-organizational networks, communities of practice
Representative authors	Brooking, 1996; Stewart, 1997; Sveiby, 1997	Teece et al., 1997; Leonard-Barton, 1995; Eisenhardt & Martin, 2000; Ståhle et al., 2003; Pöyhönen, 2004	Brown & Duguid, 1991; Lave & Wenger, 1991; Nahapiet & Ghoshal, 1998; Cohen & Prusak, 2001

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assets is important (Teece et al., 1997; Eisenhardt and Martin, 2000; Ståhle et al., 2003). Finally, in the relational approach, knowledge is understood as a socially constructed and shared resource. The focus of the relational approach is on the social relationships connecting the various actors and the social capital embedded in these relationships (Brown and Duguid, 1991; Lave and Wenger, 1991; Nahapiet and Ghoshal, 1998; Cohen and Prusak, 2001).

In this chapter, we suggest a new capability and relationship-based view to the IC creation in a regional cluster. The regional cluster of small firms is studied in accordance with the network theories and the influence of social relationships and interaction on organizational success.

Recent studies show that new innovations are created in networks which combine different actors and resources (i.e., Lundvall and Borrás, 1998; Powell, 1998; Miettinen et al., 1999). There have also been suggestions that regional competitive advantage is related to the formal and informal networks between the actors in the region (McDonald and Vertova, 2001). In our research on a regional cluster, we set out to determine how IC is created between the actors in a region, by dividing the regional cluster of small firms into distinct entities according to their IC functions. The main goals of the case study were to define the kind of knowledge and competence the actors have, the nature of relationships between the actors, how information is transmitted, and how these processes are managed and coordinated.

Our solution for a new approach for understanding regional knowledge creation is a concept we call the regional knowledge system. This system includes knowledge implementation, knowledge transfer, and knowledge creation levels in a regional cluster of small firms. The region needs all of the levels to be successful. On the one hand, new knowledge is transferred from the knowledge creation level to the knowledge implementation level via the knowledge transfer level. On the other hand, new ideas for innovation emerge from the knowledge implementation level and are transferred to the knowledge creation level. In the regional knowledge system, we call these levels the production, development, and innovation network of the regional cluster.

This chapter presents a classification of three types of interorganizational networks, illustrates them with the findings from a case study, and introduces a novel approach to IC creation in regions. The research is a case study conducted during the winter of 2002 to 2003 in a regional cluster of small firms in eastern Finland. The case of this chapter is based on a research project coordinated by the Finnish Association of Graduate Engineers, TEK, during the years 2002 and 2003.

The Benefits of Inter-Firm Networking

The social scientist Manuel Castells defines network simply as a "set of interconnected nodes" (Castells, 1996, p. 470). Actors form nodes in any network structures, and transmit various types of flows to other actors in the network. Castells' view about networks is related to his theory about the world as a "space of flows." According to this theory, the world is going through global decentralization and reallocation of operations. Regions compete against each other in global markets and try to attract important flows to themselves. The most important type of flow is capital. Other flows can be, for example, competent employees and information (Castells, 1996). According to Castells (1996), actors in the markets can be divided into two categories: insiders and outsiders. Insiders are the ones who have managed to get into a network with growth opportunities. Outsiders are the ones left out to get the lowest bids.

The idea about insiders and outsiders is related to the concept of "markets as networks." In this view, markets are dominated by alliances. These structures consist not only of buyers and sellers, but also of other actors such as consultants, service providers, and institutions. According to the markets as networks view, the markets of industrial products are complex networks of multiple actors. In these networks, relationships between the actors contain three main components: activities, resources, and actors (i.e., Håkansson and Johanson, 1992; Ford et al., 1998). The roles of the different actors in the network can be defined on the basis of this distinction.

The economists Shapiro and Varian (1999) also see networks as a prerequisite for succeeding in competition. In the new economy, the markets are dominated by networks that gain strength as more actors join the network. In the economy dominated by alliances and networks, the value of a product is dependent on the amount of other users of the product. It is better to be connected to a bigger network than a smaller one. Typical examples of this effect are communication technologies, such as telephone, email, and fax (Shapiro and Varian, 1999).

Alliances that several different actors form in the markets divide the old model of value chains introduced by Porter in 1985. When the markets are seen as networks, the actors in the network can consist of many other types of actors than traditionally thought. The actors include not only the focal firm but also customers, suppliers, hardware suppliers, institutions, and so on, which are all important for the whole network. The information flows between all of the actors in the network.

The Porterian value chain theory (Porter, 1985) is based on the old industrial tradition. In Porter's view, raw material is processed in different phases of production, where every phase adds the value of the final product. The Porterian value chain theory is usable with physical raw material, due to the fact that physical raw material can be moving only in a certain direction at a time and it can be located only at a certain point at a time.

The main difference between the Porterian value chain theory and the concept of value networks is that the value chain theory did not take into account the fact that the flows between the actors can also be intangible and the information can be flowing between all the actors. The value network generates economic wealth with complex exchanges between the actors involved in the network. The value chain and network are also different in terms of social relations. For example, Allee (1999) argues that in the old industrial world, trust could be expendable over a short-term benefit. In the transparent world of value networks, even an occasional loss of trust may be harmful in unexpected ways. AQ1

Network-based alternatives for the value chain model have been presented by numerous scholars (i.e., Prahalad and Hamel, 1990; Allee, 1999; Allee, 2000; Normann, 2001; Allee, 2002; Pirnes, 2002). The key components common for all value network-based models are that they emphasize the combination of different resources and competence. Small firms will be able to compete against big corporations only by realizing their core competencies (Prahalad and Hamel, 1990; Hamel, 2000). According to Hamel (2000), all new and revolutionary business models are a just a novel, innovative way to combine old ideas, resources, and competence from different actors and fields of businesses.

Being an active actor in a value network in a regional cluster of small firms provides the actors with numerous benefits. First, according to the theory of transaction costs and from the strategic alliance point of view, networks lower the transaction costs of

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the actors by allowing them to concentrate on their core competencies. Second, according to social capital theories and research, the networks in a regional cluster initiate learning from other actors with trustworthy and communicative relationships. Third, according to research on innovation processes, a regional cluster of small firms provides an opportunity to continuously improve products, production methods, and processes by providing conditions for combining different resources and knowledge.

The First Benefit of Networks in a Regional Cluster: Lower Transaction Costs

In a regional cluster of small firms, interorganizational networks lower the transaction costs by allowing the actors to concentrate on their core competencies. The actors form strategic alliances with each other. In strategic networking, cooperation is developed and organized according to the shared objectives of the actors involved. Strategic cooperation is extended to all levels in the subcontracting network and the relationships are seen as significant investments, which makes them long-term and carefully chosen. (Paija, 1999; Luomala et al., 2001)

Networking for strategic competitive advantage differs from other forms of cooperation. According to Hyötyläinen and Simons (1998), the other forms of cooperation are: 1) bidding contest for subcontractors, 2) subcontracting cooperation, and 3) partner-type of cooperation. All of the three other forms of cooperation are dyadic in nature, but in strategic networking dyadic relationships are expanded to the level of multilateral cooperation.

The transaction cost theory provides one solution for understanding inter-firm cooperation (for theory, see, e.g., Coase, 1937; Williamson, 1975; Williamson, 1981; Williamson, 1985). The basic idea behind the transaction cost theory is that organizations try to minimize their total costs, which are formed by production and transaction costs. Transaction costs can be seen as "friction of the economy," and they have to be minimized. According to the transaction cost theory, as the cost of capital rises, the transaction costs also rise (Williamson, 1985; Schienstock and Hämäläinen, 2001). Market-based controlling of actions is good when the capital costs and transaction costs are low. In the market-based model, the firm buys the material and parts needed in production, and then sells the products in a market where the buyers and sellers stay anonymous. Hierarchies function best in the kind of businesses where high capital costs and high transaction costs prevail. In the hierarchical model, the firm controls the whole production chain from raw material acquisition to the selling of the product. Networks, on the other hand, are a good option to control actions when the business involves average capital and transaction costs (Coase, 1937; Williamson, 1975; Williamson, 1985; Schienstock and Hämäläinen, 2001).

In Jarillo's (1988) opinion, networks are the ultimate way to organize business, if the company is able to create a system which lowers the transaction costs of the firm, outsources functions to the best subcontractors, and keeps the firm-specific core competence inside the firm. When networks are used consciously to gain competitive advantage, Jarillo calls them "strategic." Essential for Jarillo's strategic network is that there is a focal company which has started the cooperation. The focal company then maintains long-term relationships with the companies in its network to gain the trust of the subcontractors and to lower the transaction costs. The companies in the network specialize in their own core competence.

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The Second Benefit of Networks in a Regional Cluster: Learning From Others

The second benefit that networking inside a regional cluster offers is learning from other companies through the mechanisms of social capital.

The basic idea behind social capital is similar to the old saying: "it's not what you know, it's who you know." A well-constructed social network opens doors to sources of information which would normally beunreachable. With this information, an actor gains a competitive advantage, because they know more than others. With the information gained from the social network, the social capital that the actor possesses is transformed into the personal human capital of the actor (Johanson, 2000).

Putnam (1995, pp. 664–665) defines social capital as "features of social life – networks, norms, and trust – that enable participants to act together more effectively to pursue shared objectives."

Nahapiet and Ghoshal (1998, pp. 251) present the same idea in the context of organizations. Organizations foster social capital, and firms that have high social capital gain a competitive advantage. Nahapiet and Ghoshal also divide the concept of social capital into three different components slightly similar to Putnam's definition, although they call the components structural, cognitive, and relational dimensions of social capital.

In his comprehensive literature review, Ruuskanen (2001) argues that the components of social capital create advantages through two mechanisms that are connected to each other: trust and communication. In his opinion, trust towards other people and formal or informal institutions is essential. The information flow in the network and the capability of the actors to understand each other is also essential. In addition, Ruuskanen states that communication in the network and trust between the actors are especially important on a regional level.

The components of social capital have been argued to enhance learning and productivity among the actors in the network. Yli-Renko et al. (2001) have studied the power of social capital in explaining the development of a competence-based competitive advantage in new technology firms. They conclude with the data of 180 new technology firms in Great Britain that social interaction, customer network ties, and the quality of the relationships have a statistically significant connection to learning in key customer relationships. They also note that learning in the relationship significantly explains the competitive advantage (Autio, 2000; Yli-Renko et al., 2001). Autio (2000, p. 47) even states that the correlation between social capital and the learning benefits gained from social capital explain the fact that technology-based firms tend to be concentrated to specific regions.

However, as forging and maintaining social capital entails significant costs, it may not always improve financial success. When studying 143 Finnish firms Pöyhönen and Waajakoski (2004) found that social capital was related to organizational growth only in those cases where the firms either had extensive collaboration with their most important business partner, or belonged to an established interorganizational network. In other cases, the costs of social capital neutralized its positive effects.

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The Third Benefit of Networks in a Regional Cluster: Continuous Innovation

A regional cluster of small firms provides an opportunity to continuously improve products, production methods, and processes by providing conditions for combining different resources and knowledge.

Innovations have a social character and innovations today require highly specialized knowledge from different fields. For example, in 1901 81% of U.S. patents were issued to independent inventors, but in 1980, individuals acquired only 20% of new patents (Whalley, 1991, p. 208). Powell (1998, p. 229) argues that new innovations are not even created in individual companies, but in the networks of multiple companies and actors. Miettinen et al. (1999) studied innovations in several Finnish projects, and the conclusion of this study was that most of the new knowledge creation occurs in networks. It has also been argued that regional networks have an important role in the competitive advantage and innovativeness (Lundvall and Borrás, 1998; McDonald and Vertova, 2001). According to Lundvall and Borras (1998, p. 109) the regional dimension is important for new innovations because of three reasons. First, the creation of human capital requires geographical proximity. Second, geographical proximity increases the possibility for casual and planned meetings, as well as spontaneous and structured information exchange, and thereby increases the emergence of formal and informal networks. And third, synergies can emerge from the shared cultural, psychological, or political perspectives of those engaged in the same industry within the same economic space or region.

Production, Development, and Innovation Networks

In this section, we will present the theoretical background for our theory of three types of networks in a regional cluster. According to the value network approach introduced by Allee, and some of the network theories previously described, we also suggest three main purposes for networking in a regional cluster.

Allee's Theory on Value Networks

Allee's work with value networks (1999; 2000; 2002) is one of the most recent contributions towards understanding the complex networks that generate value. In her opinion, any organization can be understood as a value network (2000). Her view is based on the idea that dynamic exchanges of goods, services, knowledge, or intangible benefits create value in a network. It is also possible to map all of these dynamic exchanges, which makes understanding and measurement of the value networks possible.

Allee sees organizations in new economy as living systems, which is a totally different point of view than defining organizations as traditional mechanistic ones. She describes organizations as living systems, and bases this account on Capra's (1996) theories about the definition of a living organism, and with the concepts of the autopoetic network and the dissipative structure of a living system from the systems theory literature. According to Allee's model, organizations are combinations of actors

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with tangible and intangible exchanges flowing between them. When compared to a living organism, tangible flows are flows of energy and matter in the organization. Intangible flows, such as knowledge, make the organization intelligent as a living system. The intangible flows also prove that the organization is capable of taking conscious actions (Allee, 2002).

By relating Allee's views about value networks with the theory about network-based alternatives for the value chain, to the concept of "markets as networks" and the social character of innovations, three main purposes for value networks can be described. A regional cluster can be seen as a value network where the flows between the actors are not only tangible, but also intangible.

The first purpose for a value network is to generate value, that is, to bring cash flow to the system and make a profitable business. As previously described, the value creation process in value networks is different from the traditional value chain introduced by Porter (1985). In the value network, intangible benefits and knowledge support the exchange of goods and services to money. This makes it possible to combine different resources and competencies in innovative ways to generate value for the network.

The second purpose of a value network is to ensure that information is transferred between the actors. Intangible flows, such as strategic information and process-related information, are byproducts of tangible flows, which help to form relationships to exchange information and make the organization run smoothly. According to Allee (2002), intangible flows are important, because they make the system "alive".

The third purpose of a value network is to bring different actors and resources together. According to the "markets as networks" (Ford et al., 1998; Shapiro and Varian, 1999) point of view previously described, the network is more valuable when it encompasses more actors, and according to theories about innovation networks (i.e., Lundvall and Borrás, 1998) new innovations emerge from the combination of highly specialized knowledge from different actors. Dynamic exchanges of tangible and intangible flows attract more actors to join the network.

Knowledge Environment of a System

In her 1998 dissertation, Ståhle proposed a theory about the self-renewal ability of groups and organizations. By analyzing system theories, she was able to define four basic determinants for organizations: 1) knowledge and competence, 2) relationships, 3) information flow, and 4) management and leadership method (Ståhle, 1998; also see Ståhle & Grönroos, 2000; Ståhle et al., 2003). Ståhle's main theoretical contribution is that in organizations there are different environments, where organizational determinants are different. These environments are 1) a mechanic, 2) organic, and 3) dynamic environment. Ståhle labels them the "knowledge environments of an organization." Every environment has its own way to produce value with knowledge, which we call the "IC-related function" (Pöyhönen, 2004; Pöyhönen and Smedlund, 2004). In the mechanistic category, the IC-related function implements knowledge into practice as effectively as possible. In the organic category, it transfers knowledge inside the organization. The IC-related function of the dynamic category is to create new knowledge. In order to be successful, an organization has to have each type of knowledge environment present. This means that the organization has to: 1) implement knowledge, 2) transfer knowledge, and 3) create knowledge in order to continuously renew itself. With continuous self-renewal the organization is able to produce new innovations according to the needs of the markets and find a competitive advantage.

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The differences between the knowledge environments and the organizational determinants are summarized in Table 2 below. In order to be efficient in knowledge implementing, the actors in the mechanic knowledge environment have to have defined, explicit knowledge about what they are doing. An example of an organization with mechanic system logic is a factory. In a factory, it is important to produce something that has already been designed as efficiently as possible. To do this the factory needs knowledge, relationships, information, and leadership similar to mechanic system logic.

To transfer knowledge between actors, the organic system logic has to be led with dialogue and empowerment. This means that in the organic environment, the relationships are of the consensus-seeking type, and the actors have their own tacit form of knowledge. For example, in a service organization it is important to learn from the experiences of others and improve customer service step by step. A service organization can be steered more towards organic system logic.

On the dynamic, knowledge-creating level it is important to have a great amount of intuitive and potential knowledge. Relationships are spontaneous and abundant. Information flow is chaotic and it is managed by networking and relinquishing of power. An example of an organization with dynamic system logic would be an advertising agency that has to constantly design new ideas.

Every organization has to have all of the knowledge environments present in order to be successful. This means that even if a factory has a mechanic systems logic emphasized, it needs characteristics from organic and dynamic knowledge environments as well. According to Ståhle and Grönroos (2000), the dynamic knowledge environment is in key position for continuous innovation. On the other hand, an organization needs an organic and dynamic knowledge environment as well to turn innovations into profitable business.

Production, Development, and Innovation Network

In a regional setting, three basic network types can be distinguished. These types function as knowledge creation, knowledge transfer, and knowledge implementation

Table 2: Knowledge Environments, IC Functions and Organizational Determinants (Based on Ståhle and Grönroos, 2000; Pöyhönen and Smedlund, 2004)

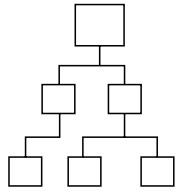
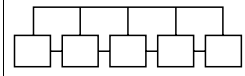
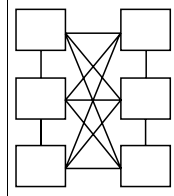
Knowledge environment	IC function	Knowledge and competence	Relationships	Information flow	Management and leadership method	Example
Mechanic	Implement knowledge	Defined, explicit	Determined by hierarchy	One-way, top-down	Orders, direct use of power	Factory
Organic	Transfer knowledge	Experiental, hidden, tacit	Reciprocal, seeking consensus	Multi-way, horizontal	Dialogue, empowerment	Service organization
Dynamic	Create knowledge	Intuitive, potential	Spontaneous, abundant	Chaotic, sporadic	Personal networking skills, relinquishing power	Advertising agency

levels in a regional cluster of small firms. As previously described in our first article about IC creation in regions (Pöyhönen & Smedlund, 2004), the three network types are different from each other in terms of their structure, IC-related function, and Ståhle's (1998; 2000; 2003) knowledge environment. The different network types are summarized in Table 3. We name these three different network types production network, development network, and innovation network.

In our approach, the sales process is always considered to be in the production network. In the production network, the flows between the actors are related to the production of a product, so they consist mostly of physical products or money. All of the information flowing between the actors is related to production, e.g., information about stock levels. The production network can be dominated by a single, central actor, or the network can be coordinated by a broker outside the actual network setting. The actors in the production network do not necessarily know all of the other actors involved. The relations in the network are based on dyadic relationships between an actor of the network and the dominating actor or the broker. The network structure is hierarchical. The essential characteristic of the production network is that it serves as an effective manner to produce a pre-designed product or service.

Ideally, a production network functions as mechanistic machinery (Ståhle & Grönroos, 2000), which efficiently produces permanent quality and achieves predetermined goals. In order to do this, the network necessitates clear and coherent rules and regulations. Thus, the essential knowledge of the production network should be in explicit form and circulated to all relevant actors. It is enough that information

Table 3: Production, Development, and Innovation Network

	Production Network	Development network	Innovation Network
Illustration			
Structure	Vertical	Horizontal	Diagonal
IC function	Implement knowledge	Transfer knowledge	Create knowledge
Knowledge environment	Mechanical	Organic	Dynamic
Flows between actors	Tangible (i.e., products, money) Intangible (i.e., production-related information)	Intangible (transferable firm specific information, know-how)	Tangible (i.e., innovation related products, money) Intangible (i.e., research knowledge, experimental knowledge, know-how)

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flows in one direction, mostly top-down, because discussion and elaboration open up the possibility for modifications, which in this type of network are unwanted and mere hindrances to its effectiveness. This kind of operational mode is facilitated by centralized control and hierarchical structure.

The development network is a horizontal network construct that can be used for joining together firms in a regional cluster, even if they do not have cooperation in the production function. The actors in a development network can even be competitors. In the development network, the actors share information that benefits all of the actors individually. The flows between the actors in the development network are intangible by nature. The flows can be, for example, information about the production methods and customers, or personal know-how of the actors. The development network is the only type of network where there are no tangible flows between the actors. By learning the best practices of others, firms can achieve a higher level of efficiency. In a regional setting, a development-focused network can improve the actors' performance in, for example, marketing or acquisition of venture capital. The essential characteristic of the development network is its knowledge-sharing nature.

The development network resembles Ståhle's and Grönroos's (2000) account of organic knowledge environment within organizations. The continuous development conducted in the organic environment is based on tacit knowledge, lateral two-way information flows, double contingent relationships, and empowering leadership. Similarly, in the development network, the actors' capabilities develop over time as they learn from each others' experiences. The relations are reciprocal and based on trust rather than on detailed formal agreements. Cooperation is conducted in everyday casual communication between the actors, and active participation is encouraged. In the development network, there is no single dominating actor. However, there can be a coordinator that supports knowledge sharing.

In the innovation network, new knowledge is created and new solutions for problems are developed consciously in cooperation with the actors involved. The flows between actors are related to the innovation process at hand. The flows can be samples of products, research knowledge, or experimental knowledge. The relationship structure in an innovation network is diagonal. This means that the actors participating in the innovation network are from different production chains and different industries. The innovation network can also tie together institutional and entrepreneurial actors.

The innovation network should master the creation of knowledge that is novel for everyone in the network. This requires that there is room for creativity and that the operational mode of the network is not too structured and formalized. Along the lines of Ståhle's and Grönroos's (2000) description of dynamic knowledge environment, potential and intuitive knowledge, even self-transcending knowledge (Scharmer, 2001), should be highly valued. The relations are informal and rich and the actors' capabilities are multifaceted. The innovation network is ideally led by the actor who is the most suitable for coordinating the resources and knowledge, i.e., authority migrates according to expertise rather than position in the hierarchy.

The Case

The idea of production, development, and innovation networks was applied to a case cluster. The main research problem was to determine whether it is possible to divide the inter-firm cooperation which occurs in a specific region into these three network types. Our goal in the case region was to map all of the actors involved, model the relationships between the actors, and find the strengths and weaknesses of the cooperation.

Background

The case region is a relatively young cluster of small firms located in the eastern part of Finland. The firms in the cluster operate in the mechanical wood processing industry, which is a traditional field of business dominated by a few large corporations. At least in Finland, there has been very little network-based cooperation in this particular industry, and almost all previous attempts to form network arrangements between small firms have failed (Passila, 1998). AQ2

In March 2003, there were eight internal actors involved in the cluster. All of the internal actors were situated within approximately 100 yards from each other in the same industrial area provided by local municipalities. Four of the actors were small manufacturing firms that manufactured end products (sawn timber) to the market. All of the manufacturing firms had slightly different raw material requirements and products, so they were not in direct competition with each other. One of the actors was a service provider that managed one phase of the production (the drying of the timber) for the manufacturing firms. The raw material acquisition firm was owned jointly by all of the municipalities in the region. One of the actors rented labor and machinery to all of the other actors in the area. In addition, there also was a university's research laboratory in the same industrial area.

The case cluster was a collaboration bringing together several regional actors: local entrepreneurs, venture capitalists, and institutional actors. The main institutional actors were several local municipalities and a local university. Compared to their overall budgets, the local municipalities had invested heavily in the formation of the cluster.

Figure 1 provides an overall view of the region and shows what the relations looked like in March 2003. The illustration was been made according to Allee's value network approach recommendations, except that the flows are pictured with two-headed arrows. Allee does not like two-headed arrows, because they do not tell anything about the direction of the flow (Allee, 2002, p. 9), but we have used them in this overall picture to make the figure readable. In this picture, the arrows represent the existing relationship between the actors. Internal actors (actors within the same industrial area) are depicted as circles and external actors (actors outside the industrial area) are depicted as ovals.

In designing a network graph, it is always difficult to decide which actors belong to the network and which do not. We solved this problem by including only the actors that the interviewees mentioned. The gray area in Figure 1 illustrates the industrial area. The actors in this area were located only approximately 100 yards from each other. The actors outside the gray area were located somewhere else, but the internal actors considered them important. The role of the development company owned by the local municipalities was considered important by the interviewees. The development company had been in an essential role in the formation of the region.

Methods

We examined the case region according to the socio-centric network perspective, which means that we assessed the benefits of networking from the viewpoint of the whole network, not from the actor-centric perspective of an individual organization (Adler and Kwon, 2002). The research method was a case study. The data was gathered with 11 theme-based interviews and site visits. As a part of the theme-based interview, the

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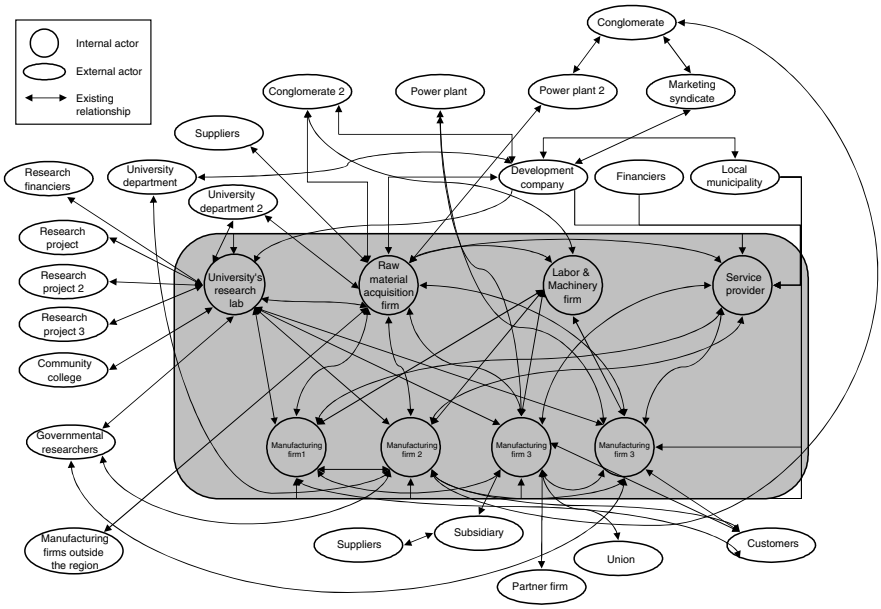
Figure 1

Overall illustration of the case regional cluster according to Allee's (2002) value network model.



interviewees were asked both to draw a graph of how they perceive the network and to verbally explain the connections and flows between the actors. Some of the interviewees commented on a graph made by us. Based on these graphs and the related explanations, an overall presentation of the cluster and the three network types identified within it were modeled using Allee's (2002) value network approach model. The interview themes were constructed on the basis of the knowledge environment theory by Ståhle and colleagues (Ståhle and Grönroos, 2000; Ståhle et al., 2003). The IC creation process in different network types was thus studied from the viewpoints of: 1) what kind of knowledge and competence the actors had, 2) what the nature of relationships between the actors was, 3) how information was transmitted, and 4) how these processes were managed and coordinated.

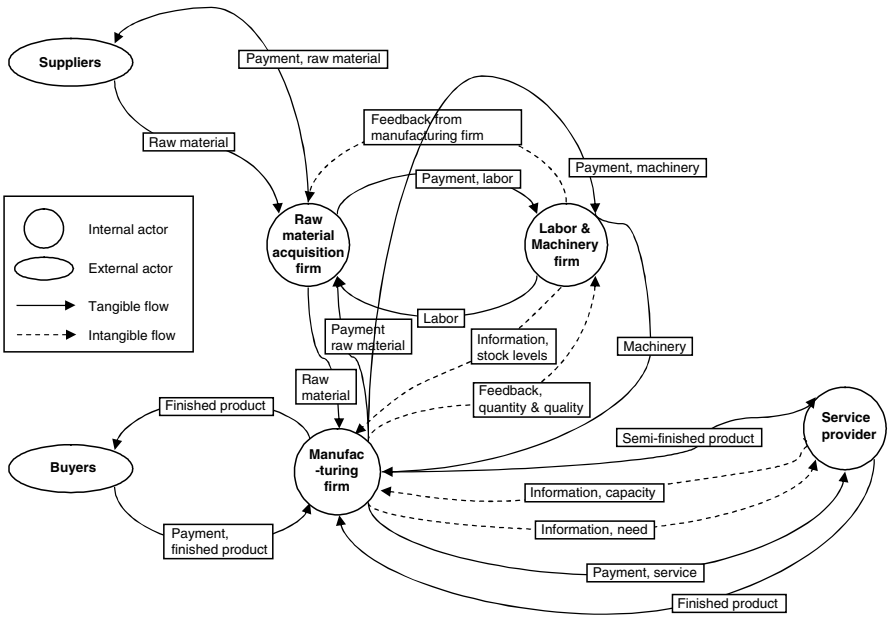
Based on the organizational determinants introduced by Ståhle, we were able to make two important conclusions about the case region. First, we were able to discern the systemic logic according to which the various types of networks within the cluster were functioning. And second, we were able to find specific strengths and weaknesses in the operation of the different network types. As a byproduct of the theme-based interviews, we also managed to define the strategic goals for the different network types.

Case Production Network

The production network was the heart of the whole region. With the operation of the production network, the final products were sold to the customers and money was

Figure 2

Production network according to Allee's (2002) value network model.



flowing to the region. All of the manufacturing firms in the case region followed the production network logic described in Figure 2.

In the production network of the case region, the manufacturing firm buys raw material from the raw material acquisition firm, uses the service provider to make one phase of the production, and then sells the finished product to the customers. The labor and machinery firm provides labor and machinery services for the manufacturing firm and material acquisition firm.

Most of the flows in the production network are tangible (products, money, machinery, or labor). Intangible flows related to production are production-related information about stock levels, capacity, and need.

After drawing the picture of the typical production network in the region, we noticed that the production related information flow was not working properly. For manufacturing firms, it is important to know what type of raw material is available and when. Information about stock levels in the raw material acquisition firm helps the manufacturing firms in production planning and saves the costs of production significantly. In the case production network, information about the stock levels was circulated through the labor and machinery firm, which caused problems for the manufacturing firms. In the most favorable situation, the information would have to flow directly from the raw material acquisition firm to the manufacturing firm. On the other hand, the information flow between the service provider and the manufacturing firms was satisfactory. The manufacturing firms informed the service provider about the needs for services and the service provider told the manufacturing firms about the

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service capacity. The service provider had limited capacity, so it was important for it to know the service need and urgency.

Considering competence, the production network had good preconditions, because none of the manufacturing firms competed directly with each other. All of the manufacturing firms had different products and needs concerning the type of raw material. The only competence-related problem in the production network was that the core competencies were not clarified in every manufacturing firm. It seemed that some of the manufacturing firms had machinery that they did not necessarily need.

A lack of clear agreements about transactions caused unnecessary disputes between the raw material acquisition firm and the manufacturing firms. Despite the fact that the whole region was originally built around the centralized raw material acquisition firm, some of the manufacturing firms considered the centralized raw material acquisition as a threat. As a whole, the relationships in the production network were not very good. Some of this was merely caused by the lack of information from the acquisition firm to the manufacturers.

The management and leadership of the production network should always be in the hands of the firm who sells the final product to the customer. This was not the case in the region. The raw material acquisition firm had a too dominating role in the production network.

Case Development Network

The development network level represents the social and informal side in the cooperation between the actors in a region. In principle, all of the actors in the same geographical region should be included in a development network in some way or another. In the most favorable situation, the actors in the development network exchange information with all of the other actors in the same region.

In Figure 3, the two-headed arrows were used because of practical reasons to illustrate the development network in the case region. In this figure, the two-headed dotted line illustrates the knowledge exchange between the actors. Some of the actors had close relationships to a few external actors as well, so we included them in the figure.

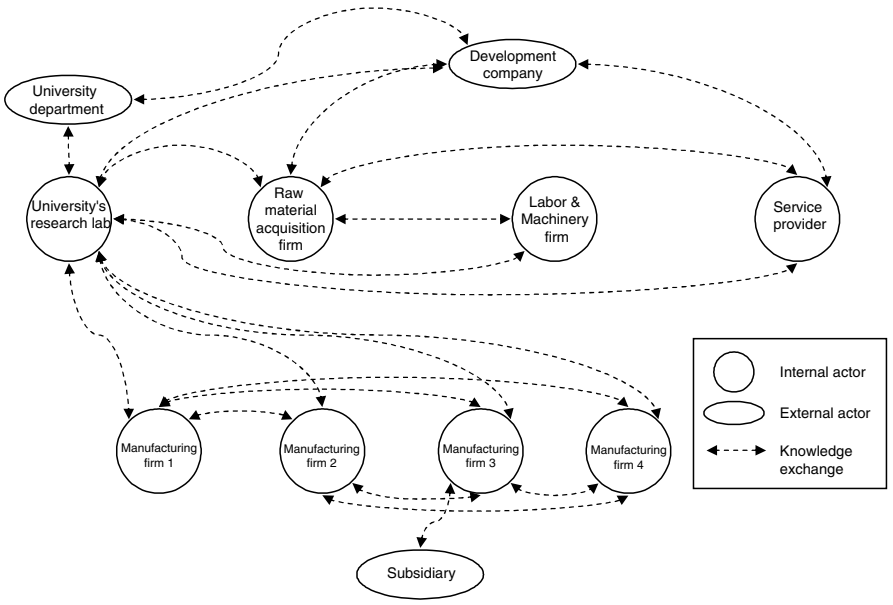
As with the production network, we can again make important observations about the information flow in the region just by examining the figure of the development network. In the development network setting, the manufacturing firms communicate with each other daily. The manufacturing firms exchange experiences continuously and the geographical proximity makes the knowledge exchange easy. The raw material acquisition firm, the development company, and the service provider also exchange information regularly.

The development company owned by the local municipalities was an important actor during the creation of the region. The development company still tried to lead the informal communication and knowledge sharing between the actors by bringing the actors together in common meetings. The entrepreneurs in the manufacturing firms did not like these meetings and some even thought that they were useless.

The university's research lab functioned as a link between the two cliques in the region. This setting had many negative consequences to the functioning of the whole region. Trust between the cliques was not very good, which hindered all communication and processes between the cliques. The role of the university's research lab sometimes seemed to be just that of a referee in the disputes between some of the

Figure 3

Development network according to Allee's (2002) value network model.



actors in the region. For some reason or another, it seemed that the problems in the production network level caused friction to the relationships and a couple of persons had a bad reputation among the manufacturing firms. The university's research laboratory, on the other hand, was quite trustworthy in the eyes of the manufacturing firms. The researchers from the university had been sharing production-related knowledge since the foundation of the region.

All of the entrepreneurs in the region had different backgrounds and know-how about the field of business. Knowledge about the raw material the region processes was quite rare, and some phases of production were still unclear. The region used birch as raw material, but most of the manufacturing firms had experience only of pine wood. The region needed a good atmosphere for knowledge sharing, because the actors needed to improve their material and process-related knowledge constantly. The manufacturing firms learned some production-related issues from each other and technical problems were in some cases solved in a group. Some of the manufacturing firms were considering a united marketing force. In March 2003, the manufacturing firms had a couple of shared customers, but normally every firm was selling their own products to their own customers. It would be possible to form a shared marketing function, if the firms would share their marketing knowledge with each other. A shared marketing function between the manufacturing firms would benefit all of the manufacturing firms. Together, the firms could offer larger quantities of products to the market. A shared marketing function would also let the manufacturing firms concentrate more on their core competencies, because they could use each others' products in case a customer needed them.

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Case Innovation Network

The innovation network combined different resources and knowledge to create solutions for production-related problems. Although the core of the innovation network was inside the region, it had actors from outside the region as well.

Figure 4 is just one example of an innovation process in the region that the interviewees shared with us. In our case (Figure 4), a manufacturing firm noticed a quality-related problem in the semi-finished product that the service provider handled. The manufacturing firm then told the university's research laboratory about this problem. The university's research laboratory used the manufacturing firm's tacit knowledge (know-how), theoretical research knowledge from other research projects, and funding from the financiers to solve the problem.

Some notes about the relationships and information flow in the region can be made on the basis of Figure 4. The university's research laboratory had a dominating role in this particular innovation example. Most of the flows between the actors were intangible by nature (information, research knowledge, and know-how) and the research laboratory seemed to dominate them. The research laboratory had the leadership of the innovation process. Considering the information flow, the region benefited from the short distances between the actors. The geographical proximity made communication easy, and face-to-face knowledge sharing was very common. Even the research knowledge was usually transferred in oral form. This was seen as a good thing, because written research reports tend to stay unread by the entrepreneurs.

The competence of the innovation network was the research laboratory's theoretical research knowledge and the empirical tacit knowledge of the entrepreneurs. The research laboratory and the other actors had symbiotic relationships in the region, and the interviewees thought that everybody benefited from the presence of the research laboratory in the area. From the point of view of the research laboratory, the region was quite a rewarding place for new research ideas. Day-to-day communication with the manufacturing firms provided many new ideas that are usually difficult for a researcher at a university to obtain.

The relationships in the innovation network were good. The informal relationships enhanced the communication between the researchers and the entrepreneurs. The manufacturing firms also used other types of services of the researchers frequently and the researchers were appreciated among all the actors in the region.

The Strengths and Weaknesses of the Production, Development, and Innovation Networks in the Case Cluster

By using Allee's (2002) value network approach and Ståhle's (1998; 2000; 2003) organization determinants, we were able to divide the regional cluster into three distinct network types according to the model previously. We were able to find the strengths and weaknesses of the operation of the different network types by using: 1) knowledge and competence, 2) relationships, 3) information flow, and 4) management and leadership method as criteria. The findings are summarized in Table 4.

In summary, the greatest weakness of the production network was poor information flow about stock levels between the actors. The relationships in the development network were not very good due to some production-related problems, and the leadership of the innovation network was still in the hands of one actor. To ensure the future success of the case region, the organizational determinants of production,

Figure 4

Innovation network according to Allee's (2002) value network model.

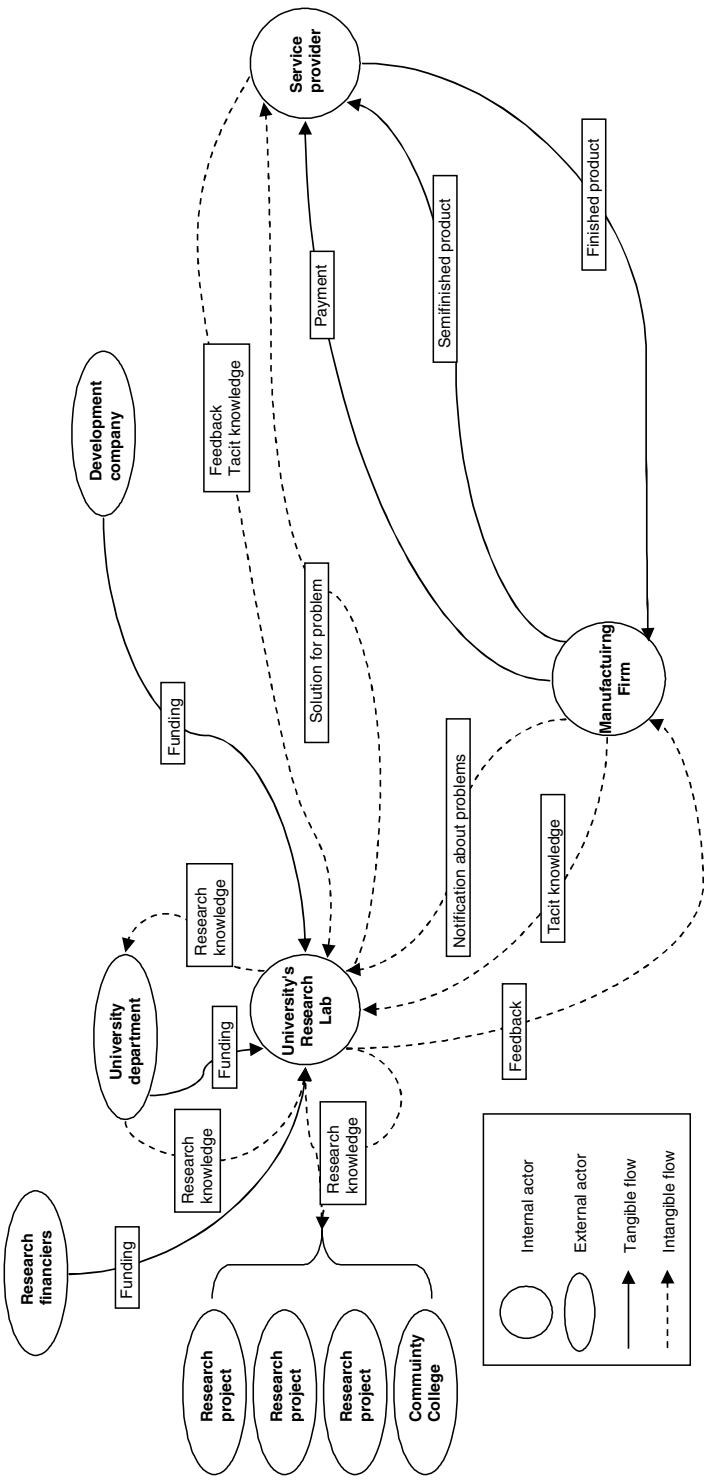

Table 4: Strengths and Weaknesses in the Operation of Three Identified Network Types Within the Case Cluster (Ståhle et al., 2003; Pöyhönen and Smedlund, 2004).

		Production network	Development network	Innovation network
Knowledge and competence	CRITERIA	Defined, explicit	Experiental, hidden, tacit	Intuitive, potential
	CASE	Actors' core competencies have not been clarified and internal production processes are not as efficient as possible.	Formation of mutual experience-based tacit knowledge has not begun.	Tacit knowledge of diverse actors is combined with theoretical research knowledge to create innovations.
Relationships	CRITERIA	Determined by hierarchy	Reciprocal, seeking consensus	Spontaneous, abundant
	CASE	Agreements between the focal company and subcontractors are unclear.	Lack of trust between some actors hinders collaboration.	Plenty of personal and casual relationships between almost everyone. Researchers are highly appreciated by other actors.
Information flow	CRITERIA	One-way, top-down	Multi-way, horizontal	Chaotic, sporadic
	CASE	Information about stock levels is not circulated to all relevant parties.	There are two separate cliques in the area, which do not communicate directly.	A lot of real-time communication and problem-solving. Quick reaction time to problems arising from entrepreneurs.
Management and leadership method	CRITERIA	Orders, direct use of power	Dialogue, empowerment	Personal networking skills, relinquishing power
	CASE	The raw material acquisition firm has too much power over the manufacturing firms' processes, even though it is not the focal company of the network.	The development company has the leading position. The other actors are not empowered and active enough.	The university's research laboratory coordinates innovation process in a manner that respects the needs of the other actors.

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development, and innovation network should be led towards the basic criteria determined by Ståhle (2003).

Strategic Goals for the Production, Development, and Innovation Network

According to the interviews and the observation, we were able to define strategic goals for the different network types in the region. These were to get the material flow as effective as possible, form a united market force, and develop new technologies for a certain phase of production.

The strategic goal of the production network in the region was to enable the raw material flow to be as effective as possible. The cooperation of the production network in the region was "strategic" in Jarillo's (1988) terms, because the production liaisons were seen as a long-term investment of a profit-seeking nature. The production network was "strategic" also in the line of Hyötyläinen and Simons (1998). In their approach, strategic networking means fewer suppliers with more power. In the field of business our case region functions, the raw material acquisition is very capital intensive.

The strategic goal of the development network was to form a united marketing syndicate to the region. Big buyers do not want to buy products, if they cannot be sure that they receive enough products regularly. The small firms in our case region had problems in providing enough products to the market by themselves. According to the "markets as networks" view presented earlier (i.e., Håkansson and Johanson, 1992; Ford et al., 1998; Shapiro and Varian, 1999), the region could form one alliance for the market. This means that the region would seem like a single unit for the customers. The marketing syndicate would provide the actors "the economy of scale" together with the flexibility of a small unit, thus combining the benefits of a small and big firm.

The strategic goal of the case innovation network was to invent a new production method for the drying of the timber. This phase is difficult in the region's field of industry. By reaching this goal the region would gain a pronounced competitive advantage against its competitors.

The Regional Knowledge System

Together, the different types of networks previously described form a system which we named the regional knowledge system. From the viewpoint of IC creation in regions, the regional knowledge system provides both a capability-based and a relational approach to the dynamics of regional IC creation. The system that the production, development, and innovation network together form in the region gives the region a better ability to create intangibles, renew itself, and adapt to the changes in the environment.

The region needs all of the three network types to reach a competitive advantage. On the production network level, the innovations invented in the innovation network are converted into profitable business. Innovation can be new products, production methods, or production processes. The role of the development network is to function as an intermediary between the production and innovation networks. With the social and learning-based character of the development network, new innovations are transferred to the actors, which can use them in production. Besides innovations, feedback and new innovation ideas are also transferred from the production level to the innov-

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ation network because of the knowledge-transferring nature of the development network.

The benefits, purposes, IC-related functions, and case-specific strategic goals of networking in the regional cluster can be put into practice with the mindset the regional knowledge system provides.

Benefits, Purposes, IC Functions, and Strategic Goals of the Different Network Types

The network type of cooperation creates benefits for a regional cluster of small firms. These benefits were previously drawn from the existing network literature. When combined with the network typology presented in this chapter (also see Pöyhönen and Smedlund, 2004), we can link them to the production, development, and innovation networks in a regional cluster. First, the benefit of a functioning production network in the region is that it lowers the transaction costs by letting the actors concentrate on their core competencies. Second, the benefit of the development network is that this network type enables learning from other actors, with trustworthy and communicative relationships between the actors. Third, the benefit of the innovation network is that it facilitates continuous improvement of products, production methods, and production processes by combining different actors, knowledge, and resources.

Using the value network approach by Allee (1999; 2000; 2002) with the ideas from the "markets as networks" theory and the social character of innovations, we were able to argue that network based cooperation has three purposes. By linking these ideas with our network typology, we can bring these purposes to the regional level. The purpose of the production network is to create value by selling the products to the customers. The purpose of the development network is to ensure that the information, supporting the value-creating process is transferred between the actors, and finally the purpose of the innovation network is to bring the different actors together to raise the value of the network as a whole.

We previously argued that every systems theory-based knowledge environment (Ståhle et al., 2003) has a distinct IC-related function. These can also be transferred to the regional level with the idea of our network typology. The IC-related function of the mechanic production network is to apply knowledge into practice as effectively as possible. The IC-related function of the development network, which functions according to organic systems logic is to share firm-specific transferable tacit knowledge. Finally, the IC-related function of the dynamic innovation network is to create new knowledge in collaboration with different actors and resources.

We were able to determine the strategic goals of our case region by analyzing the interview data. In our case region, in March 2003, the goal of the production network in the case region was to obtain the raw material flow as effectively as possible. The goal of the development network in the case region was to form one united market force to introduce more products to the markets than one actor could produce by itself. The goal of the innovation network was to develop better technology for a certain phase of production.

The three network types in the regional knowledge system function as: 1) IC implementation (production network), 2) IC transfer (development network), and 3) IC creation levels (innovation network) in the region. Each network type creates a certain type of knowledge-based competitive advantage and has its own operational logic and effectiveness criteria. Table 5 illustrates the benefits, purpose, IC-related function, and goals of the different network types in the case region.

Table 5: General Idea of Different Network Types in a Regional Knowledge System

Network type	Benefit	Purpose	Intellectual Capital-Related function (Pöyhönen & Smedlund, 2004)	Goal in the case region
Production network	Lowers transaction costs by allowing actors to concentrate in their core competencies.	Bring cash flow to the region. Make profitable business.	Apply knowledge into practice as effectively as possible.	Raw material flow as effective as possible.
Development network	Increases learning through trust and communication between the actors.	Ensure that information is transferred between actors.	Share firm-specific transferable tacit knowledge.	United market force.
Innovation network	Enables continuous improvement of products, production methods and processes by combining different actors knowledge and resources.	Bring together different actors and resources to raise the value of the network.	Create new knowledge.	R&D of new technologies for a certain phase of production.

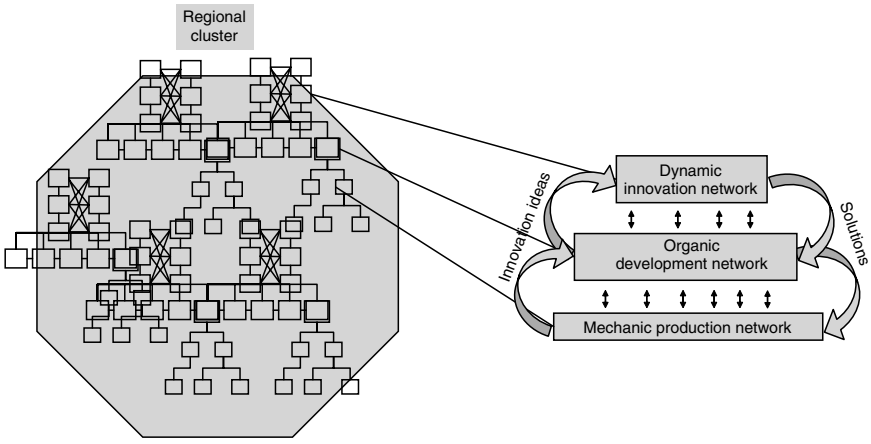
The three network types are not closed systems inside the region. A regional cluster consists of many overlapping production, development, and innovation networks, and some of the networks also have actors from outside the region. An actor in the regional cluster can simultaneously be a member in every type of network. In Figure 5, the ideal regional dynamics of the production, development, and innovation networks are presented. When the innovation network finds a solution for an individual actor's specific problem, the solution is diffused, before long, to other the actors due to the knowledge transferring nature of the development network. On the other hand, innovation ideas constantly emerge from the production network when the actors share their day-to-day problems or ideas with each other. When the innovation idea reaches the right actor, that actor will form an innovation network with or without the original actor where the idea originated and try to find a solution to the problem.

Our findings in the case regional cluster indicate that the key to a successful regional knowledge system is a functioning development network. If the development network does not work properly, new ideas will "die" on their way to the person who might be able to offer a solution to the problem. The main task of the development network is to keep the communication and trust between the different actors on a good level. If the actors do not trust each other, they will not share any ideas or solutions.

According to Ståhle and colleagues (Ståhle, 1998; Ståhle and Grönroos, 2000; Ståhle et al., 2003), an organization must have all of the knowledge environments

Figure 5

The regional knowledge system.



present in order to be successful. According to this idea, the innovations are born on the dynamic level of an organization with the right combination of information, competence, and creativity. On the organic level, the innovation is improved step-by-step, and on the mechanic level the innovation is put into production. In other words, innovativeness per se is not enough, but the organization also needs an organic and mechanic level to turn innovativeness into money. Similarly, the regional knowledge system needs production, development, and innovation networks in addition to the right actors to make the region competitive.

In our case regional cluster, the production network was dominant, but not the most important type of network in the cluster. The development network generated trust and communication between the actors with the sharing of knowledge, and the innovation network solved production-related problems. In our case region, the ideas for innovations were derived mainly from the production function. The presence of the university's research laboratory and the joint projects with research financiers and firms also provided innovation ideas that the production function in the region would not need in the short-term. Naturally, all of the network types of cooperation between for-profit companies have a very clear main goal: to make profit. But without learning, sharing of knowledge, and continuous innovation, the production network cannot have a future.

Discussion

In this chapter, we presented a systems theory-based view for understanding the creation of IC in a regional cluster of small firms. In our opinion, a single actor can simultaneously be a member of different kinds of networks. In order to be successful, the regional cluster has to be able to: 1) make use of existing knowledge as efficiently as possible in a vertical production network, 2) transfer firm-specific knowledge and ideas in a horizontal development network, and 3) invent new knowledge, products, production methods, or processes in a diagonal innovation network.

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The production network forms the core processes of the region. On the production network level, knowledge is implemented to production to make products or services for the customers. With the development network, the actors in a region share information with each other and improve the social capital of the region. In other words, on the development network level the actors form relationships, find a common language, and gain trust with each other. The new innovations produced on the innovation network level are transferred to improve the production methods with the knowledge-transferring nature of the development network.

When these network types are all present in a region, new innovations are transmitted to all of the actors to benefit each of them individually, and new innovation ideas constantly emerge. In this chapter, this cycle of innovations and innovation ideas between the production, development, and innovation network was named the regional knowledge system. Every network type in the region should lead towards the optimal situation in terms of competence, relationships, information flow, and leadership defined by Ståhle and colleagues (Ståhle, 1998; Ståhle and Grönroos, 2000; Ståhle et al., 2003) in their theory about different knowledge environments. When a regional cluster of small firms takes this into account, it makes the creation, transferring, and implementing of knowledge effective. In the optimal situation, the regional innovation network reacts to the problems in production almost immediately.

As a small cluster, our case region provided an easy opportunity to model different types of networks, and evaluate their critical factors. Our case region was dominated by a lack of trust and communication between the actors. This was partly due to the young age of the cluster. Some of the production-related problems caused trouble and made cooperation difficult. The main conclusion of the case study was that the development network level was the most important level in the case cluster. The development network can be seen as a prerequisite for trust and communication. If the development network in the region is not in good shape, the other types of networks between the actors are difficult to manage as well.

The idea of a regional knowledge system described in this chapter provides a new set of tools for understanding the regional dynamics of IC creation. With this mindset, the strategy process of a regional cluster can be improved. When the complex value network inside a regional cluster is divided into smaller entities according to their IC function, it is possible to manage and understand the whole region more effectively.

The regional knowledge system allows us to identify the structure of a complex regional cluster more easily. By separating the production function from the learning or innovation levels, it is easier to improve each level separately. With our view, it is also possible to discover the core processes and competencies in the region that need improving. When successful, the regional knowledge system approach allows the combination of innovativeness and efficiency in a regional strategy process. Products can be produced at the same time as innovation processes occur, which improves the competitive advantage of the region.

To validate our approach to regional clusters, the idea of the regional knowledge system should be applied to a larger number of clusters. With more cases, we strongly believe that it would be possible to create an assessment tool to manage the overall strategy of a regional cluster. One promising route for future research could be the formation of standardized, quantitative measures.

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APPENDIX 3

Paper III. Smedlund, A. (2006). "The Roles of Intermediaries in a Regional Knowledge System". Journal of Intellectual Capital 7(2). 204-220.

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The roles of intermediaries in a regional knowledge system

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Abstract

Purpose – The purpose of this article is to provide a tool to map the critical roles of intermediate organizations. To clarify the concept of intermediate organizations in a regional context, especially from the network dynamics point-of-view.

Design/methodology/approach – Regional dynamics are presented as networks of production, development and innovation in the regional cluster. The intermediaries are divided into national, regional and local level actors. The roles of the intermediaries from the network dynamics point-of-view are then illustrated with examples from a case study in a medical technology cluster located in a sparsely inhabited area in Finland.

Findings – According to the results of the case study, the regional intermediaries have the most important role in the creation and supporting of the network dynamics. The most critical roles include forming shared innovation strategies between the actors and attracting anchor tenants to the region.

Research limitations/implications – The characteristics of the case region are discussed in a generic sense with the concepts of social capital and communities of practice.

Practical implications – Conceptually, the article provides an approach to reducing the complexity of the regional networks to a more understandable level. The model provides a tool for the decision makers in a region to define the critical roles of the intermediaries from the network dynamics point-of-view.

Originality/value – The novel approach introduced in this paper addresses three gaps in existing research: it helps to define the concept of an intermediary in a regional context; it shows that the intermediaries have a much broader role in a region than just knowledge transfer and that the roles of the intermediaries differ on national, regional and local levels.

Keywords Intermediaries, Innovation, Regional development, Intellectual capital, Knowledge processes, Finland

Paper type Conceptual paper

Introduction

Globalization has made it possible for companies to outsource virtually anything to a country with lower costs of production. This leads to numerous challenges in regional development. It has been said that in the new knowledge-based economy, the importance of attractive regions is emphasized (Castells, 1996). A region and the clusters within it are the main building blocks of successful states. The region has to be able to maintain its critical mass of constant innovation and effective production in order to prevent slow decay. Only a healthy region is capable of attracting flows of capital, competent employees and multinational companies, and compete against other regions in the world.

Based on a case study in the mechanical wood processing industry, Pöyhönen and Smedlund have taken a dynamic knowledge-based view on clusters and argue that regional clusters can be perceived as consisting of three types of networks: production, development and innovation networks. Each network type creates a certain type of

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knowledge-based competitive advantage, and has its own operational logic and effectiveness criteria. Furthermore, it can be claimed that in order to implement, develop and innovate intellectual resources effectively, a regional cluster has to include all types of network. (Pöyhönen and Smedlund, 2004).

Smedlund and Pöyhönen also argue that a single actor in a regional cluster can be a member of different kinds of networks at the same time. In order to be successful, the regional cluster has to be able to:

- make use of existing knowledge as efficiently as possible in a vertical production network;
- transfer firm-specific knowledge and ideas in a horizontal development network; and
- invent new knowledge, products, production methods or processes in a diagonal innovation network.

When these network types are all present in a region, new innovations are transmitted to all the actors to benefit each of them individually, and new innovation ideas emerge constantly. The cyclic nature of innovations and innovation ideas between the production, development and innovation networks can be called the regional knowledge system (Smedlund and Pöyhönen, 2005).

In brief, the main idea of the dynamic, knowledge-based view of regions can be summarized as follows: a regional cluster of small firms is structured in a network type of co-operation, depending on the intellectual capital-related functions. These functions come in three basic forms:

(1) knowledge creation;

(2) knowledge transfer; and

(3) knowledge implementing.

They represent the basic tasks of a firm in the new knowledge based economy. Knowledge creation is needed in new innovations, knowledge transfer is needed in learning the best practices, and knowledge implementing is needed in producing products as efficiently as possible. A single firm in a region can be a member of a dynamic innovation network, an organic development network and a mechanic production network at the same time (Ståhle *et al.*, 2003). The networks have members outside the region as well.

Thinking of a regional cluster as a set of interconnected networks that serve different IC-related functions provides a preliminary understanding on how regional competitive advantage is created in the knowledge -based economy. The question that still remains is how to foster the process of continuous and simultaneous innovation, learning and production in a regional cluster. In other words, how to improve the overall dynamics of the regional knowledge system? According to Saxenian (1994), networking among firms in a region is enabled and supported by regionally embedded institutions such as chambers of commerce, employers' unions, banks, science parks, universities, and training centres (Saxenian, 1994; Ebers, 1997). These kinds of institutions can also be called intermediaries, or intermediate organizations that transfer knowledge inside the region and influence the success factors of the region.

In this paper, the roles of intermediaries are discussed from the regional dynamics point of view. The dynamic, knowledge based view of the region adopted in this paper reduces the complexity of the regional networks into a more understandable level. Besides knowledge creation, knowledge transfer and knowledge implementing functions, the intermediaries are divided into national, regional and local level actors. The roles of the intermediaries in a regional knowledge system are then illustrated with examples from a case study in the eastern part of Finland. As the result of the case study, it is argued that the regional level intermediaries have the most important roles in the improvement of regional dynamics. These regional roles include such tasks as ensuring coherent innovation strategies between the actors and attracting anchor tenants to the region.

There is no one recipe to create successful regions. Managers and decision makers working with regional development issues face difficult challenges, including how to attract not only physical capital but also creative human capital to the region. Furthermore, the needs and motives of the different regional actors seem in many cases inconsistent and undefined. With the simple modeling tool that this article provides, it is easier to see the critical roles of the intermediaries that are associated with the dynamics of a region, and this way improve the overall regional capability to meet the future challenges and adapt to the global market environment.

Dynamic success factors of a region

In this paper, the success factors of a region are divided into three classes:

(1) substance;

(2) structures; and

(3) dynamics (Ståhle *et al.*, 2003; Smedlund *et al.*, 2005).

This division is logical and provides a mind map to explain different kinds of factors that are related to the success of regions. This division is highly inspired by the intellectual capital literature, where IC is commonly explained in terms related to: human capital; structural/organizational capital; and relational capital (for a good overview, see Andriessen, 2004).

In the regional context, the substance factors are field specific knowledge, skills and competence. Structural factors form the infrastructure of a region and dynamic factors make the region alive. This way, the dynamic success factors can be seen as the processes that turn the substance and structures of a region into value.

The production and transaction cost-based structures of regions have traditionally been regarded as their success factors. These components include factors of production, demand conditions, related and supporting industries, and rivalry, as presented by Porter (1990), and geographical distance and the economics of scale as presented by Krugman (1991).

Both Porter and Krugman argue that the success factors of clusters are "hard" structures typical for mature and physical capital intensive industries. These hard structures are easier to make concrete than new intellectual capital-based, "soft" structures. From the viewpoint of the overall success of a region, the soft structures include such things as regional steering methods, strategies, institutions and legislation that are likely to support innovation, development and production activities

in the region. The soft structures should be as unequivocal as possible to steer the economic activity in the region persistently and consistently (Smedlund *et al.*, 2005).

Besides structures, a region also needs a solid base of substance that is the knowledge, competence and managerial skills – human capital – of the actors inside the region. Even though the structures and substance are important for a region, the new knowledge-based theory emphasizes dynamics – the tangible and intangible flows that occur inside the region that make the system alive (i.e. Allee, 1999, 2000, 2002). In the heart of the dynamics are the different networks and their interplay.

The structure, substance and dynamics of a region can be further made concrete by using the terms appearing in the intellectual capital literature. The approaches to the determinants of competitive advantage in the knowledge-based economy can be divided into three categories: assets, capabilities and relations (Pöyhönen and Smedlund, 2004). To take full advantage of the hard and soft structures of a region, the existing intangible assets need to be identified and valued. Capabilities are related to the substance of a knowledge-based region, because the capabilities view emphasizes the capability to create, develop and modify intangibles. The capabilities view also highly emphasizes personal skills and know-how. Thirdly, the relations are connected to the dynamic side of a knowledge-based region. Production, development and innovation networks require social relations, interaction and collaboration (Figure 1).

The dynamics of a region can be argued to be the most important success factor of the region. In Allee's view of value networks, the flows that take place in the networks make a value system alive (Allee, 2002). Without the dynamics, a region is just a skeleton. The tangible and intangible flows between the actors function as a blood circulation system in the region, enabling the system to meet the changing needs of the business environment.

According to the idea of a regional knowledge system (Smedlund and Pöyhönen, 2005), the tangible and intangible flows flow in the regional networks of production, development and innovation. An individual actor can be a member of each type of

Substance	=	Knowledge, skills and competence	→	Needs *capabilities* to create, develop and modify substance
Structures	=	*Hard structures:* factors of production, demand conditions, related and supporting industries, rivalry, distance and economics of scale. *Soft structures:* regional steering methods, strategies, institutions and legislation	→	Needs identification and evaluating of existing *assets*
Dynamics	=	Networks of production, development and innovation	→	Needs social *relations* and interaction combined with networks and collaboration

Figure 1.
Substance, structures and dynamics as success factors of a region

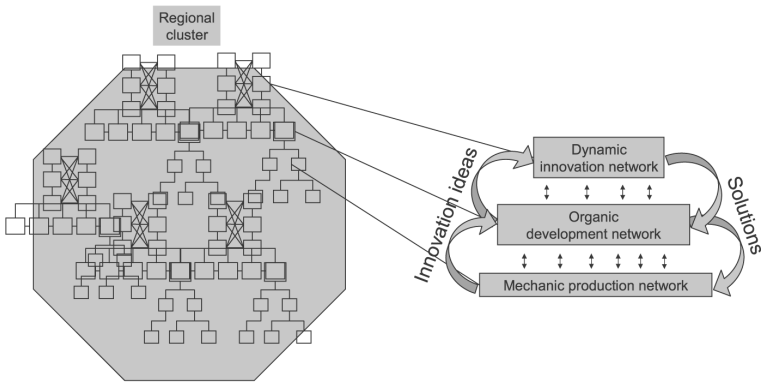
network simultaneously. A production network is a vertical type of co-operation between multiple actors, and its purpose is to create value to the region by producing and selling products to the markets. In achieving this purpose, the production network implements the existing knowledge as effectively as possible. The main benefit of the production network is that it lowers the transaction costs of the actors by letting them to concentrate on their core competences.

The development network is horizontal, and the purpose of the network is to ensure that information is transferred between the actors. In achieving this purpose, the development network shares firm-specific knowledge between the actors. The development network increases learning among the actors by creating trustworthy relationships and increased communication.

The shape of the innovation network is diagonal. The innovation network is a complex network of many kinds of actors, for example firms, institutions, financiers etc. The relations in the innovation network cross many traditional borders of hierarchy. The main purpose of the innovation network is to bring together different actors and resources to raise the value of the network. The task of the innovation network is to create new knowledge. The main benefit of the innovation network for the region is continuous improvement of products, production methods and production processes.

The idea of the three types of networks of knowledge creation, knowledge transfer and knowledge implementing is originally based on the theories of the knowledge environments of an organization presented by Ståhle (Ståhle, 1998; Ståhle and Grönroos, 2000; Ståhle *et al.*, 2003). According to Ståhle the competitive advantage of an organization is formed with the interplay of mechanic, organic and dynamic knowledge environments. The knowledge is managed in the organization by creating different environments that have different logic of producing value with knowledge. Another similar classification has been presented recently by Möller and Svahn (2003). In their theoretical article based on the theories of the industrial network approach, strategic management and dynamic capabilities, Möller and Svahn argue that there are three main archetypes of inter-organizational networks. These are stable value systems, established value systems and emerging value systems. In their approach, firms in a certain market form strategic "nets" that follow different value system logics. In a stable value system, well-known and specified value activities prevail. The actors, technologies and business procedures are clear and defined. In an established value system, the incremental improvements take place between the actors. The value system is well known, but the network evolves through local and incremental modifications within the existing value system. An emerging value system represents radical changes, where the whole value system is not yet defined, the actors are not known and the old value activities are changed radically. An emerging value system is capable of changing rapidly, but there is also a lot of uncertainty involved.

The implications of the different knowledge environments and value systems on the regional level are the production, development and innovation networks. These networks form a hologram type of system that we call the regional knowledge system (Figure 2). According to this framework, new innovations are innovated on the innovation network level with the combination of different knowledge, competence and creativity. On the development network level the innovations are improved gradually, but nothing new is invented. In the production network the final products are produced



Source: Smedlund & Pöyhönen (2005)

Figure 2.
Regional knowledge system

as effectively as possible, or a new production method or process is applied into practice. It is important to understand that the dynamic innovation network level alone does not guarantee the success of a region. The region also needs organic development networks and mechanic production networks to turn innovations into money. Besides having these different types of networks, the networks have to be linked with each other. According to the framework that this thinking provides, the region is able to achieve the benefits of lower transaction costs, economics of scale as a form of united market force, and continuous innovation simultaneously.

In the regional knowledge system, the production network (order and supply chain) brings cash flow to the region and functions as a customer interface. The development network (best-practice type of learning, spillover of knowledge) improves the performance of the independent actors. The innovation network (research and design) ensures continuous creation of new knowledge. In the regional knowledge system of production, development and innovation networks, not only new innovations are utilized, but also new innovation ideas that emerge in the production function can be taken into account rapidly.

In the regional knowledge system framework, every actor in the region can be a member of every type of network. The network-based view of the dynamics of a region is that the actors form collaboration relationships to serve different tasks. Production, development and innovation are just the archetypes of different tasks that firms need in the knowledge-based economy. The actors have to be conscious of other actors in the region as well. The interplay of the different networks is a prerequisite for the dynamics of a region. New innovations require a platform for new ideas, a broad learning base and the capability to make products effectively. Links between the networks are formed when an actor is involved simultaneously for example in production and innovating. This makes it possible for new innovation ideas and best practices to improve the production processes through mutual learning.

As mentioned above, the success factors of a region can be thought of as factors related to substance, structures and dynamics. Substance consists of the field-specific knowledge base in the region and structures are the factors that make it possible to

make profit out of knowledge with the dynamics. In this paper, regional dynamics are defined as being the networks of production, development and innovation and their interplay. Structures and substance can be influenced directly to some extent, because they are easy to understand and concretize. Dynamics, instead, cannot be acted on directly. The networks cannot be administered, but they can be steered towards the desired outcome. In the following I will discuss the concept of an intermediary and particularly the roles that intermediaries have in the network dynamics of a region.

National, regional and local intermediaries

In general, an intermediate organization is an organization that functions in the midst of the users and producers of knowledge. According to Vonortas, intermediaries can be found between the government and the private sector (Vonortas, 2002). Case studies in Latin America have shown that these intermediaries have a significant effect on the performance of SMEs. The intermediaries assist SMEs in many ways. Vonortas argues that "Frequently, the most useful type of assistance to SMEs is not technological but more general business oriented such as locating and approaching the customer, achieving a steady cash flow, developing relationships of trust, accessing finance, managing the firm effectively, and training the employees" (Vonortas, 2002, p. 4).

A narrow definition of the concept of an intermediary is related to the substance of the region. According to this definition, the purpose of an intermediary is solely knowledge transfer from the creators of knowledge to the users of knowledge. This is the definition that is used when the technology transfer from universities to local firms is studied.

However, the effect of an intermediary to the surrounding region is broader than just technology transfer. For the success of a region, the founding of structures and dynamics is also an important task of an intermediary. The broad definition of an intermediary thus covers:

- the knowledge transfer related to the substance of a region;
- the direct or indirect effect of intermediary on the structures of a region; and
- the direct or indirect effect on the dynamics – production, development and innovation network and their interplay (Smedlund *et al.*, 2005).

Defining clear roles for intermediaries is not simple. On one hand, an intermediate organization can be a form of an organization of its own, but on the other the concept of an intermediary can be defined as being a role or a mission of any organization in a region. In a regional cluster, there seldom are organizations that focus exclusively on intermediating tasks. Many organizations can function as intermediaries unconsciously. The concept of intermediary should be defined as a framework in which the roles of different actors in a regional knowledge system can be studied.

In the field of social capital research, and especially in the publications of the World Bank, the unit of application highly depends on whether the event studied is considered to be on the macro, meso or micro level (Grootaert and van Bastelaer, 2001).

The macro level is the national political atmosphere in which the norms, networks and trust between individuals and groups evolve. It is possible to influence the macro level social capital by influencing the institutions, political regime, laws, or the freedom of speech (Grootaert and van Bastelaer, 2001). Some researchers even consider the differences on the macro level social capital between nations to be the reason for the

economical success of certain nations (Hjerppe, 2003). This view is based on the idea that even though the knowledge is available to all, only nations with high social capital can turn this knowledge into economic value. The social capital on the macro level offers national conditions for the success of the regions and it also includes the meso and micro levels.

The micro level covers the relationships between individual persons and/or individual small groups of persons. When these micro level groups function properly, they cause positive externalities to the surrounding society. Of course, the externalities can also be negative, as for example in the case of mafia. The meso level perspective includes mainly the relationships and networks between organizations and groups. Individuals or organizations perform actions within a certain type of social structure. The links on the meso level are both vertical and horizontal, and therefore it functions as a link between the macro and micro levels (Grootaert and van Bastelaer, 2001).

As with the concepts of social capital, the goals and missions of an intermediary vary according the level of observation. These levels are:

- national (macro);
- regional (meso); and
- local (micro).

The mission of a national intermediate organization is to ensure the success of the nation as a whole. The mission of a regional intermediary is to support the success factors of the region, and the mission of a local intermediary is to serve local firms in their business. The macro, meso and micro level intermediaries have a different effect on the success of the regional knowledge system. The different levels of intermediate organizations represent the nature of the mechanisms that make a region successful.

The macro level intermediate organizations create national prerequisites for successful regions. According to Porter (1996), the government has to support companies, because companies create competitive industries. Porter also states that "Government policies that succeed are those that create an environment in which companies can gain competitive advantage rather than those that involve the government directly in the process" (Porter, 1996, p. 185). The macro level intermediate organizations are those that function, in Porter's terms, as catalysts and challengers for companies.

On the regional level, the main task of an intermediary is to orchestrate collaboration between the key actors in the region. The regional meso level ensures that regional strategies are consistent and up to date. An intermediary on the regional level also functions as a link between the micro and macro levels.

The local micro level intermediary functions locally and helps individual firms or persons to gain knowledge. On the micro level, interpersonal relationships are emphasized and the basis for trust and communication between the actors is created. The local intermediaries establish contacts, arrange networks and offer resources to the companies in the region. Examples of local intermediaries are knowledge intensive business service firms (KIBS). According to Miles, KIBS organizations, for example, work with companies in the innovation process, mobilize new ideas for further development, and keep track on possible partners and markets (Miles, 2001; Kemppilä and Mettänen, 2004).

Roles of intermediaries from the regional dynamics point of view – case Kuopio region

National, regional and local intermediaries influence the substance, structures and dynamics of a successful region in many different ways. The right substance – knowledge and competence – require regional capabilities to create, develop and modify intangible assets. The intermediaries are able to influence these capabilities for example by creating national programs, by regional politics or by supporting local competence. From the point-of-view of structures, existing assets need to be identified and valued. An intermediary can evaluate the existing structures and intangible assets and focus on developing essential structures. A national intermediary can for example try to change patent laws, a regional intermediary can build the basic infrastructure, and a local intermediary can improve the business services of a region.

In this paper I concentrate merely on the dynamics creation aspect. As mentioned above, by regional dynamics I mean different networks and their interplay in a regional cluster. From the viewpoint of regional dynamics, the roles of the intermediaries are related to relationships, interaction, networks and collaboration. Naturally, a successful region is based on a solid base of substance that the structures support. It is also obvious that without dynamics the substance and structures cannot be turned into value. Therefore, substance, structures and dynamics are connected together with positive feedback loops. The intermediaries can affect the loops by taking the right initiatives. When the roles of the intermediaries are known, it is easier to make the right decisions.

The roles of the intermediaries from the regional dynamics point of view were constructed during the summer 2004 in a research project launched by the Finnish Ministry of Trade and Industry (Ståhle *et al.*, 2004; Smedlund *et al.*, 2005). The result of this short research project was a report on the challenges of Finnish national, regional and local intermediate organizations. The case region was the Kuopio region in the eastern part of Finland, and especially the medical technology cluster in the region. The data collection method was a theme-based interview ($n = 8$) with the key persons in the region. The themes were the missions, roles and collaboration of the organizations, and the personal opinions of the interviewees. Also previous reports and articles about the case region and the Finnish innovation system were used. During the case study, around 20 organizations were identified in the Kuopio region that have a role of an intermediate organization in the region. In this paper I use only three of these organizations to illustrate the roles of the intermediaries in the region. The three intermediaries presented in this part are: the national "Finnwell" technology program (www.tekes.fi/eng/), the regional "Health-Kuopio" project (www.tervekuopio.fi/freimstart.htm), and the local "Teknia"-technology center (www.teknia.fi/).

In Finland, the growth of the economy takes mainly place in three areas: in the Helsinki area, where most of the people live, in the Tampere region in central Finland, and in the Oulu region in the north. Oulu has been successful mainly because of Nokia, Tampere has a long industrial history, and Helsinki has most of the head offices of Finnish companies as well as most of the research and development activity in Finland. The Kuopio region is an exceptional region compared to the other growing regions in Finland. The whole region, including the town of Kuopio and the surrounding municipalities has only 117,000 inhabitants (Valovirta and Virtanen, 2004). The Kuopio region is located far from all the other growth areas (Helsinki = 250 miles,

Oulu = 150 miles and Tampere = 180 miles). Also, Kuopio does not have a port and there are no natural resources, except for spruce trees and lakes. The industrial history of the region is also not very notable, except for a couple of forest mills and pulp factories. The main field of business in the region has been agriculture, but along with the structural changes in the agricultural politics of Finland and the EU, farming has become unprofitable. Furthermore, basic labor in Finland is too expensive, so basic factory labor will not be the source of the future success of the Kuopio region.

The main competitive advantage of the future that the whole Kuopio region counts on is the University of Kuopio and the research and development activities that the university supports. The University of Kuopio was founded in 1972 as a result of the regional politics of the Finnish government. In the 1960s and 1970s, three universities were established in the sparsely inhabited eastern part of Finland. It is widely agreed among the key persons of the Kuopio region that the university provides a solid base of substance and knowledge. In fact, the university is the third biggest employer in the region after the city of Kuopio and the central hospital. There are only a few considerable employers in the private sector, and the rate of unemployment is around ten percent (Statistics Finland, 2003). This skewed employment situation in the region illustrates the present situation of the region as a periphery of the EU and one of the poorest regions in Finland.

The main direction of the strategy of the region is clear, and all the key actors think similarly about the future of the region. The competitive advantage of the region is going to be built on technology related to medical technology. There is no clear definition for this field, but the concepts of wellbeing, welfare or life-science are commonly used.

Examples of national, macro level intermediaries affecting the dynamics of the region are national technology programs where the actors in the region participate. The actors in the region take part in numerous national research and development programs that provide funding and form national and international links between universities, research laboratories and companies. Examples of the programs are "iWell" and "FinnWell", both of which study how to improve health care services with new technology. According to de Juan (2002), the strength of the Finnish national system of innovation is often considered to be the close cooperation between companies, research organizations and universities. One reason for the cooperation is that the National Technology Agency (TEKES) requires joint research projects between companies and universities in their funding programs.

In the research of regional development, the "triple helix" model is often used to describe the regional collaboration between universities, government and firms. In the "triple helix" model, private, public and science worlds are interwoven when the processes of innovation and strategy formation are built up in the region. Shared discussions and projects blur the borders of the institutions, and the actors may even take up the role of each other in the region (Etzkowitz and Leydesdorff, 2000).

In the Kuopio region, an example of a regional "triple helix" type of shared building of strategies and visioning is a project led by the city of Kuopio. This project, called "Health-Kuopio" is a kind of an "umbrella" project for the overall strategy of the whole region. The ambitious vision of the project is that the region will be the best life-science centre in the EU. The steering group of this project consists of members from all-important actors of the region from private, public and science sectors. This project

was considered as being important, because it keeps the different strategies of the different actors consistent. One result of this project is a study of the region's strengths and weaknesses compared to other life-science clusters in Finland. Besides strategy formation, one of the goals of this project is to give a positive image of the region to the outside world.

High-technology industrial parks and technology centers are examples of intermediaries of the local level. In Kuopio, the technology center "Teknia" was considered to be the most important local level intermediate organization. Teknia's role in the region is to help the small firms in the region. It provides a set of basic services to the firms: for example office space and legal consulting. Teknia also seeks partners from outside the region and evaluates the business ideas. To some extent, the publicly owned Teknia functions as a KIBS organization. This is a good thing because the region is not big enough yet to support specialized private service organizations. In the long run, however, the business services should be privatized.

As a whole, the Kuopio region has good conditions for new innovations. From the innovation network point of view, the region has the right substance and structures. Universities, financiers and small businesses are located close to each other. From the viewpoint of the development networks, the region lacks high quality business services and the substance of a knowledge base for example in marketing, patent laws and international relationships. In fact, the interviewees mentioned a variety of examples of excellent innovations that had failed to succeed because of lack of management and market competence. The production function in the region is very poor. At the time of the interviews, it seemed that there were only a couple of firms in the region that actually sold their life-science -related products to the market successfully. The obvious hindsight of the lack of production networks was that the new knowledge did not find its way to be used in practice. There was also no feedback system to receive innovation ideas from the production. Roughly speaking, the new research and innovations were either left unutilized or they were taken out of the region.

The interviewees saw the absence of big firms a problem in the region. The presence of big, anchor tenant type corporations creates regional dynamics and provides growth opportunities for other firms in a region (Agrawal and Cockburn, 2003). Also, the trend in the field of medical technology seems to be that the nature of the business environment favors large units. Furthermore, evidence of the importance of anchor tenants can be found in the success of the Oulu region. Oulu in northern Finland seems to be based on the fact that the Nokia corporation functions as an anchor tenant in the region. Nokia, its subcontracts and the University of Oulu have been working in close collaboration since the 1970s (Synocus, 2004). The substance created in the university has been utilized successfully in Oulu and the knowledge has been successfully anchored inside the region to benefit other regional actors.

As a result of the interviews and the regional knowledge system framework (Smedlund and Pöyhönen, 2005), the main roles of the intermediaries from the regional dynamics point of view can be introduced. National, regional and local intermediaries have distinct roles from the point of view of the innovation, development and production networks of a regional cluster of small firms. As summarized in Table I, the main roles of a national intermediate organization is to support the joint projects of science and private sectors in innovation, provide national forums of knowledge sharing, and influence the institutional environment for production. The roles of

	National/macro level intermediaries	Regional/meso level intermediaries	Local/micro level intermediaries
Innovation networks	Supporting joint projects of science and private sectors	Keeping the innovation strategies coherent between the actors. Promoting triple helix type of cooperation.	Trusted third parties. Selection of innovation ideas. Hubs in the transfer of information.
Development networks	Providing national forums to encourage firms in building national and international links	Forming national and international relations. Forming regional forums for knowledge sharing	Coordinating forums of knowledge sharing and learning among entrepreneurs. Creating trust and communication
Production networks	Influencing the laws, taxation and other institutions for a better environment for production	Attracting anchor tenants to the region	Knowledge intensive business services to small firms

Table I.
The roles of intermediaries in the dynamics of a regional knowledge system

regional intermediate organizations are related to the overall strategy of the region. The regional intermediaries promote the triple helix co-operation, form relations and attract anchor tenants to the region. Local intermediate organizations are in a close relationship with the firms in the region. The local intermediaries function as hubs in the networks, coordinate forums of knowledge sharing and provide knowledge intensive business services to firms.

In the Kuopio region, the main roles of the case intermediate organizations support the roles introduced in Table I. The technology programs, such as the FinnWell program, financed by the National Technology Agency (TEKES) are joint projects between the universities and the private sector, the "Health-Kuopio" project lead by the city of Kuopio is an umbrella type of a project to provide shared vision and strategies to the whole region, and finally, the main role of the technology center Teknia is to support the development of the start-ups and small firms in the region.

Discussion

Defining the concept of an intermediary and making sense of the numerous roles that national, regional or local intermediaries have in a region is not simple. The narrow definition presented in this paper was that the intermediaries transfer knowledge between the producers and users of knowledge, thus improving the knowledge and competence base of the region. In a broader sense, the intermediaries also influence the structures and dynamics of a region. The view presented in this paper considered the universities as producers of knowledge and local firms as the knowledge users. In real life, besides the knowledge transfer from universities to firms, there is also a lot of knowledge transfer and sharing between firms. The role of corporations as knowledge producers is increasing and firms even produce the same kind of reports and articles as universities do. Also, joint projects between firms and universities blur the distinction between knowledge producers and knowledge users.

According to the case study, the regional intermediaries can be argued to have the most important roles from the point of view of the overall dynamics of the region. The regional intermediaries link local and national levels together with mutual strategy formation and visioning processes. With the functioning triple helix of public, private and science worlds, the overall strategy of the region can be steered towards the right fields of business. This conclusion supports de Juan's view that direct national interventions cannot work alone when building successful regions (de Juan, 2002). It seems that in addition to national regional politics and other macro level steering methods, a successful region needs mutual commitment of the key actors in the region as well as good business services to local firms.

The regional level intermediaries seemed to be emphasized in the case region, possibly due to the small size of the region and the lack of possible paths of success in the future. Medical technology was seen as the only possible competitive advantage in the future among the interviewees. The region has good preconditions for this, only companies making use of the knowledge and competence of the region are still missing.

The case region has many unique Finland-specific characteristics, such as the high involvement of national government as the buyer of products and services from the firms in the region, and the fact that nearly all of the intermediaries studied in the Kuopio region were publicly run. The intermediaries introduced above (Finwell, Health-Kuopio and Teknia) have been founded and have hired professional managers

at the expense of the tax-payers. In the early stages of building the regional dynamics in Kuopio, this was considered a good thing, because according to the definition of the intermediary introduced in this paper, intermediaries "patch up" holes in the existing regional networks and influence the success factors of a region in many ways. In this sense, the focus of the roles of intermediaries is always different depending on the characteristics of a region.

The general characteristics of the Kuopio case can be transferred to other regions as well by using the concepts of social capital and communities of practice. At its simplest, the concept of social capital is based on the notion that "social relationships have value" (Putnam, 2000). Cohen and Prusak (2001, p. 4) define social capital as follows: "Social capital consists of the stock of active connections among people: the trust, mutual understanding, and shared values and behaviors that bind the members of human networks and communities and make cooperative action possible". It was stated above that social capital has three dimensions, namely macro-, meso- and micro level (Grootaert and van Bastelaer, 2001). In the regional context, there are studies that show positive correlation with social capital and learning benefits in young technology firms (Autio, 2000; Yli-Renko *et al.*, 2001). In the case region, the intermediaries seemed to leverage the social capital on macro-, meso- and micro level by directing funding to the shared projects between firms and universities, bringing different actors together to form shared strategies in a "triple helix" (Etzkowitz and Leydesdorff, 2000) for the region and building shared technology centers for the firms in the region.

The concept of communities of practice is related to social capital. In fact, it can be stated that communities of practice represent micro level social capital that has positive externalities to the surrounding region. Wenger and Snyder (2000, p. 139) state that communities of practice are "groups of people informally bound together by shared expertise and passion for a joint enterprise". They also argue that communities of practice cannot be created intentionally, but they can be encouraged by bringing the right people together and providing an infrastructure for them. From the learning perspective and in the light of a case study in Silicon Valley, Benner (2003) argues that significant individual level learning takes place in communities of practice. He also argues that communities of practice can be actively built through the formal activities of professional associations.

In the Kuopio region, the intermediaries were able to encourage the formation of communities of practice. The local level intermediaries working directly with the companies can be considered especially important in building communities of practice. During the work with companies, the intermediaries form a good understanding of the characteristics and competencies of the region's firms. This way they can act as brokers in the building of different work-related associations between individuals working in these firms. In Kuopio, Teknia also arranged seminars and other events regularly for the firms in the region. Furthermore, mentioned as a curiosity, it was noted that the shared cafeteria in the technology center Teknia was purposefully built to be a little bit too small to encourage social networking between the employees of different companies during lunch and coffee breaks.

The main contribution of this paper is the framework for defining the roles of intermediaries in a region. By dividing the regional networks according to their intellectual capital functions – knowledge creating, knowledge transfer and knowledge implementing – and combining this with macro, meso and micro

perspectives, provides a tool for the decision makers of a region to understand the critical roles of the intermediaries.

In the final analysis, only private sector companies can turn the substance, structures and dynamics of a region into economic value. The most important task of the intermediaries should be to offer support to the companies located in the region, make the region attractive for entrepreneurs and allure anchor tenants to the region. From the dynamics point of view, this leads to numerous challenges in the leadership of the intermediaries. Especially on the regional level, the challenges will be to improve the image and identity of the region, leverage the social capital and encourage communities of practice in the region, create appealing environments to creative individuals, and generate local, regional, national and international links and relationships of knowledge creation, knowledge transfer and knowledge implementing. When the roles of the intermediaries are realized first, it is easier to meet these challenges.

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APPENDIX 4

Paper IV. Smedlund A. and Toivonen M. (2007). "The Role of KIBS in the IC Development of Regional Clusters". Journal of Intellectual Capital 8(1). 159-170.

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The role of KIBS in the IC development of regional clusters

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Abstract

Purpose – The paper seeks to introduce the concept of knowledge-intensive business services (KIBS) in the context of regional networks and to analyze the roles of KIBS in regional development, especially from the viewpoint of regional intellectual capital.

Design/methodology/approach – Regional networks are presented as the networks of production, development and innovation in the region. Drawing from recent literature, the roles of KIBS in regional networks are discussed.

Findings – It is argued that networks for production emphasize explicit knowledge, networks for development emphasize tacit knowledge, and networks for innovation emphasize emergent, potential knowledge. It is further stated that KIBS provide the timely information needed in production networks, transfer best practices that support learning in development networks, and function as sources of innovation and facilitators of innovation processes in innovation networks.

Practical implications – The paper provides an approach to reduce the complexity of regional networks into a more manageable level, and highlights the importance of knowledge-intensive business services in regions.

Originality/value – The approach used in this paper addresses the following gaps in existing research: it argues that KIBS are important actors in the regional IC development, highlights that the roles of KIBS are different in production, development and innovation activities, and argues that a successful region needs all of these activities.

Keywords Intellectual capital, Knowledge management, Networking, Knowledge organizations

Paper type Conceptual paper

Introduction

The role of knowledge has been widely discussed in the management literature. It has been argued that the so-called "knowledge-based economy" functions – at least to some extent – with a different value-creating logic to the industrial economy. The special attributes of knowledge, especially its characteristic as a "public good" and the endless replication possibilities included in it, make knowledge a key economic resource. Knowledge is seen today as the dominant source of competitive advantage (Drucker, 1995; Marr, 2005).

The role of regions is highlighted in knowledge-based economy. Knowledge sharing contains elements that require physical proximity – learning by doing and learning by using are good examples of this. Although the new information technology increases the possibilities for codifying knowledge and transferring it over long distances, much

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of what needs to be communicated remains tacit. Besides the opportunities for contacts and informal links provided by spatial proximity, there are also other rationales behind focusing on regions. The peculiarities of the institutional fabric vary between regions, and the primary place of firms' decision-making is at the regional level. Furthermore, there are often localised pools of specialised expertise for certain industries. Finally, actors in the same region share, at least to some extent, common perspectives, norms and culture, which helps in creating an atmosphere of trust and confidence (Dosi, 1999; Howells, 1999; Kautonen, 2001; Zenker, 2001).

Thus, the increasing internationalisation does not erode the significance of regions. On the contrary, many researchers consider the globalisation and regionalisation tendencies to be interconnected and mutually reinforcing (Howells, 1999). However, regions have to be active and find their own strengths in order to survive. With this kind of a strategy even remote regions can attract different kinds of flows: capital, employee and knowledge flows (Castells, 1996).

Networking and the development of strong regional clusters have been argued to be a method by which the competitiveness of regions can be increased. The discussion on regional clusters is topical, for example, in those peripheral regions of the European Union where structural alterations have made traditional industries and agriculture unprofitable. The role of supporting services beside the industrial core has aroused growing interest in regional networks and clusters in recent years. Sufficient supply of services in a region often causes the emergence of "a virtuous circle": the services attract more firms to the region and the growing regional economy needs more services (Martinelli, 1991). Along with the development of the knowledge-based economy, advanced manufacturing industries depend on the availability of so-called "knowledge-intensive business services" (KIBS) in particular.

The purpose of this paper is to analyse the roles of KIBS in regional development, especially from the viewpoint of IC development in regional clusters. Regional clusters are collaborations of several organizations within the same geographical area and industry (Porter, 1990). The roles of KIBS are examined in three kinds of networks developing in the context of a regional cluster:

(1) production networks;

(2) development networks; and

(3) innovation networks.

It is argued that in each of these network types a specific type of knowledge – explicit, tacit and potential, respectively – becomes highlighted (although also other kinds of knowledge are needed). Correspondingly, the roles of KIBS are to some extent different in different kinds of networks. Before going more deeply into these roles, we summarise briefly the central findings of the earlier KIBS research as well the arguments behind the above-mentioned categorisations of networks and knowledge[1].

The nature and significance of KIBS

KIBS are expert companies that provide services to other companies and organisations. IT services, R&D services, technical consultancy, legal, financial and management consultancy, and marketing communications are typical KIBS industries (Miles *et al.*, 1995; Hermelin, 1997; Strambach, 2001).

KIBS have been found to hold a crucial position in the knowledge processes between and within firms, due to which their role as a supporter of the development of the knowledge-based economy has inspired broad discussion. Several studies have shown that KIBS are important sources of knowledge, facilitators of knowledge creation and carriers of knowledge (Miles, 1999). The role of KIBS as knowledge sources is linked to their functioning as active innovators. The versatile innovation activities in KIBS – measured both by investments in innovation and by the outputs of innovation – have been confirmed, for example, by the Community Innovation Surveys (Miles, 2001). The ability of KIBS to facilitate the knowledge processes of other companies stems from their numerous and versatile contacts with various stakeholders. On the basis of these abundant contacts KIBS have a broad view of the latest developments, which enables benchmarking (Strambach, 2001). While "shuttling" between different clients, KIBS also carry new ideas and best practices from one firm to another. They have been found to be the most common vehicle for the diffusion of innovations from larger firms to small and medium-sized enterprises in many countries (Organisation for Economic Co-operation and Development, 1999).

In the analysis of knowledge networks, the role of KIBS as "brokers" or "bridging intermediaries" has been the focus of several studies, i.e. besides the above-mentioned functions KIBS have been studied as actors which combine knowledge sources and knowledge users. They have been seen to form nodes in systems of customers, cooperation partners, public institutions and R&D establishments (Werner, 2001). The significance of the brokering function of KIBS is highlighted by the fact that most innovations today are not created inside single companies, but in networks of multiple companies (i.e. Powell, 1998). Empirical studies suggest that the network relationships and the bridging function of KIBS are mainly horizontal, linking firms within and across industries. However, as the employees in KIBS typically have an academic background, there are also natural linkages to the scientific world. (Kautonen, 2001; Leiponen, 2001).

KIBS act as an interface and mediator between the knowledge buried in the daily practices of firms and the generic knowledge available in the economy as a whole. They are containers and dynamic sources of "quasi-generic knowledge" extracted from repeated interactions with firms and other actors, including producers of new scientific knowledge (Antonelli, 1998, 1999). Some researchers have summarised the role of KIBS in the society by saying that KIBS form an informal, private, "second" knowledge infrastructure, which complements the intermediate role played by the formal, public knowledge base, i.e. education and research institutions (den Hertog and Bilderbeek, 2000).

The development of information and communication technologies (ICT) furthers the demand for KIBS in several ways. Along with the "explosion" of the amount of information, there is a growing need for highly qualified professionals who are able to provide comprehensive and customised interpretation of random data (Lundvall and Johnson, 1994). On the other hand, the development of ICT also gives new incentives to the codification of knowledge (Lundvall, 2001). It increases the divisibility of information, which, together with the enhanced accessibility, results in the growth of the commercial potential of information. KIBS tend to be among the chief advocates and supporters of the emerging information markets. Finally, ICT has essentially increased the opportunities to effectively combine external and internal knowledge

sources. It has enabled easier interfaces and higher levels of appropriability of specific problem-solving methodologies. Through the use of these new means, KIBS can better than previously provide their clients with access to information dispersed in the society and enhance shared learning experiences between the nodes of innovation networks (Antonelli, 1998, 1999).

As many KIBS operate regionally or locally, selling services to nearby firms (Kautonen, 2001; Muller and Zenker, 2001), their contribution has been considered to be of special importance in the regional context. Besides the creation and transfer of knowledge, KIBS also develop an understanding of the different actors in a region. In knowledge networks, KIBS use their sense of the surrounding business environments and bring different actors together. Thus, KIBS have an important role not only from the general IC point of view, but also in the formation of regional IC. Regional IC can be viewed as a capacity of a region to create wealth with intangible assets.

Knowledge types and different kinds of regional networks

Researchers of knowledge management have identified three different types of knowledge:

(1) explicit knowledge;

(2) tacit knowledge; and

(3) potential knowledge.

Explicit knowledge is especially linked with the issues of timely information provision. Tacit knowledge is most often discussed in the framework of conversions between tacit and explicit knowledge brought to general awareness by Nonaka with his SECI model (Nonaka and Takeuchi, 1995). In the strategic management of a firm, the SECI model has been argued to be best suited to situations where existing processes are gradually improved (Scharmer, 2001). At the moment, the chaotic and complex elements of knowledge and their management are attracting increasing attention. Scharmer (2001) describes this third knowledge type – potential knowledge – as "not-yet embodied, self-transcending". It is needed in sensing and actualizing emergent business possibilities; in other words, it is the type of knowledge that gives momentum to the knowledge spiral of the SECI model[2].

In general, the focus in the knowledge management literature has shifted from seeing knowledge as an asset of a firm towards seeing it as a capability. This notion has also been the starting point in the network model of a regional cluster described in this paper (Smedlund and Pöyhönen, 2005).

In some earlier studies (Pöyhönen and Smedlund, 2004; Smedlund and Pöyhönen, 2005), we found that the nature and structure of networks in a regional cluster vary according to the strategic goals of cooperation. These goals may be:

- efficient production;
- gradual development; or
- continuous innovation.

In order to reach competitive advantage, a regional cluster needs efficient production of pre-designed products, learning of best practices and ideas with trustworthy

relationships, and finally, innovation of totally new products, production methods or processes. Correspondingly, the network structure consists of:

- production networks targeted primarily to the implementation of knowledge;
- development networks targeted primarily to the transfer of existing knowledge; and
- innovation networks targeted primarily to the creation of new knowledge.

When the production, development and innovation networks are working properly, innovative ideas find the right parties in order to become processed; also, new innovations diffuse fast and thus enhance productivity.

It is important to point out that the three network types are not closed systems inside a region. A regional cluster consists of many overlapping production, development and innovation networks, and some of the networks have also actors from outside the region. An actor in the regional cluster can simultaneously participate in every type of network. From the viewpoint of individual firms, a certain type of network may dominate the firm's operations in a given time, but successful firms usually have elements of all three network types simultaneously. In other words, a firm has to be able to manage its existing business efficiently, to ensure the growth with these businesses, and to develop new businesses (Fitzroy and Hulbert, 2005).

The idea of three basic types of networks provides a model that helps to understand how competitive advantage is created in regional clusters. The separation of the functions linked with production, gradual development and innovation activities also reduces the complexity of the network relationships into a more manageable level.

In the following, we combine the ideas of the three different network types and the three different knowledge types. We argue that explicit knowledge is especially important for production-centred networks. In development networks, tacit forms of knowledge and the conversions between tacit and explicit knowledge play a central role. In innovation networks, knowledge is still to a large extent in a potential, chaotic form; the task of the network is to bring order to this chaos and make some elements of the potential knowledge "existent". A more detailed discussion on this argument follows in the next section, where we analyse the knowledge functions of KIBS in each of the different types of networks.

The roles of KIBS in production, development and innovation networks

The three types of networks can be described with some basic dimensions. Following our earlier work (Pöyhönen and Smedlund, 2004; Smedlund and Pöyhönen, 2005), we analyse the networks in terms of the nature of relationships, competences, information flows, and leadership methods. These dimensions were originally identified by Ståhle in her study on the "knowledge environments" of different types of companies (Ståhle *et al.*, 2003). We also find the categorisation to be applicable at the network level, and we have discovered differences between the three network types on the above-mentioned dimensions. This result provides additional grounds for our argument about the different nature of knowledge and the different roles of KIBS needed in different kinds of networks.

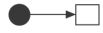
KIBS in production networks

In the production network (Figure 1), pre-designed products are produced in a hierarchical network of suppliers and customers. The relationships are seen as long-term investments and they are dyadic between the focal company and other actors. The relationships are strategic in Jarillo's (1988) terms, because in production networks the competencies are well-specified core competencies of participants. Allowing the actors to concentrate on their core competencies, a well functioning production network reduces the transaction costs of the actors, and all participants are able to benefit from the strategic networking.

In order to produce permanent high quality and to achieve the pre-determined goals, clear and coherent rules and regulations are enforced by the focal actor. Thus, the essential knowledge of the production network should be in an explicit form and circulated to all relevant actors. It is enough that information flows in one direction, mostly top-down, because discussion and elaboration open up the possibility for modifications, which in this type of network are unwanted and mere hindrances to its effectiveness.

In the production network, KIBS also operate first and foremost in the realm of explicit knowledge. There are, however, several different functions that KIBS can carry out in this context. First, they can take care of some well-defined tasks or some specific stage in the client's business process – work on behalf of the client. Financial analyses, feasibility studies, design documents and managerial services (e.g. facility management) are examples of such services. For example, in the case of feasibility studies, KIBS can provide information about the regional structures that include knowledge about factors of production, demand conditions, related and supporting industries, and rivalry (Porter, 1990). The activity of KIBS may consist of the provision of an individual service, but it can also contain a broader service package or a turnkey service.

Secondly, the activity of KIBS may concentrate on solving the client's production-related problems, including, among others, diagnosis and problem clarification tasks. After a diagnosis, KIBS usually provide some advice. Thus, suggesting and evaluating possible solutions for the client is the third typical function

	Production network	
Illustration	 Nature of the network	 Position of KIBS
Purpose	Efficient production of a pre-designed product for a focal company	
Relationships	Hierarchical, long-term relationships with selected partners	
Competencies	Well specified core competencies	
Information flow	Specified, one-way and mostly top-down	
Leadership method	Focal company. Direct use of power	
Role of KIBS	Providing explicit and timely knowledge. Performing a specified phase in clients' business processes, diagnosing and clarifying clients' problems, providing advice, acting as a change agent	

Source: Ståhle *et al*. (2003); Smedlund and Pöyhönen (2005)

Figure 1.
The role of KIBS in production networks (cf. Ståhle *et al.*, 2003; Smedlund and Pöyhönen, 2005)

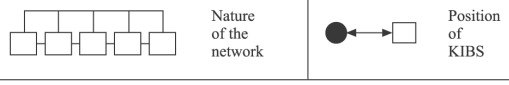
of KIBS, which can vary from legal issues to environmental engineering. Finally, KIBS also function as a change agent, i.e. they provide a neutral outside perspective, which facilitates the implementation of changes. It is, however, typical of KIBS operating in a production network that they do not get deeply involved in the decision making process of the customer. Their activity can be characterised more as inducement of the clients' decisions by providing timely and context-specific information (Miles, 1999).

KIBS in development networks

The development network (Figure 2) is a horizontal network that can be used for joining firms in a regional cluster, even though they do not cooperate in the production function. Benefits that can be acquired through a development network in a regional cluster are, for example, improved marketing or the acquisition of venture capital. In development networks, co-operation is conducted in everyday casual communication between the actors, and active participation is encouraged. There is no single dominating actor, but there can be a coordinator who supports knowledge sharing.

Tacit knowledge based on best practices plays a central role in development networks. This knowledge is related both to products, production methods and processes. The actors of a regional cluster learn from each other's firm-specific experiences, and in this way their competencies develop gradually in the course of time. The continuous step-by-step development occurring in the development network is based on lateral two-way information flows, double contingent relationships, and empowering leadership. Also learning about innovations and new solutions takes place in reciprocal, long-term and trustworthy relationships at the inter-personal level and through informal dialogue – in a way which very much resembles the idea of the working of communities of practice (Brown and Duguid, 1991). Further, important information about the behaviour of customers can be conveyed in development networks, and they also provide opportunities for the actors to get to know each other (Smedlund and Pöyhönen, 2005).

The role of KIBS in a development network is to intermediate tacit knowledge by distributing experiences and ideas, and by benchmarking different actors in a region. Several studies have confirmed that the role of KIBS as an intermediary of tacit knowledge is highly important, besides the provision of explicit expert knowledge (Bessant and Rush, 1995; Miles, 1999). KIBS also help their clients to convert tacit

	Development network
Illustration	
Purpose	Transfer of firm-specific knowledge about best practices related to products, production methods or processes
Relationships	Reciprocal, long-term and trustworthy relationships at the inter-personal level
Competencies	Evolving. Step-by-step improvements to existing competencies
Information flow	Informal dialogue
Leadership method	No dominating actor, possibly a co-ordinator. Empowerment and delegation of power
Role of KIBS	Intermediating tacit knowledge by sharing experiences and by benchmarking. Helping clients to convert tacit knowledge to explicit and vice versa

Source: Ståhle *et al*. (2003); Smedlund and Pöyhönen (2005)

Figure 2.
The role of KIBS in development networks (cf. Ståhle *et al.*, 2003; Smedlund and Pöyhönen, 2005)

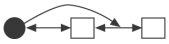
knowledge into explicit knowledge, and *vice versa*. Activation of these conversions when a client hires a KIBS shows itself, for example, in the new project teams that are often set up in this connection (den Hertog, 2002). The contribution of KIBS in a development network is based on the fact that they serve numerous clients in a region. The firms often learn from each other through KIBS. KIBS do not only carry best practices between firms in the same industry, but also across industries, modifying the original industry's ideas so that they are applicable in another environment. For example, management consultants can support the development of a new regional cluster by gathering experiences and models from other, already established clusters in the region. In the course of time, KIBS develop a solid base of expertise on different best practices adopted from previous clients and use this with their new clients.

KIBS in innovation networks

In the innovation network (Figure 3), the goal is to continuously innovate new products, production methods or processes. The relationships are mainly informal and spontaneous, and they last until the innovation is finished. The relationship structure in an innovation network is diagonal. This means that the actors participating in the innovation network can be from different production chains and from different industries. The innovation network can also tie together institutional and entrepreneurial actors. As the innovation process moves forward, a lot of actors join the innovation network (Powell, 1998). The information flow is fast, chaotic and includes a lot of extra information.

The innovation network should master the creation of knowledge that is novel for everyone in the network. This requires that there is room for creativity and that the operational mode of the network is not too structured and formalized. Potential and intuitive knowledge, not yet invented – in Scharmer's (2001) terms "not-yet embodied, self-transcending" – should be highly valued. The relations are informal and rich and the actors' competencies are "hidden", to be found with innovation activities. The innovation network is ideally led by the actor who is the most suitable for coordinating the resources and knowledge (i.e. authority migrates according to expertise rather than position in the hierarchy).

In innovation networks, KIBS contribute to the client's processes and decision making more actively than in the production and development networks. There are

	Innovation network
Illustration	 Nature of the network  Position of KIBS
Purpose	Constant innovation of new products, production methods or processes
Relationships	Informal and spontaneous relationships that last until the innovation is finished
Competencies	Intuitive, hidden
Information flow	Fast, chaotic and a lot of extra information
Leadership method	Leader is the one who suits best in terms of resources and skills. Relinquishing power
Role of KIBS	Functioning as sources of potential knowledge, as facilitators of the complex process typical of innovation and as brokers between the actors

Source: Ståhle *et al*. (2003); Smedlund and Pöyhönen (2005)

Figure 3.
The role of KIBS in innovation networks (cf. Ståhle *et al.*, 2003; Smedlund and Pöyhönen, 2005)

three main ways in which KIBS help in discovering potential, hidden knowledge in a regional cluster:

(1) they function as sources of innovation;

(2) they function as facilitators in the management of innovation processes; and

(3) they function as brokers between the actors in the innovation network.

The first role is made possible by the fact that KIBS themselves are active innovators, i.e. they can act as "containers" of new ideas. The second role is especially important due to the recursive and complex nature of the innovation process. The outcomes searched for cannot be known precisely beforehand and the procedure leading to a solution is unknown; most often there are several plausible alternatives that have to be explored (Schienstock and Hämäläinen, 2001). Carrying out innovation processes successfully – coping with uncertainty and complexity – is often a bigger problem than the ability to create new ideas. Facilitation provided by experienced management experts can be of great help here.

The brokering function of KIBS is important for all kinds of networks. In the case of innovation networks it is especially crucial, as innovations are more and more often created by recombining existing things. This means that innovation processes are today multi-organisational phenomena, collective undertakings where different actors with different skills and competences have to be brought together (Schienstock and Hämäläinen, 2001). Due to their abundant contacts with various stakeholders, KIBS are able to recognise relevant actors for each case. For example, IT infrastructure providers in the region may have good contacts to the law firms that provide consulting in IPR issues in the region, and they can further recommend these law firms to new customers.

Concluding remarks

In this paper we have argued that regional clusters need three different kinds of networks to carry out successful business – production, development and innovation networks. In each network a specific type of knowledge is dominant, although also other kinds of knowledge are needed. In order to produce products efficiently, production networks need first and foremost directly applicable explicit knowledge. Tacit forms of knowledge and conversions between tacit and explicit knowledge are characteristic of development networks, where firms concentrate on step-by-step learning from each others' experiences. In innovation networks knowledge is still to a great extent in a potential form. The development of regional intellectual capital, and consequently the competitive advantage of a regional cluster, is based on successful functioning of all network types and on the use of all knowledge types. This way regions can hold on to their existing success factors, building new strengths simultaneously.

We have further argued that the intermediating functions of KIBS in knowledge processes – a topic that has aroused growing interest in recent years – can be examined in the framework of the three network types and three knowledge types. KIBS convey explicit knowledge to help their clients to manage their existing business efficiently. They ensure the growth of their clients' business by transferring best practices which abundantly involve tacit knowledge. Finally, they help their clients develop new business by acting as sources of potential knowledge and by facilitating

the innovation processes. These categorisations are naturally ideal models that in everyday life are intermingled in many ways. We hope, however, that our simplified categorisations may bring some new light to the complex issues of networks and knowledge management.

Notes

1. This paper is theoretical by nature. It is, however, based on earlier empirical studies made by the authors in Finnish regions and companies. The first author has, together with his colleagues, conducted studies of different network types in particular (Smedlund and Pöyhönen, 2005; Pöyhönen and Smedlund, 2004), the second author has examined the functioning of KIBS (Toivonen, 2004).
2. The different knowledge types have been recognized in different stages during the development of the discipline of knowledge management. At the first stage, explicit knowledge was the focus of attention. Gradually the significance of the tacit forms of knowledge was understood. The adoption of the concept of potential knowledge is the newest stage (Snowden, 2002).

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