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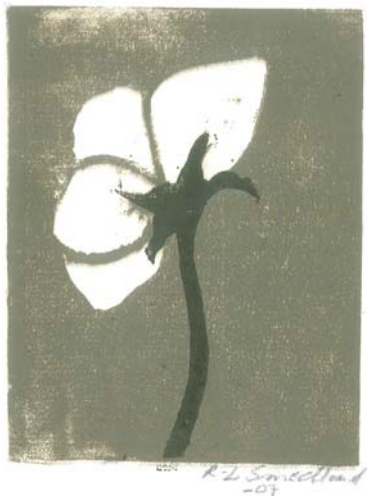
NETWORK APPROACH TO FUNDAMENTAL TASKS IN KNOWLEDGE-BASED ORGANIZATIONS

Anssi Smedlund



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ABSTRACT

Author: Anssi Juhani Smedlund

Subject of the Thesis: Network approach to fundamental tasks in knowledge-based organizations

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Organizational networks are increasingly drawing the attention of management scholars worldwide. It is commonly expected that certain intra-organizational network structures predict how well the individual, the group, and the firm will perform. This study focuses on the structures and management of intra-organizational networks in knowledge-based organizations, studied with a literature review and with three separate research settings. The settings include the network perspective on the development of a professional service, network analysis of team communication structures, and communication networks among employees in a professional service firm.

It is argued in the study that a firm utilizes its knowledge resources in value creation with intra-organizational networks. An essential insight of the study is that production, development and idea generation are the fundamental tasks of a firm, and by managing the intra-organizational networks in these tasks successfully, the firm can find a sustained competitive advantage compared to other firms in the market.

The study consists of four papers and an introductory part. Based on the literature review presented in Paper I, it is stated that the structure of a production network is centralized, a development network is distributed, and an idea generation network decentralized. According to the theme-based interview study presented in Paper II, each task-related network needs different management initiatives. In Paper III, it is argued on the basis of theory and a case that the ideal communication network structure of a team in production tasks is hierarchical, in development tasks it is core-periphery, and idea generation tasks are ego-centric. According to the results of statistical analysis in Paper IV, the communication network structure in routine tasks is dense, whereas in non-routine tasks it is sparse. It is also shown in Paper IV that centrality in intra-organizational networks predicts employees' performance according to their roles. Individuals in non-routine roles (managers) benefit more from centrality compared to individuals in routine roles (professionals).

The results of the study indicate that there is no one optimal network structure, but many, according to the task. Theoretically, the distinction between the three task-related networks is evident, but in the case study in Paper III, the development network and idea generation network were difficult to distinguish from each other. Therefore, in empirical research, the distinction between routine and non-routine tasks is more useful, as shown in Paper IV. According to the results of Paper IV, centrality predicts employees' performance less than expected – only the managers in a professional service firm seemed to enjoy positive consequences of centrality measured with performance at work. As a managerial implication of the study, it is suggested that managing the three task-related organizational networks separately, the firm will achieve improved simultaneous scanning of the environment, seizing opportunities and transformation of the organization – mechanisms also known as the dynamic capabilities of the firm.

The study is related to the disciplines of knowledge management, strategic management, network theory and social capital.

Keywords: organizational networks, knowledge management, professional service firm	Language: English

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

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Työn ohjaaja: Dosentti Marja Toivonen		

Organisaatioverkostoja tutkitaan yhä enemmän. Yleisesti ajatellaan, että tietyt organisaation sisäiset verkostorakenteet ennustavat miten yksilö, ryhmä tai yritys tulee menestymään. Tässä tutkimuksessa tutkittiin organisaation sisäisten verkostojen rakenteita ja johtamista asiantuntijayrityksessä. Tutkimus tehtiin kirjallisuusanalyysillä ja kolmella erillisellä empiirisellä tutkimuksella. Tutkimuksissa tutkittiin palvelun kehittämistä, tiimin kommunikaatiorakenteita, sekä kommunikaatioverkostoja asiantuntijayrityksessä.

Tutkimuksessa väitetään, että yritys käyttää sisäisiä verkostojaan tuottaessaan arvoa tietoresursseistaan. Tutkimuksen keskeinen ajatus on, että tuotanto, kehitys ja ideoiden luominen ovat kolme perustavanlaatuista tehtävää yrityksessä ja näihin liittyvien sisäisten verkostojen menestyksekäs johtaminen johtaa yrityksen kilpailuetuun markkinoilla.

Tutkimus koostuu neljästä julkaisusta ja yhteenveto-osuudesta. Kirjallisuusanalyysiin perustuen julkaisussa I väitetään, että tuotantoverkosto on rakenteeltaan keskittynyt, kehitysverkosto levittäytynyt, ja ideoiden luomisen verkosto hajautunut. Julkaisussa II teemahaastattelujen perusteella voidaan sanoa, että jokainen perustehtävään liittyvä verkosto vaatii erilaisia johtamisaloitteita. Julkaisun III mukaan, joka perustui teoriaan ja case-tutkimukseen tiimin kommunikaatioverkostoista, voidaan sanoa, että tiimin tuotantoverkostot ovat ihannerakenteeltaan hierarkkisia, kehitysverkostot keskus-periferia-tyyppisiä, ja ideoiden luomisen verkostot egokeskeisiä. Julkaisuun IV perustuen, joka oli tilastollinen analyysi organisaation sisäiseen kommunikaatioverkostoon, voidaan näyttää, että kommunikaatioverkoston rakenne rutiinimaisissa työtehtävissä on tiivis, mutta ei-rutiinimaisissa löyhä. Lisäksi, julkaisun IV tulosten mukaan verkoston keskeisyys ennustaa työntekijän suorituskykyä työssään riippuen työntekijän roolista. Työntekijät ei-rutiini rooleissa (johtajat) hyötyvät keskeisyydestä enemmän kuin rutiinityötä (asiantuntijat) tekevät.

Tutkimuksen tulokset merkitsevät sitä, että ei ole olemassa yhtä oikeaa yrityksen sisäistä verkostorakennetta, vaan monia riippuen työtehtävästä. Teoreettisesti jaottelu kolmeen tehtävään liittyvään verkostoon on ilmeinen, mutta julkaisun III case tutkimuksessa kehitysverkosto ja ideoiden luomisen verkosto oli vaikea erottaa toisistaan. Siksi tutkimuksellisesti jaottelu rutiini- ja ei-rutiini tehtäviin on käyttökelpoisempi, kuten sovellettu julkaisussa IV. Julkaisun IV tulosten perusteella verkoston keskeisyys ennustaa työntekijöiden suorituskykyä vähemmän kuin oli odotettavissa – vain johtajat hyötyivät keskeisyydestä mitattuna työhön liittyvänä suorituskykynä.

Liikkeenjohdollisina johtopäätöksinä tutkimuksessa esitetään, että kolmen perustavanlaatuiseen tehtävään liittyvien verkostojen erillinen johtaminen johtaa yrityksen parantuneisiin dynaamisiin kyvykkyyksiin, eli kykyyn havainnoida liiketoimintaympäristöään, tunnistaa oikeat mahdollisuudet ja muuttaa sisäistä organisaatiota samanaikaisesti.

Tutkimus liittyy tietojohtamisen, strategisen johtamisen, verkostojen ja sosiaalisen pääoman tutkimusalueisiin

Avainsanat: yritysverkostot, tietojohtaminen, asiantuntijayritys	Julkaisukieli: Englanti

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This study is a sequel to my licentiate work, which included papers concentrating on regional inter-firm networks, and where the framework used as the starting point was based on Professor Pirjo Ståhle's knowledge environments model. Here, the three-dimensional model of production, development and innovation networks created in the licentiate study is applied in the intra-firm context, and background of the model is the theory of the firm.

I wish to express my greatest gratitude to the faculty and colleagues at Helsinki University of Technology. Docent Marja Toivonen managed the research project where the data for this study was collected. She helped me to get access to the case companies, and provided comments on the structure and language used throughout the introduction part, as well as papers II and III. Professor Eila Järvenpää, who was the supervisor of this study, helped greatly in organizing the papers to a coherent line of reasoning, and provided valuable comments throughout the writing of the introductory part, as well as papers III and IV. In Paper II, Mrs Saara Brax worked with me to design and implement the interviews in the case company, and pointed out some key service science literature as well. Computer experts, Mr Mikko Porkola, Mr Jesse Kivialho and Mr Jarno Marin were invaluable in implementing the web-based questionnaire used in papers III and IV. Project Coordinator Terttu Tamminen has been irreplaceable in taking care of the paperwork related to the research projects at HUT. Furthermore, I wish to thank all my colleagues at BIT Research Centre collectively, especially the service research team, for providing me a great atmosphere to work on my PhD research among other work.

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Espoo, October 2009

Anssi Smedlund

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Paper II Smedlund, A. (2008). "Identification and management of high-potential professional services". Management Decision, 46(6): 864-879.

Paper III Smedlund, A. (2010). "Characteristics of routine, development and idea networks in teams". Team Performance Management, 16(1-2). In press.

Paper IV Smedlund, A. & Choi, E (2009). Communication networks in routine and non-routine tasks. Helsinki University of Technology, Laboratory of Work Psychology and Leadership, Working Paper no 2009/2, Espoo, Finland, 45 pages

CONTRIBUTION OF THE AUTHOR TO THE PUBLICATIONS

Paper I	Sole author
Paper II	Sole author
Paper III	Sole author
Paper IV	The main author, except for the design of the OLS regression analysis and the outline of the results chapter, which were done by the second author

1 INTRODUCTION

Organizational networks are increasingly drawing the attention of management scholars worldwide. The attention is well deserved: in inter-organizational relationships, globalization and advancement in information and communication technologies have decreased the cost of obtaining knowledge for firms, and increased the awareness of markets and competitors, even from geographically distant sources. This has resulted in a decrease of transaction costs between firms, and in an increase of the accessibility of resources outside the firm's boundaries. In intra-organizational relationships, the increasing complexity and knowledge intensity of products and services has increased the amount of knowledge work, and led to a point where work is performed and problems solved in a network between individuals rather than by individuals alone. Research on the structures of intra-organizational relationships is on the rise, and it is commonly expected that certain network structures predict how well the individual, the group, and the firm will perform.

Network relationships allow firms to grow their knowledge assets more rapidly, due to increased inflow of knowledge from the network relationships. This results in Williamson's (1975) terms in a decrease of opportunism and uncertainty, as well as improved sensing of the new market opportunities, thus making better decision making possible. However, the increase of network relationships in the knowledge-based business also forces firms to renew and innovate more rapidly, in order to fulfill the needs of their clients and to keep up with competitors who offer similar kinds of products and services in the market.

This study contributes to the field of Knowledge Management and uses knowledge-based organizations as the research context in exploring how

organizational networks create value for the firm. Knowledge Management, sometimes also called intellectual capital management, is an interdisciplinary field in the management theory, which deals with the intellectual capital assets of the firm as sources of value creation (e.g. Teece, 2000). Broadly defined, Knowledge Management deals with everything that has to do with the management of human centered assets in the firm (Brooking, 1997).

The underlying assumption in Knowledge Management is that the firm is able to find sustainable competitive advantage by utilizing its knowledge resources with certain competencies, thus creating its own markets among the buyers of its products or services (see: Penrose, 1959; Nonaka and Takeuchi, 1995; Teece, 2000). This underlying assumption connects the Knowledge Management discipline to the theory of the firm, and particularly to the resource-based view of the firm introduced by Wernerfelt (1984) and Barney (1991). There has been a boom in Knowledge Management –related literature among the academia and practitioners, especially during the late 1990's and early 2000's, and numerous categorizations and models - Edvinsson's model (Edvinsson and Malone, 1997) being one of the most cited - have been presented on the nature and value creation mechanisms of knowledge (for review of the models, see Andriessen, 2004). However, due to its interdisciplinary nature, the Knowledge Management field is generally considered an ambiguous field in the management theory (McAdam and McCreedy, 2000).

It seems that in the course of producing studies and theoretical articles on knowledge creation, storing, retention and sharing in the organization from various perspectives, academics in the Knowledge Management field have sometimes forgotten how knowledge resources actually create value, and why it is important to manage human-centered assets in the knowledge economy. Individuals and human talent organized to work for common goals are the main asset of knowledge-based

firms, and the knowledge resources are seen as embedded in this network of individuals (cf. Nelson and Winter, 1982), where knowledge accumulates in use and makes the firm's survival and growth possible (cf. Penrose, 1959).

The main objective of the present study is to understand the logic of how firms create value from their knowledge resources with intra-organizational network structures, and the research questions have been set to carry out this objective. The research question of the study is to find out the role of intra-organizational networks for the value creation of the firm, specifically, how intra-organizational networks contribute to the value creation of a firm, and whether there are different kinds of networks according to the task. This study also seeks answers to the questions of what kinds of management initiatives are suitable for managing intra-organizational networks in different tasks, and how a highly central position in the communication network predicts the performance of employees in different tasks.

Production, development and innovation as the three fundamental tasks drawn from the theory of the firm have been used in this study to illustrate the structures of intra-organizational networks. The research methods are a literature review and interview and questionnaire -based network analysis methods. The scope of this study is set to the intra-organizational communication network structures, but the management initiatives in the three networks is illustrated with an empirical case study that includes inter-firm relationships related to a service that the firm offers to its clients. This is because studying the network related to the service provided a simple enough research setting to identify the management initiatives in each task. The research context of the study is a knowledge-based firm, specifically a professional service firm.

1.1 Outline of the study

This study consists of four 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, as well as theoretical background and discussion of the contribution of the papers. The introductory part is structured as follows. In chapter two, the theoretical background is presented. The theories reviewed in chapter two offer connecting themes across all the papers and form the ground to the research setting, objectives and methodologies, which are presented and discussed in chapter three. In chapter three also the collection of empirical data, the methodology, and data analysis are described.

Chapter four presents the results of the papers according to the research questions of this study. First, the results of the theoretical paper (Paper I) on the intra-organizational network and the value creation of a knowledge-based firm are presented. Second (Paper II), different management initiatives for the networks in idea generation tasks, development tasks and production tasks are elaborated on. The analysis is based on theme-based interviews in a professional service firm, where one service acts as a case example from the point of view of the focal actor. Third (Paper III), communication network structures of teams in the three tasks are described, founding on the theory and a cross-sectional questionnaire study in a work team in a professional service firm. Fourth (Paper IV), the results of a questionnaire study on communication network structures in a professional service firm are presented. These results also include the analysis of the effect of network centrality for an employees' work performance in different tasks.

In the fifth and final chapter, the findings of the study are discussed, and the contribution for research and practice is reviewed. In this chapter, also the reliability

and validity, as well as the limitations of the study are discussed, and suggestions and directions for future research are provided.

2 THEORETICAL BACKGROUND

This chapter provides an overview of the topics in the management theories that are related to the areas of the study: knowledge-based organizations, intra-organizational networks, theory of the firm and the three fundamental tasks, as well as communication networks and network structures. The concepts and research perspectives derived from these theories set ground for the research questions of the study.

First, the differences between the market-based view of the firm and the resource-based view of the firm are explained. The market-based view and the resource-based view are contradictory views on how firms create value in the market. According to Barney (1986), the market-based view sees the value creation of a firm as a result of the management's good perception of the markets, and the strategy of the firm is created according to this view. This results in the so called "structure, conduct, and performance" industrial organization logic (Bain, 1956), which is the main message of Porter's five forces framework (Porter, 1980). There the firm achieves competitive advantage by taking into account the bargaining power of the suppliers, the bargaining power of customers, threats of new entrants, threat of substitute products, and competitive rivalry within an industry (Porter, 1980).

The resource-based view (Wernerfelt, 1984; Barney, 1991), also known as Schumpeterian type of value creation logic (Conner, 1991), which is present also in Penrose's (1959) view of the firm, and according to Barney and Clark (2007), also in the knowledge-based views and dynamic capability views of the firm, is opposite to the market-based view of the firm. There the endogenously created, internal performance of the firm affects the structures of the markets. Therefore, in the

resource-based view the firm creates its own markets by utilizing its resources with competencies, whereas in the market-based view the firm merely reacts to the changes in the markets and adapts its internal structures accordingly.

The resource-based view of value creation is the underlying assumption in the Knowledge Management discipline. This has created a specific knowledge-based view of the firm in the management literature. The knowledge-based view of the firm (eg. Grant, 1996; Spender, 1996) is an offspring of the resource-based view (Barney and Clark, 2007). The difference of the two is that the resource-based view does not consider knowledge as a resource, but the knowledge-based view does. Similarly to resource-based view, the knowledge-based view argues that knowledge as a resource must fulfill the VRIO criteria (Valuable, Rare, Inimitable and Organized), and that it can be managed by the top management of the firm to find sustained competitive advantage (Barney and Clark, 2007).

The knowledge-based view considers a firm as a body of knowledge. Here, a firm is a collection of routines that are aggregate of the skills possessed by the individuals in the company, therefore the possession of knowledge is an attribute of the firm as a whole, and that firm's knowledge is not possessed by any single individual in the company (Nelson and Winter, 1982).

As Grant (1996) notes, there is no consensus on the definition of knowledge. In order to be used in the context of the resource-based view of the firm, knowledge has to be defined as an evolving and growing asset in the firm instead of a static asset in the positivist sense (Spender, 1996), similarly to the ideas of Nonaka and Takeuchi (1995). This definition of knowledge differs from other definitions, such as cognitive, situated and translational definitions of knowledge (Patriotta, 2003).

The knowledge-based view is evident in Penrose's (1959) and also Nelson & Winter's (1982) work, where the firm accumulates knowledge over time, which will

result in firm-specific knowledge assets that are used in the competition in the markets. According to this idea, all action that is aimed at leveraging knowledge assets in the firm in one way or another will result in endogenous growth of the firm and deserves to be called management of knowledge. Endogenous growth is a kind of growth of the firm that cannot be explained with traditional factors of production: land, labor and monetary capital (Solow, 1957; Romer, 1990).

The dynamic capabilities-view (Teece et al., 1997) further extends the definition of resources in the value creation of the firm to consider the capabilities for value creation that can be altered by the top management (hence the name "dynamic" capabilities). According to the dynamic capability-view, the top management of a competitive firm should be able to 1) sense new opportunities in the markets, 2) seize the best possible market opportunities, and 3) transform the organization and routines of the firm to exploit the new opportunity (Teece, Pisano and Shuen, 1997; Helfat et al., 2007; Teece, 2007).

The assumption behind the dynamic capabilities-view is that routines are the foundation of a successful company. In the course of operation, the firm builds a set of distinct routines that are utilized to produce value. These routines are firm-specific and hard to copy by other firms in the market. Formation of routines leads to efficiency and organizational inertia that ensures the future competitive advantage of a company (Nelson and Winter, 1982). However, if the firm continues to act on its established routines too long and fails to sense changes in the markets, it eventually loses its competitive advantage.

The dynamic capabilities-view highlights the need for non-routine tasks in the firm that aim to change established routines. With the dynamic capabilities, a firm is able to alter its existing capabilities and routines according to emerging market needs, and thus sustain the competitive advantage in the long run. By stating

this, the dynamic capabilities-view brings elements of the market-based view to the resource-based view of the firm, which originally states that the resources cannot be altered.

2.1 Knowledge-based organization and intra-organizational networks in the value creation of a firm

In this study, the knowledge-based firm is defined as a firm that uses knowledge both as a resource and as an output (Gallouj, 2002). The knowledge-based firm has no or very little physical capital, and its assets literally walk away from the office every evening. The concept "knowledge-based" is related to a larger change in the structures of the economy. For example Drucker has identified this change as a rise of a knowledge worker, a type of employee who does not perform manual labor, but uses his or her skills and knowledge to produce outputs for the market (Drucker, 1993). In the knowledge economy, intangible assets become a larger source of value creation for firms compared to physical assets, and the amount of intangibles in the final offering for the customer has increased radically.

According to Teece (2000), knowledge assets are fundamentally different compared to the tangible assets of the firm. Knowledge assets, for example, do not wear out in use, and the same knowledge asset can be used simultaneously in many activities in the firm. However, knowledge assets are, compared to physical assets, harder to protect with property rights, harder to calibrate in production and easily depreciated if/when imitated by competitors. Andriessen (2004) notes that as the knowledge content of products and services grows, services become as important as products, and knowledge itself becomes a product, as shown in the growth of the knowledge-based service industry.

The term 'social capital' describes and highlights the role of intra-organizational networks in the value creation of firms, in addition to other social

aspects, such as common norms and beliefs. There are many definitions and points of view for social capital that are outside of the scope of this study (for a review, see: Woolcock and Narayan, 2000), but in management science the most prominent definitions are related to the process nature of social capital. This means that in order to be called capital, social capital has to turn some kinds of inputs into outputs (Robison et al., 2002). From this point of view, social capital has to have mechanisms that result in either group-internal or group-external positive consequences – create value for either the individual participant or for the group as a whole (Portes, 1998; Adler and Kwon, 2000; Ruuskanen, 2001). The consequences of social capital can be also negative (Edelman et al., 2002), but usually the concept of social capital is expected to describe the benefits of social mechanisms (e.g. North, 1990).

Based on an extensive review of social capital literature, Adler & Kwon (2000) state that social capital consists essentially of 1) networks, 2) norms and 3) beliefs. Social network structures are the most important components of social capital, because social capital is understood as being embedded in the relationships between and among individuals (Granovetter, 1985; Uzzi, 1996). Norms form the context where the participants of the network are able to perform activities. Nahapiet and Ghoshal (1998), as well as Portes (1998) put strong emphasis on beliefs as a component of social capital. Also trust has been highlighted as a mechanism of social capital (Fukuyama, 1995), although some consider trust as a belief, because trust can be defined simply as being confidence that others will act in a way that their intended action is appropriate from our point of view (Misztal, 1996).

In this study, social capital is studied from the network point of view. The network structure among the employees of a firm creates the infrastructure and preconditions for other types of mechanisms of social capital (i.e. norms, beliefs and

trust). The network structure also facilitates communication and knowledge flows in the organization. Furthermore, the structural aspect of social capital is the one that is the most straightforward to operationalize for empirical research and quantitative studies. Other components of social capital, important as such, are either difficult or impossible to operationalize for research purposes.

2.2 Theory of the firm and three fundamental tasks

In this chapter, the background of the theory of the firm is first explained and then the three tasks of the firm – production, development and idea generation – are described.

Production, development and idea generation as the three tasks of the firm can all be separated in the theory of the firm -literature. As shown below, there are arguments in the theory that support each of the tasks separately. The three tasks are not conflicting, they merely describe how a firm can find and sustain its competitive advantage in the markets from different angles – production task from the point of view of Chandler's (1962) theories of scale and scope, development task from the point of view of Penrose's (1959) and Nelson and Winter's (1982) theories on knowledge accumulation, and idea generation task from the point of view of Schumpeter's (1934; 1942) theories on innovation.

In management science, there are no coherent streams of literature according to schools of thought, many concepts are overlapping and similar ideas have been presented many times and in different empirical contexts. The theory of the firm is one of these not-so-coherent streams of literature, and it can be considered as a general label for all strategic management literature that aims to explain the basic idea of why firms exist in the markets, and how they survive and grow.

The theory of the firm was born as a counter-theory for neo-classical economics, so-called equilibrium economics-view of the world (Rumelt et al., 1994). The underlying assumptions in neo-classical economics are for example that the decision makers are rational, there is perfect competition in the markets, and the knowledge resources are free and available to everyone. As originally pointed out by Coase (1937), and later explained by Williamson (1975), this is not true. Coase's (1937) message is that if the world functioned with the logic of neo-classical economics, all economic action would happen in one big firm, and no firm would gain competitive advantage over another. Following that logic, the mere existence of firms in the market proves the underlying assumptions in neo-classical economics incorrect.

The theory of the firm starts from the notions that firms are economic actors in the market (Coase, 1937), and survival and growth are the reasons for firms to exist (e.g. Penrose, 1959). This means that market transactions are coordinated by firms instead of individual economic actors. Survival and growth as a reason of a firm's existence means that the goal of the firm is to make money for their shareholders (e.g. Conner, 1991). This is why firms are often referred to as "for-profit organizations". It has to be noted, however, that there are many other organizations in societies besides firms, whose goals are beyond making money for their shareholders. Firms in the market are a fairly new phenomenon, as their era began after the industrial revolution, according to Chandler (1962) right after improvements in logistics and information transfer made it possible to provide a steady and organized flow of inputs to the factories and outputs to the markets.

The theory of the firm –literature examines the different aspects of what for-profit organizations must be able to perform in order to find sustainable competitive advantage over other for-profit organizations. This study, however, is related to the

tasks of the employees and teams in the organization, but the gap between the tasks of the firm and the tasks of the employees has narrowed in the knowledge-based economy. Knowledge-based firms rely on intangible assets, individual talent and expertise in their value creation, not on physical assets. This makes the strategic management of a knowledge-based firm management of human talent and organizational structures. For example, in order to generate ideas for new innovation successfully, a knowledge-based firm must engage in leadership measures to support idea generation in the organization, and in order to produce something efficiently, a more production-related leadership must be taken. The production, development and idea generation tasks of firms are examined next.

2.2.1 Efficient production

The efficient production task is illustrated in Chandler's (1962) work, which examines firms from the viewpoint of their scale and scope. Chandler's firm enjoys its competitive advantage from cost reduction in production, not for example from benefit created for the customer, or new product innovation. According to Chandler, firms grow basically by integrating forward into distribution and backward into purchasing. The essence of Chandler's (1962) work is in the concept of minimum efficiency scale, which is dependent on the cost curve of the company. If the cost curve gradient is steep, typically in industries with high physical capital and material costs, there is a big risk of failure if the plant produces in a below-minimum efficiency scale. Firms in industries with a steep cost curve enjoy benefits of scale (high volume of one product), whereas firms in other industries are more likely to benefit from economies of scope (variety of produced products).

From the point of view of the individual employee, an efficient production task means routine work. Intuitively, the definition of a routine task means factory

work in the 1920's, but according to the definition by Nelson and Winter (1982), routines are standardized procedures and rules, whatever the industry. Routine work tasks can be defined as behavioral regularity, as a recurrent interaction pattern in the work (Becker, 2005). Behavioral definition fits well to the intra-organizational network context. This is because in this view, routines have a certain recurring frequency and they are done in a sequential manner in a certain given timeframe to reach a pre-defined outcome (ibid.). In routine work, there are no complexities related to the task – the initial stage, the process and the outcome of the task are known and well defined. In this study, routine is seen as related to internal affairs of the organization, such as timesheets or reports, and routine work can be routine-type of tasks performed for the client in the area of the individual's know-how.

2.2.2 Gradual development

The task of gradual development is illustrated in the ideas presented by Penrose (1959) and Nelson & Winter (1982). Penrose's (1959) view of how firms grow and why they exist is rather different from that of Chandler (1962). Penrose was the first one to propose the resource based view – the idea that a firm is a collection of productive resources that the administrative organization, the management of the firm, controls and allocates. The measure for growth in Penrose's terms is the rate of return on investment of the firm when the firm invests in its productive resources. Therefore, Penrose states that short-term shareholder revenue maximization is not as important as investments back to the firm. This logic is based on the insight that only the investments back to the firm secure its growth and survival, which will in the long run also maximize the shareholder value.

Penrose's insight of gradual development of the firm is supported by Nelson and Winter (1982). According to them, a firm is a collection of routines that are

aggregate of the skills possessed by the individuals in the company. This organizational inertia is one of the basic ideas also in the population ecology point of view of firms (e.g. Hannan and Freeman, 1984). Gradual development of the firm, according to Nelson and Winter (1982), takes place when the existing operating routines of the firm are incrementally improved to ensure the survival of the firm.

From the employee perspective, gradual development tasks are non-routine by nature. Non-routine tasks involve managing semi-structured or unstructured problems (Pava, 1983), and are directed to something where the process is complex and the result of the work is uncertain and unspecified. In this study, the development work tasks are defined as tasks that are related to gradual development of an existing product or service. In terms of complexity, development tasks start from an initial stage that is well known, but the process and the outcome of the task are uncertain. Development tasks are step-by-step development work related to the experiences of the individuals, thus highlighting the tacit nature of knowledge (cf. Nonaka and Takeuchi, 1995) involved in the development work.

2.2.3 Idea generation

The third fundamental task, idea generation, is related to innovation in the theory of the firm. Innovation has been highlighted for example in the writings of Schumpeter (1934; 1942), and particularly his first book about the role of entrepreneurs in firms, which is usually regarded as the ground to explain innovation in firms. In his analysis of Schumpeter's ideas, Winter (2006) begins by describing the production function of a firm. The firm produces output y with input x with production function $f(x)$. The profit of the firm is maximized when the difference between py and rx is the highest possible, p being the output price and r the price of the inputs. The significance of innovation in the production function includes basically all other

changes in the production function, except for changes in the amount of labor and capital. In the knowledge-based economy, innovation is endogenous to the firm and has been argued to explain the growth of the firm through concept of Solow's residual[1] (Solow, 1957; REF: Romer, 1990).

Innovation tasks are defined in this study as non-routine activities where the initial stage, the process, and the outcome of the task are uncertain, thus involving the highest level of complexity of all three tasks. The concept is limited in this study to the generation of ideas, which is related to the front-end of the innovation process. For an individual employee, idea generation means "light bulb moments", inventing something totally new, and they differ from routine tasks and development tasks that are related to either producing or developing already existing things in the organization. In the operationalization of this study, ideas can be born at any place and any time, including in the free time of the individuals in the company, and they can be transmitted also in very informal occasions, during lunch or coffee breaks, when the knowledge related to routine tasks is usually not shared between individuals (Papers III and IV).

2.3 Communication networks and network centrality

In this study, communication relationships are studied when exploring the different network structures in a firm to create value from the knowledge resources with the three fundamental tasks. In this chapter, justification for the use of communication relationships is provided, in addition to a short overview to network research in management science. Also the role of centrality as a key structural measure in network research is described.

[1] The Solow residual describes the growth of productivity in an economy. If the output rises when capital and labor inputs are constant, it means rise in productivity. The part of the growth that cannot be explained through capital accumulation is the "residual".

According to Borgatti and Foster (2003), network research has been applied mainly in the following topics in organization science: social capital, embeddedness, network organization and organizational networks, board interlocks and joint ventures, inter-firm alliances, knowledge management, social cognition, and group processes. To shorten Borgatti and Foster's (2003) list, it can be said that besides knowledge flows and types of knowledge (e.g. Hansen, 1999; Reagans and Zuckerman, 2001; Hansen, 2002; Reagans and McEvily, 2003), organizational network research has been done mainly from three perspectives: social embeddedness and social capital (e.g. Granovetter, 1973; Coleman, 1988; Burt, 1992; Uzzi, 1996; Putnam, 2000), governance structures (e.g. Fligstein, 1985; Baker, 1990; Powell, 1990; Podolny and Page, 1998), and resource dependencies of firms (e.g. Williamson, 1975; Jarillo, 1988; Williamson, 1991).

A general assumption in the field of network research is that any kind of structure, whether social or not, can be described as configurations of interactions between the actors (Barley, 1990; Krackhardt, 1994b). Network research also presupposes that one actor does not exist without interaction to others – the network is a collective, and the roles of the actors are defined by the network interactions (e.g. Kanter, 1977).

It has been argued that all economic action is embedded in the relationships between people (Granovetter, 1985; Burt, 1992; Uzzi, 1996). Relationships form a tie between individuals that can be analyzed with network analysis method (Wasserman and Faust, 1994). According to Monge and Contractor (2003 p.3), communication networks are "patterns of contact that are created by the flow of messages among communicators through space and time". Ibarra (1993) defines communication in an organization as discussion between employees about what is going on in the organization, and includes communication among one of the basic

relationships between employees: advice, support, influence and friendship (Ibarra, 1992). Other basic relationships are defined differently from communication: advice, as to who the employees consider as an important source of professional advice, support as to who the employees consider their allies and who they depend on during a crisis, influence as to who the employees talk to when they want to affect an outcome of a decision, and friendship as to who the employees socialize with outside of work (Ibarra, 1993).

In their work, employees need communication, advice, support, influence and friendship relationships. Communication relationships, however, are the best suitable measure for studying task-related network structures among employees. By asking who the employees communicate with in certain tasks is a neutral way to map the network structure, and it does not include the bias that the other definitions of a relationship have. For example, the task may require communication with other people than the person would not normally seek for advice, support, influence or friendship. These other relationships are also interesting, but they are not necessarily related to the work tasks, and they may reveal the kinds of network structures in the organization that are outside the scope of this study.

Different types of relationships between the employees are overlapping, and some relationships entail some other types of relationships. For example, friendship relationships may create possibilities for task-related communication and vice versa (cf. Ouchi, 1980; Larson, 1992; Eisenhardt and Schoonhoven, 1996). Therefore, it can be expected that task-related communication relationships include underlying social relationships. This mechanism is emphasized in knowledge work when employees have the freedom to choose the people they do their work and communicate with.

From the knowledge management point of view, the structure of communication relationships reveals the flow of knowledge in the organization, because communication is an opportunity to share knowledge with other employees. According to Reagans and McEvily (2003), transfer of knowledge is discretionary, and it follows the path of least resistance, therefore the more communication ties there are, the more likely the employees are to share their knowledge.

Centrality is the most commonly used structural measure in social network analysis. Central employees are the ones that are the most connected to others, and they are most likely to possess large amounts of information, and are able to influence others more effectively. Central employees affect the whole structure of the network by their communication with a large number of other employees (Carley, 1991).

High centrality employees are more likely to be higher in the formal and informal status hierarchy in the organization, which makes network centrality a significant source of power (Ibarra, 1993). Employees in broker positions (the ones that bridge many sub-groups in the network), are usually also central in the communication network, because the central employees are able to facilitate the flow of knowledge between the less central employees (Scott, 2000).

It has been shown that the employees in broker positions are more likely to express an idea and discuss it with colleagues, their idea is more likely to be engaged by senior management, and to be judged valuable (Burt, 2004). Furthermore, the basic presupposition in the theories of social capital (e.g. Nahapiet and Ghoshal, 1998) is that more relationships is in most cases better than less, which emphasizes the importance of centrality in the network structure. Therefore, the more central an employee is in the organization, the more information, status,

prestige and influence he/she holds, which should further show in the employee's improved performance at work.

2.4 Intra-organizational network structures

There are different perceptions of the most suitable intra-organizational network structures, and there is a debate among scholars about what kind of structure is best. The seminal article on the structure of the network is Granovetter's (1973) "Strength of Weak Ties", which is the most cited and most influential writing in network research. The structural hole theory developed by Burt (1992), builds on Granovetter's strength-of-the-weak-ties theory. Burt's and Granovetter's main argument is that the optimal network structure is a network with many structural holes, because it allows quick access to non-redundant knowledge. There an actor who is in the broker role between different groups gains information and control benefits (Burt, 1997).

On the other hand, Coleman (1988; 1990) has stated that a dense network structure is the most optimal because of the higher degree of reciprocity and the self-enforcing norm structure that the structure allows to develop. According to Woolcock (2000), the debate between the sparse versus dense network structure constitutes a debate between American (Putnam, 2000) versus European (Bourdieu, 1986) philosophical views on social capital. The European view highlights the benefits for the ego, which is a similar concept to the internal outcomes of social capital by Adler and Kwon (2000). The American view draws attention towards the benefits of social capital for the society, which is similar to the external outcomes in Adler and Kwon's (2000) paper.

The debate between sparse and dense network structures has been identified by network scholars, and the latest views on the optimal network structure combines

the features of both networks. According to this view, an individual who occupies a position that combines both closure and bridging in a network structure that is characterized by a high degree of clustering and reach (also known as "small world network"), has the most beneficial network position (Rowley, 1997; Burt, 2002; Uzzi and Spiro, 2005; Baum et al., 2006; Schilling and Phelps, 2007). This statement is based on the reasoning that if the network structure is too closed (cf. Coleman, 1988), the relationships will seal off sources of new information and opportunities. However, bridging ties alone (cf. Burt) are too costly to maintain (Uzzi, 1996; Burt, 2002; Baum et al., 2006), so both are needed. Furthermore, it has been argued that overall, the positive effect of bridging ties depreciates as the density of the network increases, and that communication exceeding a certain threshold in a dense network has negative consequences (Krackhardt, 1994a; Burt, 1997; Ahuja, 2000).

The knowledge perspective on structural properties of networks shows that weak inter-unit ties help in the search for new knowledge, but slow down the transfer of complex knowledge, as complex knowledge requires strong ties (Hansen, 1999). There are not many studies that approach network structures from the task perspective. Experimental laboratory research conducted in the 1950's and 1960's shows evidence that there are many optimal network structures according to the type of task (Bavelas, 1951; Shaw, 1964). For example, sparse and decentralized communication network structures in teams are better in solving complex tasks, whereas dense and centralized network structures are suitable for routine-like, simple tasks (ibid.). Centralized networks channel information to a focal employee. The closer the others are to the focal person, the faster the problem is solved. When the tasks become more complex, the problems related to the task become unmanageable for the focal employees and their immediate contacts to handle. Then

the answer to the problem is sought from more distant sources, which will make the communication network of complex tasks decentralized.

According to Galbraith (Galbraith, 1973; Scott, 2003), task uncertainty is related to the amount of information that has to be processed in the organization. According to this view, when the task uncertainty increases, the amount of information increases correspondingly. In an uncertain environment, where more information must be processed compared to a stable environment, the best way to organize is a flexible organization (Wright and Snell, 1998; Datta et al., 2005). According to the contingency theory (Burns and Stalker, 1961), the communication network structure in a flexible organization is an organic, decentralized structure, whereas a stable organization is mechanistic and centralized.

3 RESEARCH QUESTIONS AND METHODOLOGY

The main objective of the study is to provide new knowledge for understanding the logic of how firms create value from their knowledge resources with intra-organizational network structures. Other objectives of the study are to identify the differences in the intra-organizational network structures related to different tasks, and to examine the relationship between network centrality and the performance of employees. In this chapter, research questions aiming at fulfilling the objectives of the study are presented and discussed, and the data collection and research methodology used in the papers are described.

It is argued in this study that the firm creates value fundamentally with the following tasks: 1) efficient production, 2) gradual development, and 3) idea generation. As argued in the theory, these three fundamental tasks make simultaneous efficiency in operations (cf. Chandler, 1962), gradual development (cf. Penrose, 1959; Nelson & Winter, 1982) and innovation (cf. Schumpeter, 1934; 1942) possible.

This study approaches the tasks of production, development and idea generation mainly from the point of view of intra-organizational network structures, but also management initiatives in the networks are studied. *The main research question of this study is: Are intra-organizational network structures different in the three fundamental tasks in the organization, and if they are, how?*

It is presumed in this study that the structure of the intra-organizational network is different in each of the tasks for three reasons: 1) social network scholars state that all economic action is embedded in the relationships between individuals (Granovetter, 1985; Burt, 1992; Uzzi, 1996); 2) in the theory of the firm, knowledge is a collective construct and occurs in the interaction between individuals in the firm

(Nelson and Winter, 1982); and 3) the resource based view of the firm suggests that a firms' pool of human capital can be leveraged to provide a source of competitive advantage (Barney, 1991; Wright et al., 1992).

3.1 Research questions

The theoretical motivation behind the research questions is related to the ambiguity of the knowledge management discipline. Although knowledge is expected to be the most important asset in the knowledge economy [*sic*], and knowledge assets are claimed to be embedded in the relationships between individuals, the reasoning of how a firm creates value with knowledge is not very evident in the knowledge management literature. To shed light on this issue, this study aims to answer the following specific research questions on how to integrate the intra-organizational network perspective to the management of a knowledge-based firm.

Q1: What is the role of intra-organizational networks in the value creation of a firm?

Q2: Is it possible to categorize intra-organizational networks according to the tasks of production, development and idea generation, what are the characteristics of these networks and how do they differ from each other in terms of network structure?

Q3: What kinds of management initiatives are suitable for managing intra-organizational networks in production, development and idea generation tasks?

Q4: How does a highly central position in intra-organizational networks predict an employee's work performance in different tasks?

The first two specific research questions are aimed at clarifying the role of intra-organizational networks in the value creation of a firm, distinguish the three fundamental tasks, and explain the structural characteristics of the networks. The third question provides an insight into the management initiatives in the networks. The fourth specific research question examines the alleged benefits that the employees gain from network centrality, and answers the question of whether these benefits are observable with work-related performance measures.

3.2 Positioning of the papers and progress of the research

Each of the papers included in this study gives a different point of view to the research questions. In this chapter, the contribution of each paper to the research questions is presented, and the progress of the research is summarized.

The first paper, titled as "The Knowledge System of a Firm – Social Capital for Explicit, Tacit and Potential Knowledge" is a theoretical paper from the point of view of value creation in the firm. It brings clarity to the concept of social capital in the value creation in firms from the knowledge management perspective, and discusses the characteristics of different types of knowledge. In terms of the research questions of this study, the first paper presents arguments on the role of intra-organizational networks for the value creation of the firm, and also presents the argument that it is meaningful to divide the intra-organizational networks according to different types of tasks.

The second paper, "Identification and Management of High-Potential Professional Services" describes the lifespan of one professional service from its

idea stage to present stage empirically with a case example, focusing mainly on the supplier-client relationship. The paper II examines the types of relationships that a professional service firm can have during the lifespan of a service from the network point of view. The second paper provides answers to the question of what kind of management initiatives should be taken in order to manage networks of production, development and idea generation.

The third Paper, "Characteristics of Routine, Development and Idea Networks in Teams" is an empirical case study. In this paper, the tasks of routine work, development work and idea generation are presented as typical tasks of individuals, and the communication network structures of these tasks are studied accordingly. The third paper seeks answers to questions of whether it is possible to categorize networks according to the work tasks, and whether the communication network structures are different in these tasks.

The fourth Paper, "Communication Networks in Routine and Non-routine Tasks" is a theory testing paper, and it compares the communication network structures between employees in a professional service firm in routine and non-routine tasks. The paper is related to the research questions of whether the communication network structures are different in different tasks, and how centrality in these task-related networks affects the employee's performance at work. Table 1 summarizes the contribution of each paper to the research questions of this study.

Table 1: Contribution of the papers to the research questions of the study

Main research question: Are the intra-organizational network structures different in three fundamental tasks in the organization, and if they are, how?				
	Paper I	Paper II	Paper III	Paper IV
Q1: What is the role of intra-organizational networks in the value creation of a firm?	x			
Q2: Is it possible to categorize intra-organizational networks according to the tasks of production, development and idea generation, what are the characteristics of these networks and how do they differ from each other in terms of network structure?	x		x	x
Q3: What kinds of management initiatives are suitable for managing intra-organizational networks in production, development and idea generation tasks?		x		
Q4: How does a highly central position in intra-organizational networks predict an employee's work performance in different tasks?				x

The research reported in this study has been a process where the task-related networks have been approached theoretically (Paper I) and empirically (Papers II, III and IV). The empirical research on the three fundamental tasks of the firm has evolved during the research process of the study. The research includes empirical evidence from different levels of examination. In Paper II, the simple research setting of describing a lifespan of a service and the network relationships related to that made it possible to identify management initiatives for the three networks. In Paper III, the structural differences between the three networks were studied with mapping the communication network structures in a case team. Finally, the research in Paper IV includes an individual-level approach to the topic, in addition to research on the differences in the overall structures of task-related intra-organizational networks.

The individual-level approach of Paper IV is a logical extension to the organizational and team level points of view, because the theory emphasizes strongly the benefits of networking for the individual, especially the benefits of centrality for the employees in an organization. Therefore, if an employee is highly central in the communication networks in his/her organization, this should lead to improved performance at work. Furthermore, the effect of centrality may differ according to the role (manager or professional) of an employee.

The multi-level approach to the empirical evidence on the task-related networks presented in this study gives a broad perspective to networks in organizations, starting from a general theory and ending in a detailed description. Paper I draws from theory the main idea used throughout he rest of the papers – Papers II, III and IV are all inspired by Paper I, and represent variations and empirical operationalizations of the basic idea of the three fundamental tasks. The starting point to the network study in Paper III were the three tasks, production, development and idea generation. In Paper IV, the tasks are presented as routine and non-routine work tasks and in that paper, non-routine tasks are operationalized as idea generation.

The difference in the operationalization of the fundamental tasks between Paper IV and the rest of the papers is due to the difficulty of separating the tasks of development and idea generation and the networks related to these tasks in the gathered network data. The early versions of Paper IV included all three tasks, but during the research process of Papers III and IV, the tasks were simplified to include only routine and non-routine tasks in Paper IV. This decision clarified the structure of Paper IV, and made it possible to highlight the differences between routines and non-routines in the network data. After the simplification of the tasks, it was

possible to show the effect of centrality between employees who perform routine work (professionals) and non-routine work (managers).

The timeline in Figure 3 illustrates when the papers in this study were written, when the data were gathered, and when the papers were published. The boxes in Figure 3 present roughly the time spent in the actual writing of the papers, the solid lines present the time period when the data was gathered and analyzed, and the dotted lines present the time period between the first draft of the paper and the actual publication date.

The first draft of Paper I was produced for Industrial Marketing and Purchasing group's (IMP) Network Analysis PhD course during the fall 2004. The paper was on hold until the end of 2005, when it was written in its current form. It was submitted to the Journal of Knowledge Management during summer 2006, where it was accepted without modifications and published in 2008.

Paper II was presented in the Service Engineering and Management 2007 Summer School in the Department of Industrial Engineering and Management of Helsinki University of Technology in August 2007. Soon after that, the paper was submitted to the Journal "Management Decision", where it was accepted with minor modifications. Paper II was published in 2008.

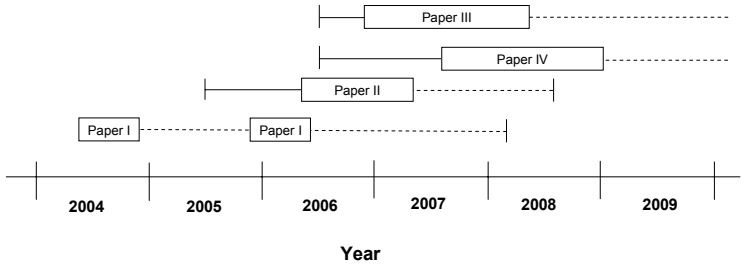


Figure 1: Progress of the research

The data gathering process for Papers III and IV started during spring 2006; due to follow-up round to gather the performance data, the data gathering for Paper IV continued during the summer 2007. The follow-up round allowed the use of the network data a year prior to the performance data to find whether the network structure would predict performance. Paper III was not presented in an academic conference or meeting before journal submission. Paper IV was presented in the 2009 Academy of Management Annual Meeting in Chicago, IL. Papers III and IV have taken the longest time to complete, and the author has been working on them interchangeably between the years 2007 and 2009. Paper III has been accepted for publication in the Team Performance Management Journal. Paper IV has been published in the Working Paper series of the Laboratory of Work Psychology and Leadership of Helsinki University of Technology.

3.3 Methodology

In this part, the research designs of the papers are discussed with special attention paid to the unique characteristics of interview-based and questionnaire-based network analysis methods, and the reliability and validity of these methods are described. The questionnaire-based network analysis method is discussed more thoroughly, because it is the main methodology in the study and it has been used in Papers III and IV. The interview-based methodology is described to the extent it was used in Paper II. In this part, also the data analysis reported in the papers is summarized.

The gathering of network data with interviews and questionnaires is highlighted in the study, because most network analysis literature and advances in the field concentrate on the techniques, mathematics and issues related to the analysis of the data, and very little of the literature deals with good design of

network study questionnaires. However, the majority of the validity problems related to the results of the analysis with network data depend on how well the data is gathered and the questionnaire designed.

3.3.1 Interview-based and questionnaire-based network analysis methods

In papers III and IV, the data were gathered with a web-based questionnaire and analyzed with social network analysis methods and regression analysis. The second paper is an example of network analysis, where the data was gathered with interviews. The differences in questionnaire-based and interview-based network analysis methods are described below, as well as the basic structure and phases of network analysis in organizational research.

Questionnaire-based methods to conduct network analysis are more common in academic research than interview-based ones. Interview-based network analysis research has its roots in consulting practice (e.g. Allee, 2002), and it is aimed at describing business models or systemic connections between different actors in value systems quickly. Questionnaire-based research uses a more rigorous, mathematical approach to make inferences from the data. The roots of the questionnaire-based network analysis methods can be found in mathematics (Wasserman and Faust, 1994; Barabási, 2002).

In both methodologies, there are two important initial steps that have to be taken before the data gathering and network analysis process can be started. These are identifying the network and defining the relationships that are under investigation.

There are many ways to identify the network under research. Halinen and Törnroos (2005) introduce four ways in the context of case study research in the inter-firm relationships that can also be applied in intra-organizational network

context: 1) taking one own actor as the starting point (focal actor view), 2) taking one dyadic tie as the starting point (for example supplier-client relationship), 3) taking an already established network as the starting point (intranet view), and 4) taking a geographical area as the starting point (micronet-macronet perspective). In the intra-organizational context, the fourth option would mean for example a certain building, or a floor in a building.

In interview-based network analysis, the focal actor perspective is most often used, because the accessibility of information dictates so. Usually it is difficult to include other actors in the interview process besides the focal actor, because the other actors may not be willing to participate in the research, or there is a legal or privacy issue that affects the access to the sources of information. In the questionnaire-based data gathering process, the most common way is to take the intranet view to gather the data from a well specified group (Stork and Richards, 1992; Robins et al., 2004). This method is called the sociocentric data gathering method, where the respondents rate the frequency of relationship with others from a roster of names specified by the researcher (Wasserman and Faust, 1994).

The scope of network research is equally important as identifying the desired network. Relationships within the scope of research affect the identification of the suitable network. The scope of research is defined according to the research question or a real-life problem that needs to be solved with network analysis. In the theory part above, it was explained that network analysis in organization science is usually done from four perspectives: social embeddedness/social capital, governance structures, resource dependencies, or flows of knowledge. The last mentioned perspective, i.e. communication relationships have been used as the primary scope of the network analysis in this study.

In Table 2, the interview-based and questionnaire-based network analysis methods are compared. In interview-based network analysis methods, the primary data is gathered with interviews and this data is then analyzed with qualitative analysis methods. There the actors and the flows of actors are discerned from the interview data and further elaborated with more in-depth descriptions from the data. The qualitative network analysis method to interpret interview data does not require mathematical skills. It is most suitable for a quick overview of for example inter-firm networks or business models and resource dependencies between firms, but it lacks the accuracy of the interpretation of the data, as the resulting network relationships are constructs of the researcher. In this sense, understanding the business of the case network is important in the interview and analyzing phase in interview-based network analysis.

Besides interviews or questionnaires, also secondary data can be used in the analysis. Secondary data is data that is not gathered by the researcher him/herself, but exists in the organization in the form of reports, marketing material, accounting information, or timesheets.

Table 2: Comparison of interview-based and questionnaire-based network analysis methods

	Interview-based network analysis methods	Questionnaire-based network analysis methods
Roots	Consulting practice	Mathematics and matrix algebra
Data collection method	Interviews, analysis of secondary data	Questionnaire or secondary data
Boundaries and scope concerns	Best suitable for inter-firm networks from governance structures, knowledge or resource dependency scopes.	Best suitable for intra-organizational networks in the scope of social embeddedness and social capital. Also inter-firm network analysis possible, depending on the data.
Data analysis process	Interviews are profiled to map the actors and the activities of actors to spot the existence of relationships. The nature of the relationships is then examined by analyzing the interview data more thoroughly. The networks are illustrated by drawing pictures of the networks manually.	The questionnaire data is combined from the questionnaires to matrixes. The matrixes are then used to analyze the network with IT tools, such as UCINET and NetDraw. Network measures produced with UCINET are used as variables in regression analysis. Network pictures created with NetDraw are used to illustrate the data.
Strengths	A fast way to understand complex wholes. Easy to present and understand. Suitable for i.e. quick presentation of the business model.	Allows testing of hypotheses. Gives an accurate view of the network. Makes it possible to evaluate individual actors' positions in the network.
Weaknesses	Inaccurate. The actors' relationships with each other cannot be fully mapped, thus making in-depth analysis impossible. Difficult to determine the strength of a tie between actors.	Slow to gather the data. Fairly complicated process to analyze the data.
Caveats	Requires understanding of the business of the case companies. Interviews and subjective interpretation of the researcher have a big role in mapping the relationships.	Requires over 80% response rate, preferably 100%. Bad design of the questionnaire can ruin the whole study, special attention must be paid to the frequency scales that measure tie strength.

Questionnaire-based network analysis methods enable accurate hypotheses testing. The resulting networks can be analyzed with IT tools, such as UCINET VI (Borgatti et al., 2002), and the network measures produced in these programs can be taken as variables in more advanced statistical analyses on the organization.

In Paper II, the interview-based network analysis method was used to describe the network relationships in different stages of the service development. Allee's work on value network modeling (2002) is a good example of the use of the qualitative network analysis method. Also, the present author's previous work on regional networks serves as an example of the qualitative interview-based method (Smedlund, 2008). Good examples of questionnaire-based quantitative network

analysis of the flows of knowledge in the organization are numerous, see for example the works of Hansen and Cross (e.g. Hansen, 1999; Cross and Parker, 2004).

The network data can also be gathered from secondary data sources, of which company data is one. Company data is understood as data that has been accumulating in the organization during its operation, for example personnel records, timesheets, or accounting information. The use of company data in research is justified, because the top management of the company bases its judgments on it. Company data reveals more relationships between individuals, enables triangulation with questionnaire-based data, supplementing of missing data, and inference based on demographic characteristics of the individuals in the network (Stork and Richards, 1992). A typical use of company data, such as a general ledger or project reports, is to use it to define the strength of ties or the importance of certain actors compared to others in the network. Lately, also email header information collected from the company servers has been used as network data (see for example: DiMaggio et al., 2009).

3.3.2 Reliability and validity in the research of organizational networks

Reliability is defined as the consistency or dependability of a measurement technique, which means that the measurement technique should return consistent results every time it is used. If the measurement is reliable, then there is less chance of measurement error in the results (Marczyk et al., 2005). In the interview-based network analysis method, it is important to ensure that every interviewee understands the questions in the same way, and that the answers are coded unambiguously. According to Silverman (1993), this can be achieved for example with pre-testing the questions and by training the interviewers. Also the use of

standardized methods to keep notes of the interviews, prepare transcriptions and have detailed diary of the interview process, as well as having several researchers analyze the same data and see whether the results are similar, are methods to ensure the reliability of interview research (Silverman, 1993).

To guarantee the reliability of the questionnaire –based network analysis method, the reliability issues should be taken into consideration in the design phase of the questionnaire (Marczyk, DeMatteo and Festinger, 2005). Similarly to the interview method, an essential feature of reliability in the questionnaire is to make sure that the questions are unambiguous and are understood in a similar way by each respondent.

Two of the most important concerns in the validity of research deal with internal and external validity – whether the research design rules out plausible rival hypotheses, and whether the results of the research can be generalized to apply to different populations, settings, or sets of circumstances (Marczyk, DeMatteo and Festinger, 2005). In the interview-based network data gathering that aims at presenting a descriptive illustration of a certain network, the internal validity of the research can be improved by gathering the data systematically, and by verifying the gathered data with the respondents. In the questionnaire-based network, the data gathering issues related to validity can be improved with questionnaire design, which is presented below.

3.3.3 Validity in the interview-based network analysis method

In the interview-based network analysis, issues related to the validity of the research method are basically the same in all interview-based qualitative analysis methods. The distinguishing factor in interview as the data collection method for network

analysis is that the themes of the interview are set to find out the actors and ties in the network according to the defined boundary and the relationship.

Theme-based interview is an interview method where the themes of the interview are defined beforehand. Theme-based interview lacks the exact wordings of the questions in structured interview, but it allows the interviewee to talk freely on a certain subject. The task of the interviewer is to make sure that all the topics are covered during the interview, but the extent and sequence of the interview may vary. (Eskola and Suoranta, 1998)

In the interview-based network analysis method, special attention is paid to the characteristics of the network ties. The networks are described in terms of 1) types of actors involved, 2) types of relationships, 3) the nature of flows between the actors, and 4) the directionality of the tangible (money, physical assets) and intangible (knowledge, information) flows between the actors (see Allee, 2002).

The interview-based network analysis method is a qualitative method where the validity of the research has to be taken care of on an ongoing basis throughout the research process (Eskola and Suoranta, 1998). There are no unambiguous definitions of validity in interview research. Eskola and Suoranta mention the following considerations in improving the validity of the data gathering. Firstly, the interviewer and interviewee should understand the topic similarly and use the same vocabulary, to avoid misunderstandings. Secondly, the actors and relationships should be confirmed from multiple interviewees. Thirdly, there should be more than one interviewer, one conducting the interview and the other taking notes.

Kvale (1996) highlights the role of a strong theoretical basis that lays ground to forming the interview themes and interpreting the results, and he also states that the validity of the results can be improved afterwards for example with presenting the results of the interview to an expert group for comments. According to

Silverman (1993), when the interview data is plausible, credible and includes enough evidence of the studied subject, the validity of the data is ensured.

3.3.4 Validity in the questionnaire-based network analysis method

In the network research, the most important issue is to collect as complete information about the actors and the relationships as possible, but time and resource constraints, as well as the respondents' varying willingness to respond limit the gathering of complete data. The network analysis method is especially vulnerable for incomplete data, but 100% response rates to network questionnaires are extremely rare. In the network questionnaire, respondents evaluate their relationships to others, and the resulting network is a combination of all the answers. Therefore, if the response rate is R%, there is complete data on only R% * R% of the relationships in the network (Stork and Richards, 1992). For example, with a response rate of 75%, there are complete data for only 55% of the relationships.

Questionnaire-based network analysis has usually been conducted with a response rate between 65% and 90% (Stork and Richards, 1992), but it has been shown with mathematical simulation that the data should have at least a 70%, and preferably over 80% response rate to offer sufficient validity for analysis. If missing relationships appear randomly in the network data, a 70% response rate should return, in theory, a similar network pattern than complete data (Robins, Pattison and Woolcock, 2004; Kossinets, 2006). It has been shown that missing data can be reconstructed in a reliable way, if the questionnaire has been designed well (Stork and Richards, 1992), which makes it possible to make interpretations of the network dynamics on the basis of relatively low response rates.

Besides non-response, also boundary specification and information inaccuracy affect the validity of the network questionnaire data (Kossinets, 2006).

There are two kinds of boundary specification problems in the questionnaire-based network methods, one that is related to the definitions of inclusion of the relevant actors, and the other that is related to the relationships of the actors under investigation. Both types of boundary specifications must be decided by the researcher and are justified by the research question and the research setting of the study. The actors can be included either on the basis of a formal definition of group membership (eg. work team), or by letting the actors define the boundaries themselves. Also measurable interaction between the actors, such as email communication, can be used as a criterion of boundary specification (Kossinets, 2006).

Such relationships as advice, friendship, support, influence and communication (Ibarra, 1992) can be studied on their own, resulting in different approaches to intra-organizational network structures (Butts, 2003). This is because employees may have different others who they communicate with about what is going on in the organization, and socialize after work with, for instance. Communication and knowledge flows have been used extensively as relationships in network analysis research (Borgatti and Foster, 2003). It can be stated that communication network studies are somewhat less prone to errors in the questionnaire design than studies aimed at describing subjective, experience-based phenomena of the actors, such as interpersonal trust. It is easier for the respondent to evaluate the frequency of communication than the nature of a relationship, which is more open to various interpretations.

Information inaccuracy is caused by the problem that in sociometric questionnaires there are always inconsistencies between the cognitive relationships and real relationships of the respondents that result in biased network data (Kossinets, 2006). The apparent gap between subjective and objective estimations of

the actors' relationships requires careful design of unambiguous wordings in the questionnaire where the respondents evaluate their relationships with others. However, the cognitive relationships of the respondents can be the main focus of the researchers' interest, for example in studying prestige or reputation in the organization.

To obtain as complete data as possible, the questionnaire can be designed so that it includes everyone within the boundary of the network. This sociocentric (Hannemann and Riddle, 2005) method offers the respondent a roster of names that helps the respondent in rating the communication with the pre-defined individuals. An alternative to the sociocentric method is the egocentric snowball method (Hannemann and Riddle, 2005), also known as the free recall method (Wasserman and Faust, 1994). Here the respondent is asked to name the others before rating the frequency of communication; the questionnaire is then later delivered to those that the respondent mentioned in his/her initial questionnaire. Sociocentric roster-based questionnaire design should be used always when possible, because it makes the filling out of the questionnaire easier, lessens the likelihood that certain relationships are overlooked, and increases the likelihood that weak links as well as strong links are included (Stork and Richards, 1992).

Besides offering a roster of names for the respondents in the questionnaire, also some kind of strength, frequency or intensity estimate must be used in the questionnaire. The strength of the ties can be measured either by asking the respondents to rate each tie separately, or asking them to rank-order names in the roster in terms of a relationship (Wasserman and Faust, 1994). Including the measure of the strength of a tie provides important information about the individuals holding weak links and reveals the hub-actors in the network more clearly. The frequency scale should be unambiguous and easy to comprehend, because such

words as “often” or “rarely” mean different things to different people. Instead of descriptive frequency definitions, concrete definitions such as “once per day” or “once per week” should be used.

Depending on the research objective, the questionnaire should be formulated to reveal the directionality of the relationships. Here the respondents should be asked to evaluate both directions of relationships, eg. evaluating in separate questions who they receive knowledge from and who they give knowledge to. These measures increase the validity of the data by making reconstructions of the network relationships possible in the case of many non-respondents (Stork and Richards, 1992), and by making it possible to identify individual respondents who clearly did not answer properly in the questionnaire. Directed questions also reveal receivers and transmitters in the network and give information about the reciprocity of the links.

Demographic factors, including formal role, tenure, age, gender, work title etc. have been argued to influence the network relationships between individuals in the organization (Ahuja et al., 2003). Therefore, in order to make inferences based on the questionnaire-based network data, demographic information about the respondents and non-respondents should be obtained from the personnel records of the organization as completely as possible.

As a summary, issues that affect validity in the social network questionnaire design are the network sample and relational boundary specifications, subjective information inaccuracy, wordings of the questionnaire, definitions of relationship frequency scales, sociocentric versus egocentric questionnaire design, and the directionality of the relationships in the questionnaire. The measures to increase validity in the questionnaire-based network methodology are many, but at the same time they make the network questionnaire long and tiresome for the respondents to

fill out. The longer the questionnaire, the more non-respondents there will be. Therefore, questionnaire design is often a trade-off between validity and the length of the questionnaire. The methodologies and data collection methods of the papers included in this study are summarized below. The validity and reliability of the methods are summarized in the discussion part of the study.

3.4 Data collection

In the papers, literature review, theme-based interviews and questionnaires have been used as data collection methods. The chosen methods followed the learning process of the author during the study. First, the research topic was approached from the theoretical perspective to get familiar with the existing research. Then, understanding of the research topic was gained with qualitative study, and finally, concrete propositions about the topic were investigated with a questionnaire-based method analyzed quantitatively.

The first paper is theoretical. The starting point of the literature review in the first paper was social capital literature, in order to understand the definition of social capital in production, development and idea generation tasks. The most relevant writings in the area of social capital were first selected, and then a snowball technique – reading the articles that cite the key writings or vice versa – was used to broaden the literature base that was used as material for the literature review in the paper.

In Paper II, the data were gathered with theme-based interviews, and in Papers III and IV with a questionnaire. In the data gathering process for Paper II, the interviews were recorded and then transcribed. The interview themes were constructed to reveal the network characteristics related to the case of a professional service. The transcribed data was then classified according to the interview themes.

The data in Papers III and IV were gathered with a web-based questionnaire to reveal the communication network structures in different kinds of work tasks, but the contents of the questionnaire was slightly different in each of the questionnaires. The implementation of the interviews and the questionnaires are presented next.

3.4.1 Theme-based interviews to map network relationships related to a service

The theme-based interviews to map network relationships related to a service were conducted during the summer 2005. The case study in Paper II was a part of a larger research project, where a total of 13 service cases in three consulting companies were studied. The particular service provided by an architect studio was selected as the case because it had a clear and well established history, and the idea generation, development and production stages were easily observable. The architect studio was a typical example of a knowledge-based firm.

All the interviews were conducted by two researchers: one led the discussion, while the other made notes and kept track that all relevant themes were dealt with. The author of this study had the latter role. The theme-based interview outline consisted of a total of 20 topics (Appendix I). The topics were provided to the interviewees in advance, usually about a week before each interview. The interviews lasted one to two hours. The outline of the interview was divided in three parts: 1) orientation part, 2) service description and history part, and 3) network connections part. At the end of the interview, the interviewee was asked if he/she had any additional comments or questions. In the orientation part of the interview, the interviewee was asked to describe the service that was under discussion and his/her role in the service. The orientation part was followed by topics related to the nature of the case service. In this part, the interviewee was asked to describe such things as the history of the service, the main clients of this service, producing

methods of the service, the role of customer in the service, and competencies, tools or systems needed to deliver the service. In the second part of the interview, also other actors besides clients were mapped.

The third part of the interview concentrated on the network relationships. Here, topics related to roles and relationships in different identifiable stages on the lifespan of the service were covered. The roles were mapped especially from the point of view of who, if any, of the actors were responsible for the management of network relationships and who, if any, set the goals for cooperation between the actors. Questions about management of information flows and development of individual competencies between the actors were also asked in the network part. From the network point of view, the interview was designed to emphasize the naming of the different actors involved in the service and describing the flows of tangibles and intangibles between the actors from the case company's point of view.

In Paper II, the data were collected by interviewing three persons working with the service. To ensure a broad viewpoint to the case service, the persons represented different levels of firm hierarchy: shop-floor, middle manager and top manager levels. The illustrations of the different identified stages of the service from the network perspective presented in Paper II are a result of multiple viewpoints gathered from the interviews, documents made available to the researchers, and a workshop in the case firm. In the workshop, the top management of the company commented the network illustrations, and modifications were made accordingly.

3.4.2 Questionnaire to map communication networks in a work team

The data for the communication networks in a work team – the case study presented in Paper III – were gathered with a web-based sociometric (Wasserman and Faust, 1994) questionnaire method. The questionnaire was designed by the present author

and it was implemented with the help of technical support personnel in the author's research group. An outline of the questionnaire can be found in Appendix II. For the purpose of the case study in Paper III, the questionnaire was sent to all individuals working in the same work team in a well established insurance company in the metropolitan area of Finland. Eight of the ten individuals working in the team filled out the questionnaire during October 2006.

The questionnaire was designed on the basis of the research question in Paper III, the question of whether the communication patterns of the individuals in a work team are different in 1) production tasks, 2) development tasks, and 3) idea generation tasks. To highlight the differences in these tasks, exact wordings of the questionnaire were carefully designed and then reviewed and modified several times by the author, his PhD study advisors, and colleagues, before setting the questionnaire online. The case team studied in Paper III was chosen because the team does knowledge-based, professional service –type of work, and the team is very well established – it had a small turnover and most of the employees had been working in the same team for more than 5 years.

Brief phone discussions with a tenured secretary of the work team were conducted to make sure that the questions would be understood correctly by the respondents. In the wordings of the questionnaire, it was highlighted that the answers include all means of communication (face-to-face, phone, email etc.), and that all the answers of the respondents are estimates of the real communication.

The online questionnaire method was based on a webpage that could be opened with a personal username and password. Therefore every individual in the work team was given his/her own username and password via email, along with a cover letter describing the research.

After the first page of the questionnaire in the web, which gathered some background information about the individuals (age, tenure and title), there was a page where the individual respondents were asked to pick and choose those individuals from the roster of names of people who they communicate with at a frequency of once per a quarter of a year or more often. This frequency was chosen, because communication at a frequency of less than once in a quarter of a year was not considered as an ongoing, established relationship by the author. The roster of names was specified by the author and only those persons who worked in the same team as the respondent were included. The results of this page were then used in the rest of the questions in the questionnaire, for example in the questions where the frequency of communication was evaluated in routine tasks.

In the instructions of the questionnaire, it was mentioned that if the respondent accidentally forgot to mention somebody, he/she could go back to page 2 anytime to complement the list of others used in the rest of the questionnaire. Furthermore, it was possible for the respondents to pause answering the questionnaire and come back later to finish it.

The following six pages in the questionnaire dealt with knowledge exchange in three of the work tasks. In each of the task, the respondents were asked to rate the frequency of communication with each of the individuals that they indicated to communicate with according to the second page of the questionnaire. The frequency of communication in each of the work tasks was evaluated separately, regarding who the respondent gives knowledge to and who the respondent gets knowledge from.

The frequency scale used in the study was set according to previous questionnaires conducted by established researchers in the field[2] (Krackhardt and

[2] For samples of questionnaires, see:
http://www.andrew.cmu.edu/user/krack/questionnaires.shtml

Hanson, 1993; Cross et al., 2001; Cross and Parker, 2004). In the previous questionnaires, the frequency of communicating "daily" had been used as the indicator of the strongest type of a relationship. In the questionnaire used in this study, the strongest relationship was set to include daily or almost daily –type of communication, still being more often than weekly, which was used to indicate the second closest communication relationship. The other frequencies used in the questionnaire were once per month, less than once per month, and once per a quarter of a year.

3.4.3 Questionnaire to map communication networks in an organization

A questionnaire study to map communication in routine and non-routine tasks was conducted in a professional service firm of 93 employees. The company in this questionnaire was the same as in Paper II. In general, the data collection followed a similar path as the questionnaire study of the work team in the insurance company in Paper III; the respondents were given a username and a password to a web-based, sociometric network questionnaire via email. The network data were gathered during the summer months in 2006, and the respondents were allowed about two months to fill out the questionnaire, which was rather time consuming to respond to, because everyone working in the company was included among the respondents. The response rate was 88%.

The network questionnaire was largely similar to the questionnaire conducted in the insurance company's work team in Paper III. It included two-way (give knowledge to, get knowledge from) questions regarding the communication in routine tasks and non-routine tasks, and the wordings of the questions were designed accordingly. In the data analysis of Paper IV, the question about development tasks was omitted to highlight the differences between routine and non-routine tasks,

though the question was included in the questionnaire. This way, the question of mapping non-routine tasks was operationalized as communication related to ideas to highlight the differences between routine and non-routine tasks.

An essential feature in the web-based questionnaire was limiting the number of names in the roster to include only those that the respondent had been communicating with during the past year. This pruning of the names roster was done before the actual network questionnaire took place, however, as in the previous questionnaire, the respondent was able to go back to the master list and include additional names between answering the questions. Then, the respondents were asked to rate the frequencies of communication (4=daily, 3=weekly, 2=once per month, 1=less than once per month, 0=not at all) with others in routines and non-routines. Also open feedback was gathered at the end of the questionnaire.

A follow-up questionnaire was submitted to the same company one year later. Some individuals had left the company, and there were also some new employees hired, but a majority of the population was the same as one year before. In the follow-up questionnaire, the respondents were asked to name other employees in their organization that they considered the best in creating and promoting ideas. The resulting rating was then used as a dependent variable in Paper IV to describe the subjective innovativeness performance of the individuals. The other performance measures used as dependent variables in Paper IV were the count of billable hours from the client and productivity, which was operationalized as count of billable client projects divided by the count of billable hours.

The follow-up questionnaire was designed to be a free recall, fixed choice questionnaire (Wasserman and Faust, 1994) to capture those individuals that the respondents recall in terms of innovativeness. The questionnaire was also easier and

quicker for the respondent to answer compared to roster-based free choice questionnaire design. Outlines of the questionnaires are presented in Appendix III.

3.5 Data analysis and summary of the methodology in the papers

The study includes papers that represent theoretical, case study, and hypothetic-deductive research approaches. In interview-based network analysis, the data were analyzed by qualitative content analysis of the transcriptions of theme-based interviews. In questionnaire-based network analysis methods, the analysis of the data was conducted with statistical analysis methods, such as the quadratic assignment procedure (QAP) and regression analysis. Table 4 summarizes the research methods, sample, data collection methods and data analyzing methods of papers in the study.

Table 3: Research methods and data collection methods of the papers

	Research method	**Research material**	**Data Collection methods**	**Data analyzing methods**
Paper II	Theoretical paper with a case study, qualitative method	Three persons working on the service in an architect studio. Company workshop.	Theme-based interviews; workshop with the top management of the case company	Qualitative content analysis of transcriptions of the interviews.
Paper III	Theoretical paper with a case study, social network analysis	One work team (N=10) in an insurance company	Social network analysis questionnaire	Quadratic assignment procedure (QAP), metric multidimensional scaling (MDS), degree centrality measures, NetDraw illustrations of the communication networks
Paper IV	Hypothetic-deductive paper, social network analysis, regression analysis	Employees (N=93) in an architect studio.	Social network analysis questionnaires	Descriptive network measures produced with UCINET VI (Borgatti, Everett and Freeman, 2002), metric multidimensional scaling (MDS), ordinary least squares (OLS) regression analysis

Papers II and III are theoretical papers with a case study. Case study methodology provides in-depth information of the studied subject. In case studies, the subject can be an individual actor, a group or a community. The case study

methodology is flexible in terms of data gathering, it allows the use of multiple ways to gather data. The approach of the case study methodology is inductive and holistic, and the phenomena are studied in their original environment. (Yin, 1994)

The inductive reasoning used in Papers II and III starts from conceptualized research data, which is then used to illustrate the theory related to the studied subject. In Papers II and III the theory part provides the definitions, the three network types that are used in interpreting the case, and further in making conclusions about the network types and management initiatives based on the case. The research questions provide the focus of the conclusions of a case study. Typical to case study research, the research questions were continuously redefined during the writing process of Papers II and III (cf. Eisenhardt, 1989), and the front-end and the back-end of the papers took their final forms after the construction of the case.

In Paper II, network relationships were studied from the point of view of the case firm (focal actor perspective), and only those ties were included that the interviewees considered as important in terms of the service studied. The data was analyzed with qualitative content analysis by identifying the actors and relationships from the transcriptions.

In Paper III, the theoretical idea of different network structures for different tasks was firstly explored through theory, and a network questionnaire was constructed on the basis the theoretical starting point. Paper III discusses the theoretical concepts with an empirical case study, and suggestions for future research are made accordingly.

The network analyses in Paper III were descriptive analyses of the network illustrations produced with NetDraw -software of the networks in three different tasks, and of the differences between these networks. In the descriptive analysis, the number of links, Quadratic Assignment Procedure (QAP) correlations and metric

multi-dimensional scaling of QAP, degree centralities, and network illustrations are presented (cf. Cross, Borgatti and Parker, 2001). The results of the analysis are then discussed on the basis of the theory.

Paper IV is a theory-testing hypothetic-deductive paper. The goal of the paper was to test certain assumptions in the theory with data. In Paper IV, the data was analyzed with social network analysis methods by producing descriptive network measures of the production and idea generation networks. The measures to describe the differences between the networks included statistics on the number of ties, densities, clustering coefficients and centralization of the networks. Also Metric Multidimensional Scalings (MDS) were generated with UCINET VI (Borgatti, Everett and Freeman, 2002) to illustrate the differences between the networks.

The hypotheses in Paper IV were tested with the ordinary least squares (OLS) regression method by using the centrality measures of individual employees produced with UCINET VI as independent variables to test their effect on three different performance measures. The objective performance measures used in Paper IV were the count of billable hours and productivity (count of billable client projects divided by the count of billable hours). The productivity measure quantified the activity of an employee in different client projects, thus describing how many client projects the employee worked on simultaneously. The innovativeness measure was a subjective measure based on the colleague ratings of the employees on creating and promoting ideas.

4 REVIEW OF THE RESULTS

This chapter presents the findings of the papers in terms of the research questions of the study. The main contribution of the papers to the research questions of this study are as follows.

The main contribution of Paper I is to show the role of intra-organizational networks as a value driver between the knowledge resources and competencies of the firm. Paper I also presents arguments that the intra-organizational networks can be categorized according to the tasks of production, development and idea generation.

The contribution of Paper II is related to the management of network in idea generation, development and production. All these need different management initiatives in a professional service firm. In idea generation tasks, a professional service firm should invest in entrepreneurial individuals, build many non-redundant network relationships and actively seek out ideas from its network. In development tasks, the firm should hire senior professionals capable of developing the service, build strong and reciprocal relationships to a small number of pilot clients, and build reciprocal and redundant relationships with a few well picked partners. In production tasks the firm should invest in well-trained managers to ensure the delivery of the service, build mechanisms to get feedback from the clients, and build hierarchical demand-supply chains.

The contribution of Paper III is related to communication network structures in teams. It was found that the communication in efficient production is centralized, in gradual development core-peripheral, and in idea generation ego-centric. According to the case study in Paper III, the case development network and idea generation networks are difficult to distinguish from each other.

Paper IV contributes to the examination of how the intra-organizational network structures differ from each other in different tasks in terms of their structural network indicators. It is shown in the paper that the communication network for efficient production (routine tasks) is dense and centralized, whereas the communication network for idea generation (non-routine tasks) is sparse and decentralized. Another result of Paper IV is that the employees who are in a non-routine role (managers) benefit from centrality more than employees in a routine role (professionals). For employees in non-routine roles, increased centrality predicts improved measured performance in innovativeness and productivity. Counter-intuitively, increased centrality predicts decrease in the performance of a manager when measured with billable hours from the client.

4.1 Paper I: The Knowledge System of a Firm – Social Capital for Explicit, Tacit and Potential Knowledge

The purpose of this theoretical paper was to bring clarity to the concept of intra-organizational networks in the value creation in firms from the knowledge management perspective, and to discuss the characteristics of different types of network structures. The paper suggests that an intra-organizational network structure is needed when knowledge resources are turned into value with capabilities. The paper argues that different types of knowledge resources require different network structures, and presents the characteristics of these network structures on the basis of theory.

It is explained that intra-organizational networks are an important value driver in the firm. With intra-organizational networks, a firm can acquire, modify, integrate, recombine and release its knowledge resources (cf. Blyler and Coff, 2003), and further create competencies that result in improved idea generation, development and production.

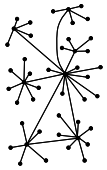
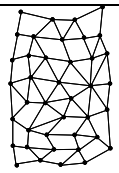
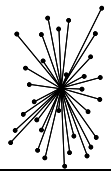
From theory, three typical network topologies – decentralized, distributed and centralized – are presented, and they are suggested to be optimal intra-organizational network structures for knowledge resources. This argument is justified by explaining that different types of knowledge resources need different intra-organizational network structures.

Potential, emerging type of knowledge is used when the firm gathers bits and pieces of information from many different sources and then condenses this information to a new idea. The decentralized intra-organizational network structure is the most suitable for idea generation tasks, because it includes many different hubs of knowledge, and spans widely across the organization.

Tacit knowledge is used to improve the existing business of the firm by gathering experience-based knowledge from inside the firm and from different interest groups, and by then applying these experiences to the development of the firm's products, processes or production methods. In the development task, the distributed social network structure is the most suitable, because it allows a deep and detailed, reciprocal exchange of experiences between the actors.

Explicit knowledge is used to manage existing business, i.e. well-specified, explicit and codified knowledge is used to improve efficiency. This task requires clear and concise orders from the top management of the firm to the subordinates. For the production efficiency task, the centralized social network structure is the most optimal to allow top-down transmission of orders. Table 4 presents a summary of the results presented in Paper I.

Table 4: The role of intra-organizational networks in the value creation of a firm

	The role of intra-organizational networks is to function as a value driver when the firm produces value from its knowledge resources. Efficient production, gradual development and idea generation all need different network structures.	
Network structure for idea generation	Decentralized, suitable for handling potential knowledge	
Network structure for gradual development	Distributed, suitable for handling tacit knowledge	
Network structure for efficient production	Centralized, suitable for handling explicit knowledge	

4.2 Paper II: Identification and Management of High-Potential Professional Services

The purpose of Paper II in terms of the research questions of this study was to present what types of management initiatives should be taken in the tasks of efficient production, gradual development and idea generation. This is presented with illustrations of the network relationships in a professional service firm in idea generation, development and production of a specific service. In this paper, the networks are studied from the point of view of a service, and the networks include inter-firm relationships.

In the case part in Paper II, one well established professional service has been taken into a closer examination. The case service is a workplace transformation service offered by an architect studio. The first ideas for the service were born in the early 1990's, the service was developed with a close relation to a certain pilot client

during the 1990's, and at the moment the service can be offered to new clients more or less off-the-shelf basis, where both the client and the supplier are well aware of the process and outcome of the service.

Figure 2 is a network illustration of the idea stage of the case service. The illustration has been constructed on the basis of the interview data and presented at the company workshop for comments. In the illustration, the architect studio is at the center. The lines and dotted lines represent tangible and intangible flows by which the actors are connected to each other. The figure shows that the initial ideas were captured from a global IT company and a cleaning firm that were transforming their offices. More ideas were received from the early clients of the service. The market demand for the transformation service built up slowly, and the architect studio got its first pilot client relationship and formed a non-profit association to share and learn knowledge about the field with other market actors. In the non-profit association, ideas were probably received from competitors as well.

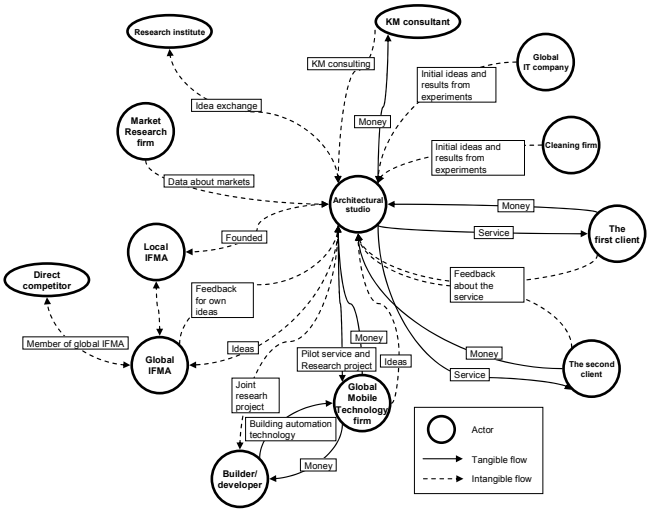


Figure 2: Network presentation of the idea stage of the workplace planning service

After the idea stage, the case service was developed gradually for many years in one close client relationship. A long-term research project (the gray area in Figure 3) was formed with a global mobile technology firm, research financiers and other actors. Besides the pilot client, also other clients were used to develop the service and learn best practices related to the service. From the point of view of the architect studio, the mobile technology firm benefited from the service through improved use of office space. For the global company, this resulted in substantial benefits in the efficiency of workspace use. Figure 3 is a network illustration of the development stage of the case service.

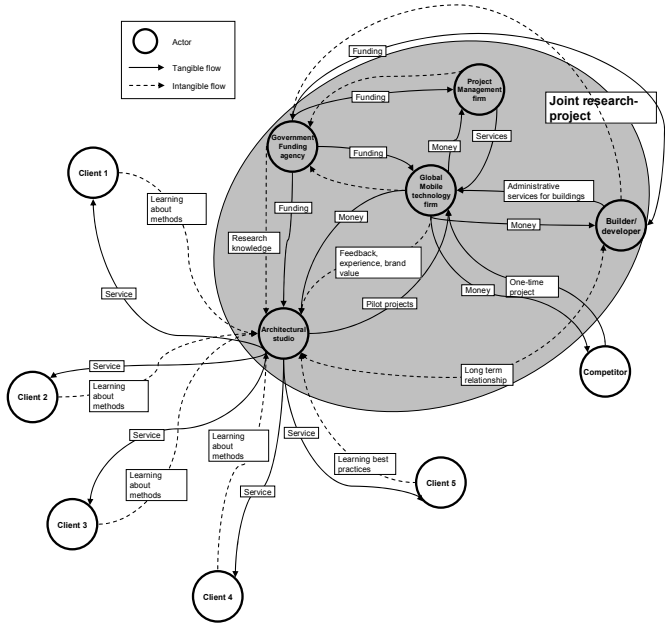


Figure 3: Network presentation of the development stage of the workplace planning service

The production stage of the case service seems well established (Figure 4), because the service has been developed to a stage where it can be offered to many clients in a similar way. The client is normally represented by the builder/developer,

the office owner and the end user, who all need to be dealt with during the production of the service. The relationship with the client is related to the delivery of the service, not to the development of the service. The service delivery, however, requires quite a bit of involvement and dedication from the client's side as well. Only a few partners are used in the delivery of the service. The delivery procedures of the service have been developed to a clear chain of events, and the work tasks are documented and defined in advance. After the service has been sold to a client, it seems that the communication with the client is related to the delivery of the service. This communication involves gathering information about the current situation and observations during the service.

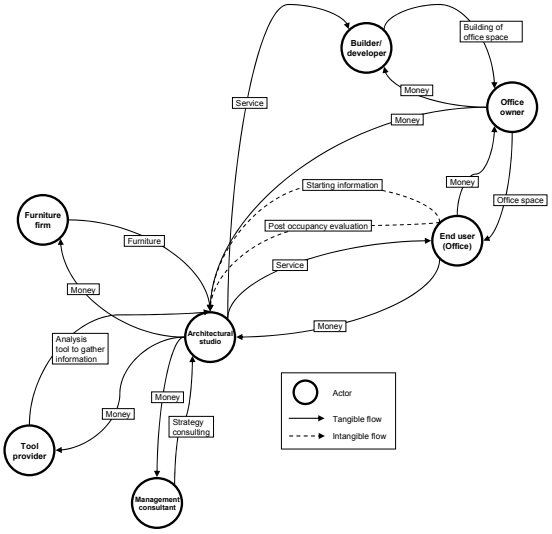


Figure 4: Network presentation of the production stage of the workplace planning service

It is argued in Paper II that the client of a professional service firm has a big role in the development of the service, and the management of service development

should be expanded to include the management of network relationships, not just internal operations of the service provider.

Table 5 summarizes the results of Paper II in terms of the research questions of this study, which are related to the different management initiatives in production, development and idea generation networks. The terminology used in the paper differs from the terminology used in Table 6. In the paper, the three tasks are presented from the point of view of the innovation process. There the idea generation task is labeled as idea stage, development tasks as development stage and production tasks as commercialization stage. Also, the row labels of Table 6 are slightly different in the paper, but describe the same subject.

Table 5: Management of production, development and idea generation tasks in a professional service firm

	Idea generation tasks	**Development tasks**	**Production tasks**
Individual competence	Invest in innovative and entrepreneurial individuals who are rich in ideas for new services.	Invest in highly talented and professionally rigorous senior professionals who have the competence to develop the service.	Invest in well-trained managers to ensure the delivery of the service.
Client relationships	Actively seek out ideas from the existing clients as well as from the market to map potential client needs.	Build strong and reciprocal relationships to one or to a couple of pilot clients.	Build mechanisms to get feedback from the client on the quality and delivery issues of the service.
Network relationships	Build many, but not very close network relationships with non-redundant sources of knowledge across hierarchical levels. Actively gather ideas from network partners.	Build overlapping and reciprocal relationships with fewer, well-picked partners. Actively engage in sharing of complex knowledge.	Build hierarchical supply-demand chains. Enforce the relationships with legal contracts. Restrict communication to issues concerning the delivery of the service and protect your core competence.

As a summary of the results of Paper II, the requirements for individual talent and the management of client relationships and network relationships are different in

production, development and idea generation tasks. In the idea generation task, a professional service firm (PSF) is advised to invest in innovative and entrepreneurial individuals who are rich in ideas and can scan and acquire ideas from their environment. In development tasks, professionally rigorous senior professionals can be hired to develop the service. In production tasks, well trained managers would ensure efficient delivery of the service.

From the client and network relationships perspective, the PSF must actively seek out ideas from the existing clients as well as from the market in the idea tasks, build strong and reciprocal relationships to a couple of pilot clients in the development tasks, and build mechanisms to receive feedback on the quality and productivity issues in the production tasks. Idea tasks are best managed with numerous and non-redundant network relationships, development tasks with redundant and reciprocal relationships and production tasks with hierarchical supply-demand chain approach.

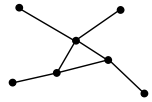
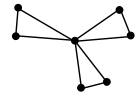
4.3 Paper III: Characteristics of Routine, Development and Idea Networks in Teams

Paper III in this study answers, from the point of view of communication network structures in a team, the questions of whether it is possible to categorize intra-organizational networks according to the tasks of production, development and idea generation, and how the networks differ from each other.

Based on organization and management theory on the structures of organization, the paper presents three ideal communication network structures. Table 6 summarizes the theoretical arguments: it is suggested that the ideal structure for production tasks is hierarchical, for development tasks core-peripheral, and for idea generation ego-centric. In the summary of the results of Paper III, the

knowledge network and communication network are considered as synonyms, and the routine tasks represent the communication network for production tasks.

Table 6: Structures of team communication networks in production, development and idea generation tasks

	Production tasks	**Development tasks**	**Idea generation tasks**
Illustration			
Structure	Hierarchical	Core –peripheral	Ego –centric
Knowledge purpose	To allow timely transfer of knowledge in the hierarchy from top to bottom and back	To allow thorough transfer of knowledge reciprocally in the core team	To allow swift transfer of knowledge from group members to the focal individual
Goal of the task	To perform pre-determined basic functions of the firm	To develop existing products, services or processes	To produce new ideas and concepts
Level of task uncertainty	No uncertainty. Initial stage, process and outcome well known and pre-defined	Initial stage certain, process and outcome uncertain	Initial stage, process and outcome uncertain

In Paper III, the three tasks are elaborated from the point of view of structure, knowledge purpose, goal of the task and level of uncertainty of the task.

In production tasks, attention is directed towards the completion of a pre-defined task in a given timeframe. In production tasks, there is no uncertainty related to the initial stage, process or outcome of the work. In a hierarchical knowledge network structure in routine work tasks, there is a leader who is responsible for getting the job done, and the leader facilitates the work of the subordinates who know exactly what to do and when. In Paper III, the hierarchical network means the

same as the centralized communication network structure. In the hierarchical network structure, knowledge must be allowed to flow from the top of the hierarchy to the bottom and back in a timely and precise manner.

According to Paper III, it is important to reach communicative and reciprocal relationships with other individuals in development tasks in order to solve a specific problem in existing products, services or processes. Development tasks involve uncertainty in the process and outcome, but the initial stage is known. In the core-peripheral communication network structure, there is no authoritative leader, but a small cohesive core and a periphery that are not connected with each other. The core-peripheral structure allows certain individuals to be interconnected with the work of others, but it also makes it possible to communicate with individuals outside the team.

In idea generation tasks, the primary goal is to generate as many ideas as possible in a short time. Idea generation tasks involve high amount of uncertainty, because in idea generation there are no clear pre-defined problems that have to be solved, and the outcome also remains unclear. Therefore, knowledge must be searched from distant others in the organization to avoid redundancy. In idea generation tasks, certain individuals function as hubs in the network that gather knowledge from all other individuals of the team.

The case study presented in Paper III describes the differences of the three task-related communication networks within a team. Measured with the number of links and Quadratic Assignment Procedure (QAP) correlations between the three structures, the three networks are different between each other, but idea generation and development networks are more similar with each other than with production network, as shown in Figure 5. Figure 5 shows the metric multi-dimensional scaling (MDS) of the QAP correlations of the three networks.

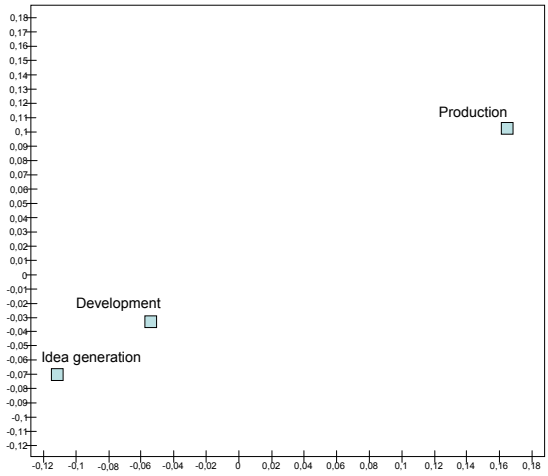


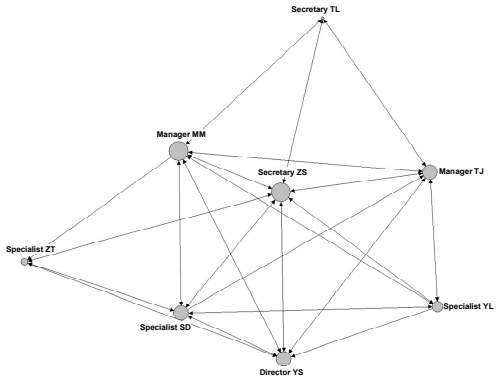
Figure 5: Metric MDS of the correlation matrix of production, development and idea generation networks in the case team

In the metric MDS of the correlation matrix of the QAP permutation test, the orientation of the figure is arbitrary, and the most important observation of the picture is how the data is clustered. The graduation of the figure is based on the MDS algorithm, where Euclidean distances of the input values from each other are determined according to the stress –criterion function (Borgatti, 1997).

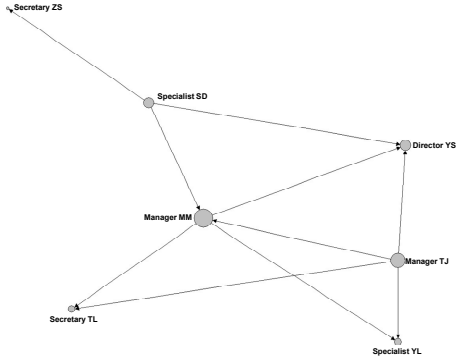
Figure 6 illustrates the network structures of production, development and idea generation tasks in the case team, the node size illustrating the degree centrality (~number of links) of the individual.

Knowledge flows in the case team provide some traces of the ideal network structures as follows: in the production network there is hierarchy, as individuals with a higher formal work role are generally more central than others. This means that employees with a responsibility of dividing labor in routine tasks are central. In development network, a core-peripheral structure is evident: a group of four individuals seems to form a tightly knit core network; they communicate with each

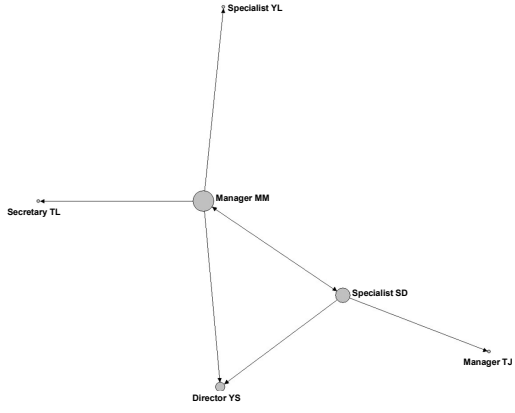
other more intensively than with people outside the core. In the idea generation network there seems to be one individual who is the most central and brokers knowledge in an ego-centric way.



Production network



Development network



Idea network

Figure 6: Illustrations of production, development and idea generation networks in the case team, node size portrays degree centrality

4.4 Paper IV: Communication Networks in Routine and Non-routine Tasks

Paper IV provides answers to the research question of how task-related intra-organizational networks differ from each other. Paper IV also brings light to the question of whether an increase in network centrality predicts the performance of employees.

Three performance measures are used in Paper IV. The innovativeness measure is based on network questionnaire results, and it is the rating of whether the employee is considered important by his/her coworkers in creating and promoting ideas. The billable hours measure is the count of billable hours from the client. The productivity measure is operationalized as the count of billable client projects divided by the count of billable hours. The performance measures have been constructed from the data one year after filling out the network questionnaire to show the effect of network centrality on performance.

Based on the results of Paper III that showed only minor differences between the development and idea generation networks, and to highlight the differences between communication networks in routine and non-routine tasks, Paper IV examines only the production and idea generation networks. In the paper, the production network is labeled as a routine and the idea generation network as a non-routine network.

According to the results, communication networks in routine and non-routine tasks are very different from each other. The employee's centrality in the communication networks predicts improved performance, but the effect is stronger with individuals in non-routine roles (managers). The individuals, whose role is to perform routine tasks (professionals) do not seem to benefit from centrality in the communication networks.

Table 7 (see appendix IV for an enlargement) presents the descriptive statistics of social network analysis of the routine and non-routine networks produced with UCINET VI (Borgatti, Everett and Freeman, 2002). The number of relations, densities, clustering coefficients and Freeman's degree centralization measures show the inherent differences between the two networks in each of the studied communication frequencies.

Table 7: Descriptive statistics of routine and non-routine networks (Appendix IV)

	Daily or more	< Weekly	< Once per month	< Less than once per month
Routines				
Number of relations	347	1080	1890	2817
Density	0.041	0.126	0.221	0.329
Weighted overall graph clustering coefficient	0.255	0.266	0.35	0.454
Freeman degree centralization	14.80 %	78.55 %	67.43 %	53.58%
Non-Routines				
Number of relations	72	275	585	1168
Density	0.008	0.032	0.068	0.137
Weighted overall graph clustering coefficient	0.053	0.162	0.22	0.244
Freeman degree centralization	11.75 %	13.41 %	18.86 %	79.14%

Figure 7 shows the metric multidimensional (MDS) scaling constructed with UCINET VI of the two networks. The figure shows that the communication network in routine tasks is denser and more tightly connected than the communication network in non-routine tasks. The figure also shows that in non-routine tasks individuals have communication relationships with more distant others than in production tasks.

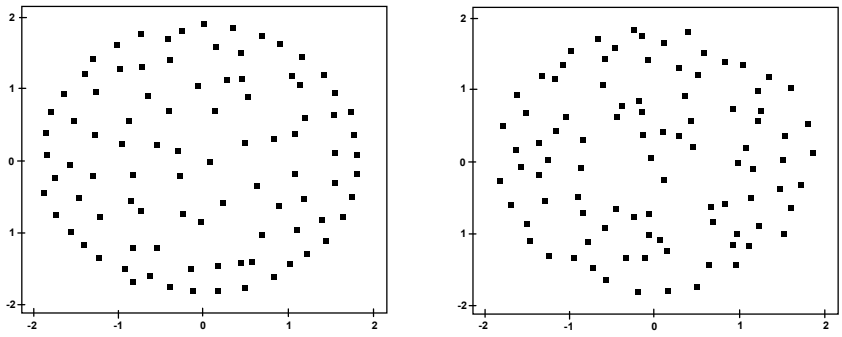


Figure 7: Metric MDS scaling of networks of routines (left) and non-routines (right) in communication frequency of weekly or more often

The dependent variables indicating the individuals' performance were the count of billable hours, project productivity and subjective innovativeness indicator. The independent variable was Freeman's closeness centrality measure. Tenure, education level, gender, language skills and formal role were used as control variables in testing the models. Table 8 (see appendix V for an enlargement) presents the means, standard deviations and correlations of the variables used in the testing of the hypotheses in the paper.

The employees working in professional roles (N=39) were considered to perform routine-type work, and the employees in manager roles (N=33) to perform non-routine work. Non-routine roles were indicated with a dummy variable 1, and routine roles with 0.

The role correlates with the education level ($r=0.67$, $p < .001$) and non-routine centrality correlates with routine centrality ($r=.74$, $p < .001$). The dependent variable productivity correlates with the role, routine centrality and non-routine centrality (r's = .33, .31, .30, < .05), and with the interaction terms of role x routine and non-routine centrality (r's = .38, .40, $p < .01$). Innovativeness correlates with education level ($r = .34$, $p < .05$), and with role and routine centrality (r's = .41, .43,

p < .01). With the interaction terms, innovativeness correlates as follows: role x routine centrality (r = .49, p < .001) and role x non-routine centrality (r=.54, p < .001). Billable hours correlates with routine centrality and non-routine centrality (r's= .28, .30, p < .05), and with non-routine centrality x role (r = .30, p < .05). Furthermore, the dependent variables correlate with each other: innovativeness with productivity (r = .62, p < .001), and billable hours with productivity and innovativeness (r's = -.80, -.57, p < .001).

Table 8: Means, standard deviations and correlations of variables (Appendix V)

VARIABLE	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11
1. Tenure	9.04	5.452542											
2. Education level	2.469388	0.8441475	0.1897										
3. Gender	0.387755	0.4922875	-0.195	-0.2967*									
4. Language skills	3.102041	1.084837	-0.0292	0.1059	-0.1537								
5. Role	0.591837	0.496587	0.1442	0.6654***	-0.0209	0.2723							
6. Routine centrality	67.68545	9.444632	0.142	0.0422	-0.2045	0.137	0.2709						
7. Non-routine centrality	57.70269	8.653174	0.0838	0.073	-0.1998	0.1093	0.122	0.7385***					
8. Routine centrality X Role	41.3032	35.42254	0.1758	0.6284***	-0.068	0.2931*	0.9784***	0.4256**	0.2185				
9. Non-routine centrality X Role	34.66408	29.7714	0.1602	0.6547***	-0.0545	0.2953*	0.977***	0.3727**	0.2759	0.9846***			
10. Productivity	-4.70243	1.01691	-0.2415	0.0564	0.0831	0.1956	0.3302*	0.3075*	0.2956*	0.3781**	0.3981**		
11. Innovativeness	-1.60E-09	1	0.0234	0.3422*	-0.277	0.2081	0.4115**	0.4283**	0.5294***	0.4876***	0.5416***	0.6145***	
12. Billable hours	-2.14E-10	1	0.2037	-0.0986	0.0905	-0.2143	-0.2162	-0.2839*	-0.2924*	-0.2788	-0.2992*	-0.7976***	-0.5691***

Sample size = 49
* p<0.05
** p<0.01
*** p<0.001

Table 9 (see appendix VII for an enlargement) presents the results of OLS regression analysis predicting individual performance. Centrality predicts performance only if performance is measured with either productivity or innovativeness. Also, centrality in the non-routine network for individuals with non-routine roles predicts performance measured with innovativeness and productivity. For the billable hours performance measure, centrality in the non-routine network results in declined performance for employees in non-routine roles.

Table 9: Results of regression analysis predicting productivity, innovativeness and billable hours (Appendix VII)

	Productivity					Innovativeness					Billable hours				
VARIABLE	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
Tenure	-0.0505*	-0.0545**	-0.0526**	-0.0596**	-0.0562**	-0.0161	-0.0213	-0.0194	-0.0278	-0.0253	0.0460*	0.0499*	0.0478*	0.0567**	0.0522**
Education level	-0.300	-0.173	-0.257	-0.165	-0.291	0.00532	0.170	0.0743	0.181	0.0180	0.114	-0.0104	0.0742	-0.0221	0.116
Gender	-0.0456	0.112	0.0815	0.143	0.0560	-0.561*	-0.356	-0.357	-0.316	-0.399*	0.292	0.138	0.175	0.0959	0.206
Language skills	0.0659	0.0677	0.0556	0.0436	0.0175	0.0493	0.0516	0.0326	0.0207	-0.0297	-0.109	-0.111	-0.0997	-0.0786	-0.0538
Role	1.055**	0.780*	0.949**	-2.141	-2.665	0.807**	0.449	0.637*	-3.293*	-5.278***	-0.566	-0.296	-0.468	3.627*	3.888**
Routine centrality		0.0272*		-0.000431			0.0354**		-1.70e-05			-0.0267		0.0105	
Non-routine centrality			0.0329**		-0.00203			0.0527***		-0.00440			-0.0302*		0.0119
Routine centrality X Role				0.0441					0.0565*					-0.0592*	
Non-routine centrality X Role					0.0641**					0.105***					-0.0773**
R-squared	0.233	0.285	0.307	0.318	0.377	0.252	0.342	0.447	0.399	0.643	0.141	0.192	0.205	0.254	0.311
F	2.62	2.79	3.10	2.74	3.55	2.90	3.64	5.65	3.89	10.53	1.41	1.66	1.80	2.00	2.64

Tenure is in years, Gender is coded 1 for "female", Role is coded 1 for "manager"
* p<0.1
** p<0.05
*** p<0.01

The results of the fourth paper indicate that the routine and non-routine networks are structurally different in the organization where the research was conducted, and that the centrality in those networks predicts individuals' performance up to a certain point. In the testing of the hypotheses, it was impossible to find significance with centrality and the routine role. However, centrality in the communication networks is significant in predicting performance for individuals in non-routine roles. There, centrality predicts decline in billable hours, but increase in productivity and innovativeness. The result is logical in the case company, where the billable work for the clients was supposed to be performed by individuals in routine roles (professionals), whereas selling, problem solving and idea generation tasks were supposed to be performed by individuals in non-routine roles (project managers, senior project managers, middle managers and top management).

5 DISCUSSION AND CONCLUSIONS

According to this study, a firm creates value from knowledge resources with intra-organizational networks that are related to the fundamental tasks of production, development and idea generation. It was suggested in the study that dividing the intra-organizational networks to three categories is meaningful, the networks are structurally different from each other in each of the tasks, each of the network types need different kind of management initiatives, and centrality in the communication networks has an effect on the employee's performance at work.

Theoretically the division of intra-organizational networks is evident, but the case study in Paper III indicated that the communication network structures in development and idea generation are difficult to distinguish from each other in a team. Therefore, the division of intra-organizational networks into routine and non-routine networks is more useful in empirical research, as shown in Paper IV.

The contribution of the study to the theory are presented in this chapter. The reliability and validity of the empirical research of the study are also discussed. Finally the limitations are reviewed, managerial implications summarized, and future research directions presented.

5.1 Theoretical contribution

The study is related to the field of Knowledge Management, and it examines the fundamental question of how firms create value from knowledge resources. The results of the study did not provide any new categorizations and definitions of intangible assets, nor new distinguishing characteristics of the knowledge-based organization. Instead, the study presented the underlying logic of how intra-

organizational networks are related to the value creation of the firm in knowledge-based organizations.

Drawn from the theory of the firm, efficient production, gradual development and idea generation are the three fundamental tasks that a firm must perform in order to find sustainable competitive advantage. Each of the three fundamental tasks is based on different mechanisms of value creation and has different reasoning logic.

The identification of the three tasks from the theory of the firm has not been presented earlier, and it is one theoretical contribution of this study. However, ideas that inherently describe a similar phenomenon of dividing the action of the firm into three categories, can be found in the writings of numerous other scholars in the management science from various perspectives (e.g. Crozier, 1964; Utterback and Abernathy, 1975; Abernathy and Clark, 1985; Cohen and Levinthal, 1989; Martin et al., 1998; Scott, 2003; Fitzroy and Hulbert, 2005).

As described in the theory part, the differences between the three tasks can be explained by describing their complexity in terms of how well known the input of the process, the process itself, and the output of the process are (Table 11). In production tasks, everything is known, in development tasks the output of the process is unknown, and in idea generation tasks the whole task is unknown.

Table 10: Definitions of production, development and idea generation tasks

	Input	***Process***	***Output***
Production tasks	Known	Known	Known
Development tasks	Known	Known or unknown	Unknown
Idea generation tasks	Unknown	Unknown	Unknown

Although, as presented as independent tasks in the theory, the three tasks do not rule each other out, and all are needed. A successful firm is able to master all the three tasks simultaneously. After operationalized as individuals' behavior in Paper

III, the team of 10 employees had relationships with each other in each of the tasks simultaneously, despite the fact that the development network and idea generation network were structurally similar to each other. This shows that a group of people forms different kinds of network structures when the type of task is used as the definition of a relationship in network analysis. In other words, the same team of employees is utilized to perform different tasks, which results in a different communication structure. Paper IV elaborates this insight further by looking at the network structure of the whole firm.

The study provides a new perspective into networks. Based on the research reported in this study, it is possible to argue that there is no one ideal network structure (Burt, 1992 vs. Coleman, 1988 debate), but many, according to the task. The classification of network types according to the type of task provides a model to understand intra-organizational networks and their management. The classification reduces the complexity of the organizational networks into a more understandable and manageable level. Therefore, the study presents a novel framework for future research on organizational networks and their management.

From the perspective of an individual employee's network relationships, this study suggests that more relationships are not always better when measured with performance at work. The optimal number of communication network relationships of an individual depends on the task. According to the results of the study in a professional service firm, centrality in the communication network does not seem to have any statistically significant effect on an individual's performance if the individual performs routine tasks (for employees in professional roles). The results show, however, a significant relationship between individual performance and network centrality if the individual perform non-routine tasks (for employees in managerial roles).

The results seem logical, because in a professional service firm, those individuals who are supposed to perform idea generation tasks, are required to communicate more, thus benefiting from centrality in communication networks; and those individuals whose formal role is related to production tasks, and are not required to communicate a lot, seem to be more relied on other qualities. The results of Paper IV are also in line with earlier network analysis studies on centrality and performance, according to which, the effect of centrality depends on the work role (e.g. Ibarra, 1993; Ahuja, Galletta and Carley, 2003).

Centrality was chosen as an independent variable in Paper IV because it is the most commonly used structural measure in social network analysis. In a professional service firm, central employees act as focal individuals in projects. They manage and integrate the work of others, and also act as brokers and hubs of new ideas. Based on earlier research stating that communication exceeding a certain threshold in a network has negative consequences on performance (Krackhardt, 1994a; Burt, 1997; Ahuja, 2000), a curvilinear relation between centrality and performance would be expected – the most central employees actually do not perform as well as their less central colleagues. The inconsistent result of the performance of employees in non-routine roles in Paper IV gives some hints towards this conclusion, although it was impossible to prove this conclusion with the data.

5.2 Summary of the reliability and validity of the empirical research

Table 10 presents a summary of the reliability and validity concerns of the empirical research in this study. In Paper II, the themes of the interview were carefully designed, and all the interviews were conducted in a similar style. The interview themes included also other aspects of the service besides network relationships, to give a good understanding of the subject to the interviewers. The research diary was

updated after each interview, which helped to keep track of the interviews and ensured that relevant actors were interviewed in each case.

In Paper II, the network relationships were studied from the point of view of the case firm (focal actor perspective), and only those ties were included that the interviewees considered as important in terms of the service. Even though the interviewees were all from different levels of hierarchy, they recalled the network relationships related to the service similarly. After the interviews, one workshop in the case firm was organized for the top management of the company. In this workshop, the participants commented on the network illustrations created on the basis of the interviews, and corrections to the network illustrations were made.

Table 11: Summary of the papers in terms of reliability and validity

	Means of improving reliability	**Means of improving validity**
Paper II	Carefully designed themes in the theme-based interview; interview considering also other aspects of the case besides network; Multiple similar interviews with the same interviewers; research diary	Multiple inteviewees from different levels of hierarchy; multiple interviewers; presenting the network pictures in a top management workshop. Modification of the network illustrations according to the feedback.
Paper III	Carefully designed wordings and definitions of frequency in the questionnaire	Work team as a boundary criteria; directed two-way questionnaire; over 80% response rate; roster (sociocentric)
Paper IV	Carefully designed wordings and definitions of communication frequency in the questionnaire; testing of the questionnaire with the author's own organization	**2006 questionnaire**: combination of the egocentric (free recall) and sociocentric (roster) method; organization as a boundary criterion; directed two-way questionnaire; over 80% response rate **2007 questionnaire:** free recall, fixed choice questionnaire

In Paper III, the wordings, as well as the definitions of communication frequency used in the questionnaire were carefully designed with the help of earlier network questionnaires and by confirming the questionnaire with an employee in the

case team. In Paper III, a work team was used to draw the boundary of the network. The network questionnaire mapped communication between individuals in both directions – giving to and getting from (cf. Cross and Cummings, 2004). The response rate of the socio-centric questionnaire was 80%, which makes the network data complete enough to be presented as a case study.

The questionnaire was carefully designed also in Paper IV, and the exact wordings of the questionnaire were commented on by the colleagues of the author. Furthermore, the questionnaire was pre-tested within the author's own organization to estimate the time spent in answering the questionnaire and to gather feedback.

In the network questionnaire of Paper IV, sociocentric and egocentric data gathering methods were combined. This was done by letting the respondents define their own networks from a roster of names that included everyone (N= 93) in their organization, before answering the rest of the questions. Similarly to the questionnaire in Paper III, the questionnaire was designed as a free-choice questionnaire with two-way directed questions about communication with others in the work tasks. Demographic data, such as the age, education, tenure and language skills of everyone, also including non-respondents in the organization was gathered from the personnel records and with the assistance of personnel in the case company.

For the follow-up questionnaire conducted in 2007 with the same individuals, the method was changed: a free recall, fixed choice questionnaire was used to map the most innovative individuals in the office. In all the network questionnaires, web-based implementation made it easier for the respondents to fill out the questionnaire and improved the response rate, because it was faster and easier to fill out than a printed questionnaire.

5.3 Limitations of the study

A general limitation of the study is the changing vocabulary of terms between the introductory part and the papers. In the papers, different words were used to describe the same phenomena. Idea generation, development and production were used to describe the three fundamental tasks of a firm in the introductory part, but in paper II, these three tasks were labeled as idea stage, development stage and commercialization stage. In Paper III, the tasks were labeled as routine work tasks, development tasks and idea generation tasks. In Paper IV, routine and non-routine labels were used. The differences in the terms were a result of the evolving thought processes of the author – in the course of the research the key terms and concepts of the study became clearer and better defined. Certain ambiguity of terms still remains – it can be argued that production tasks require a lot of idea generation, for example. To propose a label for the three tasks with innovation vocabulary, the idea generation tasks would be called radical innovation and development tasks incremental innovation.

The differences between the research designs of the papers included in the study posed a challenge to the structure of the introductory part. The research questions presented in part three of the study were formed to provide a coherent line of reasoning of how the four papers are related to each other. Of the empirical papers, Paper II is a longitudinal, qualitative network analysis that includes inter-firm relationships, and is clearly different from Papers III and IV, which are based on questionnaire data of intra-firm networks. To overcome this challenge, Paper II was treated in the study in the light of management initiatives of production, development and idea generation networks.

The goal of Paper I was to show from theory that there are three types of intra-organizational networks related to the three fundamental tasks in a firm. The

literature was reviewed to find evidence of the three networks, and the characteristics of the networks were constructed accordingly. This resulted in a selective treatment of the social capital theory, but on the other hand expanded the theory to include different types of social capital according to the task.

The limitations of Papers II and III are related to the generalizability of the qualitative case study approach used in these papers. The case in Paper II of the idea generation task, development task and production task of a service was based on a fairly low number of interviews, although the resulting network illustrations were further processed in a top management workshop to ensure their accuracy. The conclusions drawn from the interviews in Paper II were interpreted with the three-dimensional network lens introduced in this study.

In Paper III, the illustrations of the communication networks in a team were cross-sectional, and based on the subjective evaluations of the respondents, meaning that the team members had to imagine different types of tasks when they were answering the questionnaire. The drawing of reliable conclusions based on the data in Paper III about the different task-related network structures is thus debatable. A more reliable way to study communication in a team would have been an observation research of the team when it was performing either production or idea generation tasks.

The case study in Paper III showed that the communication structure is different in a team in the three tasks, which fulfills the purpose of the research questions of this study. However, the relationship between the network structures of teams and team performance in different tasks was not studied. The case also showed that there are only small differences between the idea generation network and the development network.

In Paper IV, the employees working in professional roles were categorized as performing routine-type work, and people in managerial roles as performing non-routine-type work. However, the correlation between routine centrality and non-routine centrality was high and significant ($r = .74$, $p < .001$). This may suggest low discriminant validity (question the rationality of the operationalization of the variables) between routine-type and non-routine type work, or the result may simply suggest that the same individuals are central in both networks. In Paper IV, this validity issue was not discussed.

Papers III and IV suffer from information inaccuracy in the network questionnaires (cf. Kossinets, 2006). This is a common problem in questionnaire-based research, which is due to the evaluations of the respondents. Therefore, the networks analyzed in papers III and IV were combinations of estimates of communication in the organization rather than objective facts. However, also one of the dependent variables, innovativeness, in Paper IV, was constructed based on subjective evaluations of the respondents. The other dependent variables were constructed from the company data. The subjective nature of questionnaire-based network data and the dependent variable based on individual evaluations should imply social phenomena of networking, and tell how well individuals are able to utilize their perceived network positions to increase their status as innovators in the organization. In some cases, status and the instrumental benefits that come along with it can be more important for individuals in knowledge-based work compared to objective performance measures.

5.4 Managerial implications

The starting point of the study was that there are three fundamental tasks in a firm; production, development and idea generation. Supposedly, managing the intra-

organizational networks related to these tasks ensures a knowledge-based firm a sustainable competitive advantage in the market. The three tasks have also firm-external implications – by using the three tasks presented in this study as a framework for the firm's strategy, a firm can better realize its position in a complex network of stakeholders and also "orchestrate" and manage the network relationships in the different tasks. In a professional service firm, for example, managing both the intra- and inter-organizational networks related to the delivery of existing services, development and improvement of existing services, and generating of ideas for new services would result as improved competitive advantage. As shown in this study, all three tasks involve a different value creation logic and require different kinds of management initiatives in terms of network structures. In this part, managerial implications to building and leveraging these networks are presented.

Managerial actions to leverage the three networks can be summarized as follows: 1) create fair and unambiguous rules, regulations and divisions of work to support centralized and hierarchical structures for production tasks, 2) enforce the social cohesion and team spirit to create prerequisites for distributed, closed, core-peripheral structures in development tasks, and 3) find gatekeepers and identify employees who are respected and trusted by others to encourage decentralized and ego-centric structures for idea generation tasks.

In the theory of the firm and in the dynamic capability framework (Teece, Pisano and Shuen, 1997; Helfat, Finkelstein, Mitchell, Peteraf, Singh, Teece and Winter, 2007; Teece, 2007), individuals employed by firms hold valuable knowledge resources and also form a "social infrastructure" to create value from the resources. In the social infrastructure, knowledge is considered as a firm-level phenomenon being an aggregate of the skills of the individual employees (Nelson

and Winter, 1982). The three network structures introduced in this study can be elaborated with the dynamic capabilities of sensing, seizing and transforming, as presented by Teece (2007).

Sensing capability makes it possible to identify opportunities and threats in the environment and evaluate the firm as a part of its environment. Searching for new information must take place both inside and outside the firm. The technological, market and competitive information gathered must be "made sense of" and the implications for actions figured out. Understanding the competitors' strengths and weaknesses and competitive activities and responses is an essential part of understanding the business environment (Teece, 2007).

As argued in this study, decentralized and ego-centric network structures lead to increased diagonal communication across hierarchies and formation of non-redundant links to a great variety of actors. Communication in this type of network structure leads to increased amount of information from the business environment. A direct implication for managers to improve the dynamic capability of sensing is to facilitate sparse and decentralized network structures by finding gatekeepers and identifying employees who are respected and trusted by others for idea generation tasks.

Seizing capability is the second dynamic capability that a firm needs, according to Teece (2007). Seizing is about making the right decisions at the right time. Seizing capability requires disciplined investment routines, information and data collection and analyses, objective reasoning, attention to history, and good governance (Teece, 2007). Seizing capability is equally important for a firm as sensing and transforming, because rapid technological changes in the markets cause risks related to the firm's product specifications and selection of technologies used

in the product and offering. In short, with seizing capabilities, a firm can produce something that is appealing to the customers.

To enhance seizing capability, a firm has to create an environment where the cognitive bias of decision making can be successfully eliminated, decisions can be approached with discipline, and an outside view can be obtained. This structure must offer the individuals involved in decision making a chance to express their honest opinions (Teece, 2007).

The distributed and core-peripheral network structures introduced in this study the support seizing dynamic capability. Every actor in this structure is connected to a couple of other actors with a strong tie to form a network structure of closure. A dense network structure creates commitment to the group of people, which in turn makes communication and transactions easier for the people belonging to the group. A distributed network structure leads to increased horizontal communication and formation of reciprocal and communicative exchange of information, which in turn leads to improved consideration of different strategy options for a firm. The top management can enforce social cohesion and team spirit to create possibilities for closure to improve the seizing dynamic capability.

The third dynamic capability is transforming capability (Teece, 2007). The transforming dynamic capability of a firm is about combination, reconfiguration and asset protection skills. Transforming is also about managing the threats of the firm. In short, transforming can be said to represent the dynamic capability of the firm to match the decisions made with seizing capabilities based on information gathered with sensing – transforming is a capability of a firm to reconfigure itself and turn decisions into action. (Teece, 2007)

The transforming dynamic capability requires a network structure that permits fast restructuring, modifications to the existing business model, restructuring

of labor contracts and protection of knowledge assets globally (cf. Teece, 2007). Therefore it can be argued that the best network structure in the firm to support transforming, is centralized and hierarchical. The centralized network is optimal for getting something done fast and according to pre-made decisions. Hierarchical relationships support vertical communication in the centralized network structure. The centralized structure supports one-way and top-down communication and leads to accurate and fast transfer of information. This in turn leads to improved dynamic capability to transform the organization. The top management can support the centralized network structure by creating fair and unambiguous rules, regulations and divisions of work across the firm.

As a summary, the managerial implications that this thesis suggests are that the structures of idea generation, production tasks and development tasks exist in parallel in the organization. In the context of the dynamic capabilities theory, this would mean that a firm that enjoys a sustained competitive advantage in the market would have, among its executives, separate but parallel network structures for routine decision making, business development and generation of new business ideas.

5.5 Further research

This study is limited to intra-organizational networks. This gives important insight into the structures of relationships between the employees of a firm. However, improved understanding of the issues related to networks, and more managerial implications of managing network relationships can be made if the intra- and inter-firm network points of view can be combined. The inter- and intra-firm networks undoubtedly affect each other, and the performance of the firm depends on both. The inter-firm point of view is important for each of the network types: production tasks

are done in supply chains between companies, development work in strategic alliances, and idea generation across firm boundaries. Combining the two is challenging in terms of research design – the question is how to include both firm-to-firm and individual-to-individual relationships into one study and make conclusions based on that.

This study has set grounds for several topics of further research. Social capital is an ambiguous concept, and there is a need for further clarification of the term in the context of for-profit organizations. This study concentrated only on the structural aspect of social capital and left the relational aspects – norms, beliefs and trust – unstudied. Furthermore, this study did not consider other benefits of network centrality besides performance at work. The other benefits, such as work-related well-being, would also make interesting topics for research.

Networks are a resource for a firm in order to employ the dynamic capabilities: sensing new opportunities, seizing correct decisions and transforming the firm according to a new strategy (cf. Teece, 2007). Networks play a critical role in the knowledge economy and in the world of open innovation (Chesbrough, 2003), where the ideas for innovations flow from outside the company, and where new innovations are commercialized in collaboration with multiple stakeholders. For future research agenda, it would be interesting to study how the intra-organizational networks of well performing organizations are structured to support sensing, seizing and transforming. Furthermore, according to the experiences of the data gathering for Papers III and IV, measuring work-related communication in the organization is easier than compared to measuring social relationships, such as trust, because employees answer a task-related questionnaire more willingly than questions about their personal ties.

As argued in this study, there is a significant difference in the network structure between production and idea generation tasks, but the differences between development tasks and idea generation tasks seem small according to the case in Paper III. In Paper IV, the differences between these the two networks were left unstudied. This means that the result of non-separability of development and idea generation networks is based on only one case, and therefore the idea of three-dimensional task-related, intra-organizational networks presented in this study as a starting point should not be abandoned. More research is needed to further operationalize the three tasks and confirm their differences and/or similarities in organizations.

If the development network is determined as non-existing in future studies, then the task-related network research should focus on routine tasks and non-routine tasks, as their differences are undisputable. Routine and non-routine networks have totally different goals and structures in the value creation of the firm. Their research and management is important, and could result in finding a successful combination of efficiency and innovativeness – exploration and exploitation (March, 1991), which can be thought of as being the holy grail of management for any firm in the market.

Team performance aspects should be studied further on the basis of the third paper in this study. A more rigorous research design should be employed to study what are the communication patterns of teams performing routine and non-routine tasks, and what kinds of structures are best for creating new ideas, developing them further and implementing them in practice. For this purpose, data should be collected from a number of teams over a long time – some teams performing routine tasks and others teams performing non-routine tasks. Then, conclusions could be drawn by comparing the network structures of the different teams.

Based on the fourth paper, it can be stated that the managers of a professional service firm benefit most from networking in their work. Still, it seems a bit blurred whether good performance entails a certain network position, or whether the network position comes along with good performance. Therefore, the relationships between networking and competence for individual managers seem unclear.

Further research should direct attention towards studying whether centrality in the communication networks is actually a substitute or a complement to an individual professional's competence. Using OLS regression analysis as a method limits the insights of the nature of knowledge work in a professional service firm, because the variables used in the analysis must be quantifiable. The mixed results of Paper IV may indicate that the relationship between communication among employees and employees' performance should be studied inductively by gathering qualitative data. An inductive, in-depth research design would allow defining the type of knowledge that employees need in different tasks and the corresponding optimal network structures to support this knowledge. Also the relationships of task–related networks with each other should be studied more closely – what are the path dependencies between the three tasks and how do they affect employees' performance?

The future research design to study the task–related networks and their implications to performance should be conducted longitudinally, to observe the evolution of the network ties. The results based on this type of research would be valuable, because it would give the managers of professional service firms hints of what kinds of individuals they should hire in which roles.

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APPENDIX I

Translation of the theme-based interview questions in Paper II

Orientation

1) What is the service that is under discussion now?
2) What is the background and role of the interviewee in the company and in relation to the service that is discussed?

Service as an innovation

3) How and when is the service born?
3a) On what kind of innovation or what kinds of innovations is this service based on?
3b) What actors (persons or institutions) were involved in the beginning?
3c) If the service was developed in cooperation, who made the first move to start cooperation?
3d) What kind of cooperation was there with the clients before the service was developed?

4) How has the service developed during its history?
4a) Can there be different phases in the history of the service?
4b) What actors have been essential in the different phases?
4c) What is the current situation of the service?
4c) What are the future prospects for this service?

5) Who or what is a customer of this service? How does this service provide value (is valuable to the customer)?

6) How is the service produced?
6a) Are there any (part) processes, task entities or phases?
6b) Are some part processes more important than others to provide the service successfully?

7) What is the role of the customer in this service?
7a) What does the service require from the customer?
7b) What kind of a process does the customer have?
7c) How do you think that the customer sees the lifespan of the service?

8) Are there any other actors related to this service than the provider and the customer?

10) What kind of communication is needed in the different phases of the service process?
10a) Who communicates with whom?
10b) What kind of information is needed in different phases?
10c) How is the communication managed in this service?
10d) Have there been any problems related to management of communication or information?
10e) How has the information or communication changed during the development/lifespan of the service?

11) What kind of competences are needed in this service?
11a) What kind of competences are required from the service provider?
11b) What kind of competencies are required from the customer?
11c) What kind of competencies are required from the other actors involved?

12) What tools or systems are needed to produce the service?

13) How is the service evaluated?

Network connections

14) What are the relationships for the actors mentioned above (in relation to the service)?
14a) The nature of the relationships: how close? How long has the cooperation been going on? How broad or how well defined has the cooperation been?
14b) What is the relationship based on?
14c) Are there any other actors involved in this service that have not been mentioned?

15) What are the roles of the above mentioned actors in producing the service?

16) How is the cooperation managed and by whom?
16a) What kind of issues of responsibility are related to cooperation and service?

17) How are the goals set in the cooperation?
17a) How have the set goals been met?
17b) What benefits have the network relations provided to your firm or to this service?
17c) Have there been any problems in the cooperation?
17d) Has this service or network cooperation resulted in new potential innovations or ideas?

18) How are the information and knowledge flows managed in the cooperation network?
18a) What information or communication is the most critical for successful service?
18b) Who has what information?
18c) In what form is this information?

19) How are the competencies developed in the cooperation network?

Conclusion

20) Does the interviewee have any additions or corrections to the discussion?

APPENDIX II

Translated outline of the network questionnaire questions used in the case study in Paper III

Page 1/8 – Background information:

- Name:
- Year of birth:
- Tenure:
- Title:

Page 2/8 – From the list below, indicate those individuals in your team that you have been communicating with frequently (once per a quarter of a year or more often)

Below is a list of individuals working in the same team with you. Depending on your tenure and work description, you may know some people well and somebody hardly at all. From the list below, pick the people that you have been communicating with frequently (once per a quarter of a year or more often). Communication does not have to be related to a certain work task, coffee breaks count as well. Please include all means of communication (face-to-face, phone, email, etc.)

Page 3/8 – Routines (giving knowledge to):

With this question we map those persons that you exchange information with related to routine –like work tasks. A routine work task is for example:

- A task that has been defined in advance, recurring, and has to be performed in a given timeframe
- Routine work can be related to internal affairs, such as timesheets or reports
- Routine work can be something done for the customer that you feel is routine by your own expertise
- Information related to routine work can be for example standardized information, instructions, documents or schedules. You can give or receive this information with all means of communication, i.e. face-to-face, email or by phone.

Question: Please indicate how often you **give** knowledge related to routine work tasks to the following people. (Frequency scale: 0= Not at all, 4= Daily or almost daily, 3= Weekly, 2= Once per month, 1= Less than once per month)

If you notice that you forgot to mention somebody, you can add him/her to the list before answering this question.

If you give information related to routines only to one person, pick him/her. If you give information related to routines to many persons, pick them. If you do not give information related to routines to anybody, do not pick anyone. All your entries are naturally just estimates.

Page 4/8 – Routines (getting knowledge from):

Question: Please indicate how often **you receive knowledge related to routines from** the individuals below. (Frequency scale: 0= Not at all, 4= Daily or almost daily, 3= Weekly, 2= Once per month, 1= Less than once per month)

These people might be the same that you give information related to routines to, but they can also be other people.

If you receive information related to routines only from one person, pick him/her. If you receive information related to routines from many people, pick them. If you do not receive information related to routines from anybody, do not pick anybody. All your entries are naturally just estimates.

Page 5/8 – Development work (giving knowledge to):

With the following questions we map those individuals with whom you exchange knowledge related to the business development tasks in your company. Development work can mean many things. In this survey, we define development as follows:

- Development of an existing product or service
- Development of an internal process or policy of the company
- Gradual development work that is based on your own expertise as a professional in your work.

You can give or receive this information with all communication means, i.e. face-to-face, email or by phone.

Question: Please indicate how often you **give** knowledge related to development work tasks to the following people. (Frequency scale: 0= Not at all, 4= Daily or almost daily, 3= Weekly, 2= Once per month, 1= Less than once per month)

If you notice that you forgot to mention somebody, you can add him/her to the list before answering this question.

There are no correct answers to this question, and the answers vary according to work description. It is perfectly normal if you do not recall anybody when you think about development work. It is also normal to recall many people.

Page 6/8 – Development work (getting knowledge from):

Question: Please indicate how often **you receive knowledge related to development work from** the individuals below. (Frequency scale: 0= Not at all, 4= Daily or almost daily, 3= Weekly, 2= Once per month, 1= Less than once per month)

These people can be the same that you give information related to development work to, but they can also be different people.

If you receive information related to development work from only one person, pick him/her. If you receive information related to development work from many persons, pick them. If you do not receive information related to development work from anybody, do not pick anybody. All your entries are naturally just estimates.

Page 7/8 – Ideas (giving knowledge to):

With the following questions we map those individuals with whom you communicate about new ideas and new possibilities. With ideas we mean:

- The feeling when you get "light bulb moments" in your work
- An idea is something new and you are not aware of anybody else having thought about it before
- Everybody has their own ways and places to come up with ideas. You may get ideas whenever and wherever at work, at home or in your freetime.

Ideas can be born or transmitted in informal occasions, such as during lunch or coffee breaks.

Question: Please indicate how often **you share your own ideas with** the individuals below. (Frequency scale: 0= Not at all, 4= Daily or almost daily, 3= Weekly, 2= Once per month, 1= Less than once per month)

There are no correct answers to this question and the answers vary according to work description. It is perfectly normal if you do not recall anybody when you think about ideas. It is also normal to recall many people.

If you present your ideas only to one person, pick him/her. If you present your ideas to many people, pick them. If you do not present your ideas to anybody, do not pick anybody. All your entries are naturally just estimates.

Page 8/8 – Ideas (getting ideas from):

Question: From the list below, **pick those people that present their ideas to you**. These people may be the same individuals that you tell your ideas to, or they can be other people.

If only one person presents his/her ideas to you, pick him/her. If many people present their ideas to you, pick them. If nobody presents their ideas to you, do not pick anybody. All your entries are naturally just estimates.

APPENDIX III

Translated outline of the network questionnaire and innovativeness survey used in Paper IV

2006 network survey

Background information:

- Name:
- Year of birth:
- Tenure in company x:
- Department:
- Title:
- Describe your current job with a couple of sentences:
-

Name those that you have been communicating with during the past year (from the roster of names)

With whom of these people have you been communicating during the last year? Communication includes all means of communication (face-to-face, phone, email…)

Below is a list of all people working in Company X. Depending on your tenure and work description, you may know some people well and somebody hardly at all. From the list below, pick the people that you have been communicating with over the last year.
You may pick as many people as you like.

How often do you give information related to routine work to the following people?

Below is a list of all those people you communicate with according to the first question. If you notice that you forgot to mention somebody, you can add him/her to the list before answering this question.

With this question, we map those persons that you exchange information with related to routine –like work tasks that you encounter. Routine work is:

- Something that has been defined in advance
- Has a repetitive nature
- Must be done in a given timeframe
- Routine work can be related to internal affairs, such as to timesheets or reports
- Routine work can be something done for the customer that you feel is routine by your own expertise
- Information related to routine work can be for example standardized information, instructions, documents or schedules. You can give or receive this information with all communication means, i.e. face-to-face, email or by phone.

There are no correct answers to this question, and the answers vary according to work description. It is perfectly normal if you do not recall anybody when you think about routines. It is also normal to recall many people.

From the list below, pick those people that you give information related to routines to.

If you give information related to routines only to one person, pick him/her. If you give information related to routines to many persons, pick them. If you do not give information related to routines to anybody, do not pick anyone. All your entries are naturally just estimates.

How often do you get information related to routine work from the following people?

2. Question: *From the list below, pick those people* ***that you receive information related to routines from****.*

These people might be the same that you give information related to routines to, but they can also be other people.

If you receive information related to routines only from one person, pick him/her. If you receive information related to routines from many people, pick them. If you do not receive information related to routines from anybody, do not pick anybody. All of your entries are naturally just estimates.

How often do you give information related to ideas to the following people?

Below is a list of all those people you have been communicating with during the past year according to the first question. If you notice that you forgot to mention somebody, you can add him/her to the list before answering this question.

These questions map those people that you exchange ideas with in your work. With ideas we mean:

- *The feeling when you get those "light bulb moments" in your work*
- *An idea is something new and you are not aware that anybody has thought about it before*
- *Everybody has their own ways and places to come up with ideas. You may get ideas whenever and wherever at work, at home, or in your freetime*
- *Ideas can be born or transmitted in informal occasions, such as during lunch or coffee breaks.*

There are no correct answers to this question, and the answers vary according to work description. It is perfectly normal if you do not recall anybody when you think about ideas. It is also normal to recall many people.

1. ***Question:*** *From the list below, pick those people* ***that you present your ideas to.***

If you present your ideas only to one person, pick him/her. If you present your ideas to many people, pick them. If you do not present your ideas to anybody, do not pick anybody. All your entries are naturally just estimates.

How often do you get information related to ideas from the following people?

2. Question*: From the list below,* ***pick those people that you get ideas from (that present their ideas to you)****. These people may be the same individuals that you tell your ideas to, or they can be other people.*

If only one person presents his/her ideas to you, pick him/her. If many people present their ideas to you, pick them. If nobody presents their ideas to you, do not pick anybody. All your entries are naturally just estimates.

2007 Innovativeness survey

Ideas: important individuals that promote ideas

Question – Who are the most important individuals in your organization in terms of promoting ideas?

Please write to the gaps below names of five individuals from your office that you feel are the most important in terms of promoting your own ideas. With this question we are looking for individuals whose time (or action) you would most probably use if/when you would like to put your own idea forward in the organization. Without the help of these individuals ideas would be considerably more difficult to implement.

Person 1:
Person 2:
Person 3:
Person 4:
Person 5:

Ideas: important individuals that create ideas

Question – Who are the most important individuals in your organization in terms of creating ideas?

Please write to the gaps below names of five individuals from your office that you feel are the most important in terms of creating new ideas. With this question we are looking for individuals who are known to be rich in ideas. Without these individuals, there would be considerably less new ideas created.

Person 1:
Person 2:
Person 3:
Person 4:
Person 5:

Enlargement of Table 11: Descriptive statistics of routine and non-routine networks

	Daily or more	< Weekly	< Once per month	< Less than once per month
Routines				
Number of relations	347	1080	1890	2817
Density	0.041	0.126	0.221	0.329
Weighted overall graph clustering coefficient	0.255	0.266	0.35	0.454
Freeman degree centralization	14.80 %	78.55 %	67.43 %	53.58%
Non-Routines				
Number of relations	72	275	585	1168
Density	0.008	0.032	0.068	0.137
Weighted overall graph clustering coefficient	0.053	0.162	0.22	0.244
Freeman degree centralization	11.75 %	13.41 %	18.86 %	79.14%

APPENDIX V

Enlargement of Table 12: Means, standard deviations and correlations

VARIABLE	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11
1. Tenure	9.04	5.452542											
2. Education level	2.469388	0.8441475	0.1897										
3. Gender	0.387755	0.4922875	-0.195	-0.2967*									
4. Language skills	3.102041	1.084837	-0.0292	0.1059	-0.1537								
5. Role	0.591837	0.496587	0.1442	0.6654***	-0.0209	0.2723							
6. Routine centrality	67.68545	9.444632	0.142	0.0422	-0.2045	0.137	0.2709						
7. Non-routine centrality	57.70269	8.653174	0.0838	0.073	-0.1998	0.1093	0.122	0.7385***					
8. Routine centrality X Role	41.3032	35.42254	0.1758	0.6284***	-0.068	0.2931*	0.9784***	0.4256**	0.2185				
9. Non-routine centrality X Role	34.66408	29.7714	0.1602	0.6547***	-0.0545	0.2953*	0.977***	0.3727**	0.2759	0.9846***			
10. Productivity	-4.70243	1.01691	-0.2415	0.0564	0.0831	0.1956	0.3302*	0.3075*	0.2956*	0.3781**	0.3981**		
11. Innovativeness	-1.60E-09	1	0.0234	0.3422*	-0.277	0.2081	0.4115**	0.4283**	0.5294***	0.4876***	0.5416***	0.6145***	
12. Billable hours	-2.14E-10	1	0.2037	-0.0986	0.0905	-0.2143	-0.2162	-0.2839*	-0.2924*	-0.2788	-0.2992*	-0.7976***	-0.5691***

Sample size = 49
* p<0.05
** p<0.01
*** p<0.001

Enlargement of Table 9: Results of regression analysis predicting productivity, innovativeness and billable hours (Appendix VI)

VARIABLE	Productivity					Innovativeness					Billable hours				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5	Model 1	Model 2	Model 3	Model 4	Model 5
Tenure	-0.0505*	-0.0545**	-0.0526**	-0.0596**	-0.0562**	-0.0161	-0.0213	-0.0194	-0.0278	-0.0253	0.0460*	0.0499*	0.0478*	0.0567**	0.0522**
Education level	-0.300	-0.173	-0.257	-0.165	-0.291	0.00532	0.170	0.0743	0.181	0.0180	0.114	-0.0104	0.0742	-0.0221	0.116
Gender	-0.0456	0.112	0.0815	0.143	0.0560	-0.561*	-0.356	-0.357	-0.316	-0.399*	0.292	0.138	0.175	0.0959	0.206
Language skills	0.0659	0.0677	0.0556	0.0436	0.0175	0.0493	0.0516	0.0326	0.0207	-0.0297	-0.109	-0.111	-0.0997	-0.0786	-0.0538
Role	1.055**	0.780*	0.949**	-2.141	-2.665	0.807**	0.449	0.637*	-3.293*	-5.278***	-0.566	-0.296	-0.468	3.627*	3.888**
Routine centrality		0.0272*		-0.000431			0.0354**		-1.70e-05			-0.0267		0.0105	
Non-routine centrality			0.0329**		-0.00203			0.0527***		-0.00440			-0.0302*		0.0119
Routine centrality X Role				0.0441					0.0565*					-0.0592*	
Non-routine centrality X Role					0.0641**					0.105***					-0.0773**
R-squared	0.233	0.285	0.307	0.318	0.377	0.252	0.342	0.447	0.399	0.643	0.141	0.192	0.205	0.254	0.311
F	2.62	2.79	3.10	2.74	3.55	2.90	3.64	5.65	3.89	10.53	1.41	1.66	1.80	2.00	2.64

Tenure is in years, Gender is coded 1 for "female", Role is coded 1 for "manager"
* p<0.1
** p<0.05
*** p<0.01

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