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Characteristics of routine, development and idea networks in teams

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Characteristics of routine, development and idea networks in teams

Case study

Purpose

To propose that there is not one ideal network structure of knowledge flow, but many, and that the network structures of knowledge flows between employees in teams are work task-related.

Design

In the theory part, ideal knowledge network structures are examined on team level based on literature. A case study on a well established team, presented with social network analysis methods, reveals the different structures of knowledge flow for routine work tasks, development work tasks and idea generation work tasks.

Findings

According to the case study, it is shown that the network structures of knowledge flow are different in different work tasks. It is suggested based on theory that the ideal knowledge network structures are hierarchical for routine tasks, core-periphery for development tasks and ego-centric for idea generation tasks.

Research limitations / implications

The research design presented in this paper should be applied to more cases to ascertain its validity.

Practical implications

Provides means for understanding, assessing and managing knowledge flows in work teams.

Value

Flows of knowledge have been found to be an important area in network research. In this paper it is shown how they are structured according to the nature of the work tasks.

Keywords: Knowledge networks, knowledge flows, work tasks, Team structures, Social network analysis

It is said that knowledge is the most important resource for firms, but the problem with knowledge is that it is abstract and unobservable by nature (Argote & Ingram, 2000). Spender (1996) has noted that there are no unambiguous definitions of knowledge in the context of value creation in a firm, and this still seems to be the case. From the network perspective, a firm creates value by utilizing its knowledge resource base that is embedded in the social network structure of individuals (Granovetter, 1985; Uzzi, 1996).

Networks are a good way to illustrate organizational structures, and any kinds of organizational structures can be described as configurations of interaction between the actors (Barley, 1990; Krackhardt, 1994). In the network literature, flows of different types of knowledge are increasingly used as the research context (Hansen, 1999, 2002; Reagans & McEvily, 2003; Reagans & Zuckerman, 2001), although the topics of network analysis have been mainly related to social embeddedness and social capital (Burt, 1992; Coleman, 1988a; Granovetter, 1973; Putnam, 2000; Uzzi, 1996) , governance structures (Baker, 1990; Fligstein, 1985; Podolny & Page, 1998; Powell, 1990), or resource dependencies (Jarillo, 1988; Williamson, 1975, 1991). In this paper, the networks between individuals in a team are studied from the point of view of knowledge flows.

There is no consensus on the ideal network structure. A well known debate has been going on between sparse and dense network structures. Granovetter (1973), followed by Burt (1992), claims that a sparse network with second-hand relationships and weak ties is the most optimal in terms of knowledge flow. This is because in the network of weak ties, actors in the brokerage position enjoy the

benefits of control and information over other actors and are in a better position than their socially constrained colleagues (Burt, 1997, 2004).

Coleman (1988b; 1990) has an opposite opinion. According to Coleman (1988b), a dense social structure, not a sparse one, is the most desirable structure. This is because the redundancies of knowledge that closure brings, facilitate the trust and common understanding of the group. It has been argued that both kinds of structures are needed (Baum, van Liere, & Rowley, 2007). The sparse network structure is good for searching new knowledge and the dense one for transferring knowledge (Hansen, 1999; Podolny & Baron, 1997; Reagans & Zuckerman, 2001).

This paper builds on the insight that value is created through different kinds of work tasks that require different types of knowledge networks. The flows of knowledge between individuals in an organization enables the firm to 1) profit from existing operations, 2) gradually development its operations, and 3) create new operations, simultaneously. In the field of strategic management, these three tasks are considered as the three fundamental challenges that a firm faces in competition (Fitzroy & Hulbert, 2005). The purpose of this paper is to describe how the structures of knowledge flows present themselves in routine tasks, development tasks and idea generation tasks at the team level. Thus the research question is whether there are differences in the knowledge networks in a team between the three tasks, and if so, what these differences are.

In this paper, knowledge flow is defined as a process where an individual employee is affected by the knowledge of another individual. Knowledge flow has a direction, therefore an employee can either give knowledge to or receive it from other employees. The theory part of this paper claims that the ideal knowledge network structures in a team are a vertical hierarchy for routine work tasks, a core-periphery structure for development tasks, and an ego-centric structure for idea

generation tasks. A case study of a company in insurance industry elaborates on the task –related view on knowledge networks.

Routines, development and ideas as three basic tasks

In the theory of a firm, routines are the foundation of a successful company. In the course of operation, the firm builds a set of distinct routines that can be utilized to produce value. This leads to efficiency and organizational inertia that ensures the future competitive advantage of a company (Nelson & Winter, 1982). However, a company needs also non-routine work tasks in order to innovate new or develop existing products and services.

According to Becker (2005), there are at least three ways to define routines. Routines can be approached from a behavioral point of view, they can be seen as cognitive, or as a disposition of individuals - a tendency of individuals to behave in a sequential manner when triggered. The behavioral approach on routines adopted in this paper sees routines as behavioral regularity, as a recurrent interaction pattern (Becker, 2005). The behavioral definition fits the knowledge network context between individuals in a team. This is because in this view routines have a certain recurring frequency and they are followed in a sequential manner in a certain timeframe to reach a pre-defined outcome. Routine work can be related to the internal affairs of the organization, such as timesheets or reports, and routine work can be something that is done for a client that is the routine of the individual's expertise. The knowledge related to routine work can be in the form of for example standardized information, instructions, documents, or schedules.

Development tasks and idea generation tasks are clearly activities that 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 paper, the development work tasks are defined as tasks that are related to gradual development of an existing product or service, or a process in the organization. Development tasks are step-by-step development work related to the experiences of the individuals, thus highlighting the tacit nature of knowledge involved in the development work.

Idea generation tasks are defined here as activities where both the initial stage and the outcome of the work task are uncertain. Ideas are "light bulb moments" directed to invent something totally new, and they differ from routine tasks and development tasks in that they are not related to either producing or developing already existing things in the organization. Ideas can be born at any place and time, including in the freetime of the individuals in the company, and they can be transmitted also in very informal occasions, during lunch or coffee breaks, when information related to routine tasks is usually not shared between individuals.

Knowledge networks in teams

By definition, teams are cooperative units that are formed to reach some kind of a common goal. They are important building blocks of the organization. Leavitt (1977) describes groups in the organization, which teams eventually are, as good tools to find solutions to problems, make decisions and implement them. Teams also have a social purpose, they are good for people's well-being, and function as policing bodies in organizational practices (Leavitt, 1977).

The main notion in the research on team performance is that teams with certain characteristics perform better under certain conditions than other teams. In line with the contingency theory, a bureaucratic team structure works better in a stable environment, whereas in facing uncertainty, more flexible teams find a better

fit with the environment (Datta, Guthrie, & Wright, 2005; Wright & Snell, 1998). Datta et al. (2005) show that teams whose environmental conditions are considered to be uncertain are more flexible, having broader experience sets of employees and higher sharing of information than ordinary work teams. This results in improved team performance in dynamic industries.

The type of the work task is a contingency for the team structure, and in routine work tasks the task uncertainty is lower than in development and idea generation tasks. In organizations, teams are specialized according to the nature of the goal, and in most organizations there are separate teams for different work tasks, for example R&D and ledger are functions that require a totally different mindset from the employees. However, despite of the nature of the goal of the team, there are still routine and non-routine tasks to be performed by the individuals in the team. No matter what the formal goal of the team is, it is argued in this paper that routine tasks, development tasks and idea generation tasks all result in a different knowledge network structure.

In routine tasks, the attention is directed towards completion of a pre-defined task in a given timeframe. There, knowledge must be implemented efficiently to operations. Therefore, the knowledge must be allowed to flow from the top of the hierarchy to the bottom and back in a timely and precise manner. Ideally, the hierarchical network structure as presented by Cummings and Cross (2003) is the most suitable for this purpose. In this structure, 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.

Hierarchical knowledge network structure makes accurate transfer of knowledge from the focal individual to subordinates possible, and also transfers feedback from the subordinates to the focal individual. This helps to achieve, in the

Tayloristic sense, stability and reliability in operations (c.f. Giddens, 1983). Blau and Scott (1962) state that vertical hierarchies are good for tasks requiring efficient coordination of information and routine -type decision making. If the task presents complex or ambiguous problems, centralized structures impede problem solving. According to Scott (2003), the centralized structure gets more rapidly organized to solve a specific, well defined kind of a problem. When the team engages in routine-type tasks, the communication structure should be centralized and hierarchical (Figure 1). In this combination, orders flow from the top management of the team to the subordinates.

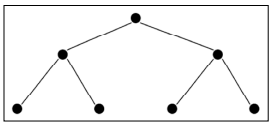


Figure 1: The ideal structure of a team knowledge network in routine tasks is centralized and hierarchical

In development tasks, it is important to reach communicative and reciprocal knowledge ties with other individuals. Development tasks aim to solve a specific problem in existing products, services or processes of the organization and this requires the application of experience-based tacit knowledge, and the nature of the network structure should allow this. Core-periphery structure (Borgatti & Everett, 1999; Cummings & Cross, 2003) is ideal for development tasks. This structure has a dense, cohesive core and a sparse, unconnected periphery. The individuals engaged in gradual development work in the core exchange knowledge frequently and benefit also from the knowledge of other individuals outside the immediate core team. The core-periphery structure allows certain individuals to be interconnected with the

work of others, but it also makes it possible to transfer knowledge from individuals outside the team.

Cohesion among the team members does not offer individual benefits that are related to possessing knowledge and controlling it, because it does not include structural holes (Burt, 1997). In turn, cohesion fosters commitment and long-term relationships between individuals. According to Hansen's (1999) research, strong relationships between R&D team members facilitate the transfer of complex knowledge between team members, but at the same time paralyze the search for new non-redundant knowledge. Strong ties between colleagues form a "closure", to use Coleman's (1988b; 1990) term.

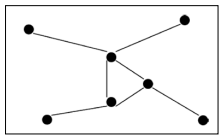


Figure 2: The ideal structure of a team knowledge network in development tasks is the core-periphery structure

Closure in the team facilitates the exchange of complex knowledge, but also increases the effort required to maintain close relationships. In closure, the knowledge becomes redundant, so new ideas are not likely to be discovered, but existing ideas can be gradually developed. Due to the resources needed to maintain close ties in a distributed network, the number of ties that span across the immediate comfort zone of individuals, across for example technological or social divides, are much lower than in a decentralized structure.

In idea tasks, the primary goal is to generate as many ideas as possible in a short time, because the task is to develop an idea for something totally new. Idea

generation tasks differ from development tasks, 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. This behavior results in an ego-centric network structure as described by Cummings and Cross (2003).

The ego-centric structure differs from the hierarchical structure, because in the ego-centric structure the actors communicate with each other and not solely with the one above or below in the hierarchy. This creates a structure where there are structural holes (Burt, 1992; Cummings & Cross, 2003), meaning that all the individuals are not fully connected to each other, even though they are connected to certain others. A highly connected focal actor in the ego-centric structure is a broker, who controls and filters the knowledge between different groups in the structure. The focal role of the broker does not mean that the broker has formal power over the other individuals. The focal individual enjoys control benefits (Burt, 1997) over the knowledge, but not towards the individuals. (Figure 3)

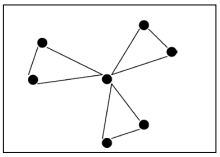


Figure 3: The ideal structure of a team knowledge network in idea tasks is ego-centric

Several studies show that a network structure characterized with structural holes and second hand relationships is good for searching for new ideas and non-redundant knowledge from multiple sources (Burt, 2004; Fleming & Juda, 2004;

Hansen, 1999). The knowledge acquired from distant connections cannot be very complex, as Hansen (1999) points out, but useful knowledge is searched from multiple sources and through acquaintances (cf. Granovetter, 1973) results in a rich and non-redundant mix of ideas.

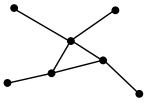
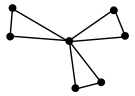
The task contingencies for the knowledge network structure are supported by the statement that when the task uncertainty increases in the organization, the amount of information that must be processed increases correspondingly (Galbraith, 1973; Scott, 2003). In a stable environment in routine tasks, the organization fits the environment with a relatively low amount of information processing needs by creating a bureaucratic system. In a dynamic, changing environment in non-routine work tasks with high amounts of information, however, the best way to organize is a flexible organization that has broader experience sets of employees and higher sharing of information (cf. Datta et al., 2005; Wright & Snell, 1998).

Routine tasks are highly certain because in them everything can be considered to be pre-defined, including the input, the process itself, and the output of the process. Development tasks and idea generation tasks represent uncertain tasks. In development tasks, the initial stage is certain, because development work aims to solve a specific problem, but the process and the outcome are uncertain. Idea generation tasks differ from development work tasks because in idea generation, also the initial stage is uncertain.

A team, and an individual as a member of a team, faces routine, development and idea generation tasks at work, which makes a team a mixture of all three task-related knowledge networks. Here routine, development and idea generation tasks each create their own knowledge network structures. This is because it is presumed that every team member has non-routine work tasks in addition to their daily routine

work. The ideal network structures and their purposes at team level are summarized in Table 1.

Table 1: Ideal knowledge network structures in routines, development and idea generation

	Knowledge network structure of routine tasks	**Knowledge network structure of development tasks**	**Knowledge network structure of idea generation tasks**
Illustration			
Structure	Hierarchical	Core –periphery	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	Initial stage certain, process and outcome uncertain	Initial stage, process and outcome uncertain

According to the theory presented above, it can be stated that the ideal knowledge network structures in a team are different in the three tasks. Summarizing the theoretical review from the viewpoint of knowledge networks, it can be stated that the ideal network structure is hierarchical in routine tasks, core-peripheral in development tasks, and ego-centric in idea generation tasks. In the following it is

examined with a case study, whether these ideal structures can be found in real life: what kinds of knowledge network structures can be found between members of a team in the context of different tasks.

The case study

The case study was carried out in a team of 10 employees, responsible for managing real estate investments in a medium-sized Northern European insurance company. This particular team was chosen for the case study because due to the relatively stable market environment in its business and high tenure of the team members, it represents a team where the day-to-day workflow is fairly established among the members of the team. In Northern Europe, the insurance industry is highly regulated and the size of the market is relatively small. The case company is responsible for securing low-risk long-term earnings for mandatory employee pension funds collected with taxes from every employee country. Everyone in the real estate investment management team has worked for the company for more than five years, and in the particular team in the particular work role for more than four years, with one exception (Appendix B).

The team members have four different roles; one director, three managers, three secretaries and three specialists. The director of the team is responsible for the corporation and reports to the board of directors on the real estate investments. The three managers are responsible for managing the existing real estate property, taking care of the agreements on maintenance, building services and new building projects, for example. The employees in the specialist roles take care of the calculations of the real estate investments and legal issues related to the real estate property. The secretaries deal with day-to-day practical matters related to the work of the managers and specialists: they write letters, schedule appointments, prepare documents etc.

The network data were gathered with a web-based survey tool in October 2006 (Appendix A). In the survey tool, each team member was given his/her

personal login and password to a webpage containing the survey questions. The survey followed the logic of the sociometric data gathering method (Wasserman & Faust, 1994), where the respondents are given a roster of names and asked to evaluate the frequency of communication with each of the given others. At first, the respondents were asked to identify those others that they communicate with in the frequency of once per quarter of a year or more often. In larger sociometric studies this is a good way to narrow down the sample size, but it did not make any difference here as there were only 10 respondents in the case team. Eight of the total of ten employees working in the team answered the survey questions (Appendix B).

In the survey, the flows of knowledge between the members of the team were operationalized as directional activity. Therefore the respondents were asked to rate the frequency of knowledge flow in 1) how often they give knowledge to and 2) how often they get knowledge from other members of the team related to the three work tasks. The frequency scale of whether the respondent gives or gets knowledge in routines, development and ideas, had four steps in addition to a "not at all" option: 1) daily or almost daily, 2) weekly, 3) once per month, and 4) less than once per month. In each work task, the communication media were defined to include every medium possible, including face-to-face, telephone, and email. The network matrixes in the three work tasks are presented in appendix C.

Results

All the respondents indicated that they communicate with everyone else in the team at a frequency of more than once per quarter of the year. As Table 2 illustrates, communication happened between nearly everybody in every task also on a monthly basis, indicating over 60 links in each work task, calculated from the raw data based on the responses of who the individuals indicated that they give knowledge to. The

maximum number of links with 8 respondents in each category is 72. In both routine tasks and development tasks, everyone was almost fully connected with everyone else at least once per month. In idea generation tasks, the number of links in once per month or more is 23, which is substantially less than in the other tasks. Knowledge transfer in idea generation was less common in weekly and daily basis as well, whereas in routine tasks, the sharing of knowledge was more frequent (Table 2).

Table 2: Number of links in four scales of frequency in each work task (maximum 72 links with 8 respondents)

Work task	Daily or nearly daily	< Weekly	< Once a month	< More than once per month (but less than every three months)
Routines	36	60	66	67
Development	5	14	63	65
Ideas	5	10	23	63

In Table 3 and 4 and Figures 4 and 5, the giving and getting knowledge-responses of the survey have been combined with UCINET's Boolean combinations between matrixes -tool after the "getting" response was transposed to match the direction of the flows between individuals. Thus the resulting illustrations describe only reciprocal links that were confirmed by both actors, one indicating the link "give knowledge to", and the other indicating "get knowledge from". This allows more accurate network illustrations, because networks about giving knowledge to and getting knowledge from validate each other, but unfortunately the non-respondents have been left out because the links reported by only one individual, are not included. The following illustrations include 8 members of the team instead of the full 10. The tables and figures below include only knowledge flows that occur at least on a weekly basis - based on the number of links in different tasks. This was

found to be the most purposeful frequency to compare the three network structures - in order to compare the networks with each other, there are not enough daily links, and there are too many links in a frequency of once per month.

The most notable difference between the routine, development and idea generation networks is the density. Density describes the cohesion of the knowledge network, and it is simply the total number of ties divided by the total number of possible ties. When dichotomized to represent knowledge flows that occur on a weekly basis and give and get –components combined, the density of the knowledge network in routine work task is 0.4556 (41 ties), the density in development task is 0.111 (10 ties), and the density in idea tasks is only 0.0889 (8 ties). The differences between the network structures are visible also when compared to each other with the Quadratic Assignment Procedude (QAP) correlations function in UCINET (see: Cross, Borgatti, & Parker, 2001). The QAP tests associations between networks. The results presented in table 4 show that the development and idea networks are structurally similar with each other, because their correlation is quite high. The routine network is different from both the development and the idea generation network.

Table 3: Correlation matrix. QAP permutation test, N=8, P-values in parenthesis

	Routines	**Development**	**Ideas**
Routines	1.000 (0.000)	0.387 (0.002)	0.341 (0.008)
Development	0.387 (0.002)	1.000 (0.000)	0.511 (0.003)
Ideas	0.341 (0.008)	0.511 (0.003)	1.000 (0.000)

Figure 4 below, which represents a metric multidimensional scaling (MDS) of the correlation matrix, further illustrates the inherent differences in cohesion

between the three networks. This figure shows how similar the idea and development knowledge networks are, compared to the routine tasks. It can be assumed that the idea, development and routine networks have characteristics of entailment in a Guttmann scaling sense – those employees that mention others as contacts in routine tasks will also name the same ones in development and idea generation tasks. Cross et. al. (2001) noted that the relationships that individuals have in certain types of networks predict the relationships in other types, when the networks are positioned approximately in the same trajectory in the matrix of metric MDS of the QAP permutation test.

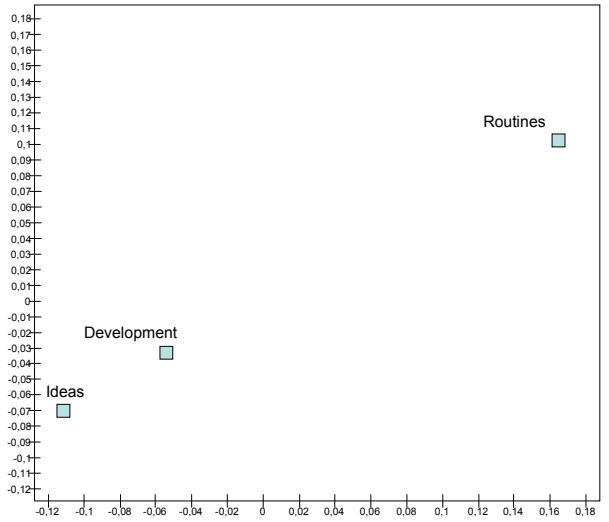


Figure 4: Metric MDS of the correlation matrix of the QAP permutation test

The existence of the entailment structure between different networks can be tested with the Guttman scaling program in Anthropac –software (Borgatti, 1985; Cross et al., 2001), but here this effect is illustrated simply by examining the most central individual's ego network. Manager MM scored the highest in degree centrality in all three work tasks, so examining her 1st degree ego network in routines, development

and ideas reveals that she exchanges knowledge in the development and idea generation tasks with the same individuals as in routine work tasks (Table 4). In fact, manager MM does not have a single other individual in her idea network that is not included in both the routine and the development network.

Table 4: Manager MM's 1st degree relationships

	Knowledge exchange link
Routines	SD, YS, YL, TL, TJ, ZS, ZT
Development	SD, YS, YL, TL, TJ
Ideas	SD, YS, YL, TL

The three knowledge networks are clearly structurally different in terms of the number of links, density and QAP correlations. Also, the relationships in the work tasks probably entail each other when the 1st degree relationships of the most central individual in the team are examined. Next, the structural characteristics of knowledge networks in routine tasks, development tasks and idea generation tasks are described in more detail.

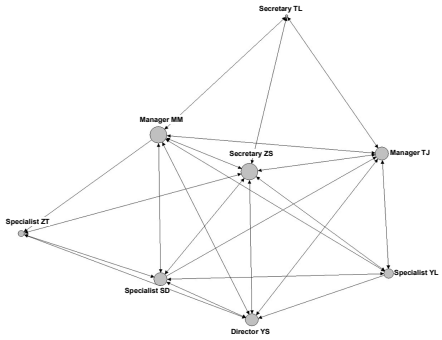
Routine network, development network and idea network in the case team

Figure 5 illustrates the knowledge networks in the three tasks according to the degree of centrality of individuals. The centrality (Degree) is marked with the node size, and the communication frequency considered is weekly or higher.

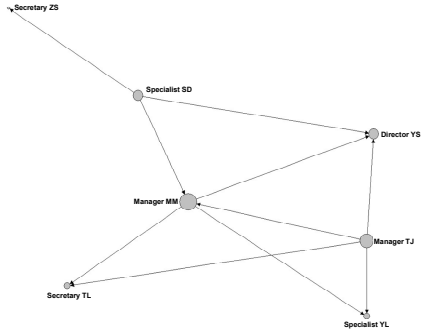
In the routine network, individuals with a higher formal role are generally more central in the network structure, except for secretary ZS. Secretaries TL and specialists YL and ZT are in the periphery, indicating that they receive knowledge on routine tasks more than they give knowledge, and with relatively few others. Manager MM, who is central in each work task, scores highest in centrality in the routine network. Director YS is not very central in the routine network.

In the development network, managers MM and TJ, director YS, and specialist SD seem to form a more tightly knit network in the team. Secretaries ZS and TL, as well as specialist YL are in the periphery of the knowledge flows of development work, and do not communicate reciprocally on a weekly basis. Specialist ZT does not deal with development issues on a weekly basis, and he has been left out of the figure.

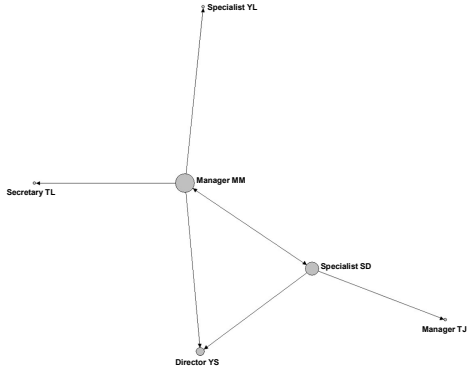
In the idea network, manager MM and professional SD share ideas with each other reciprocally, and pass them to director YS. Manager MM further shares her ideas with secretary TL and specialist YL, whereas specialist SD shares his ideas with specialist ZT and manager TJ. Manager MM seems to be the most central, and presents her ideas in a one-way manner to secretary TL and specialist YL. Manager MM and specialist SD interact reciprocally in ideas, and both give their ideas to Director YS, the director having no outgoing knowledge links. Also secretary ZS, who has the longest tenure in the company (10.2 years), does not reportedly participate in idea sharing on a weekly basis.



Routine network



Development network



Idea network

Figure 5: Routine network, development network and idea network in the case team, node size illustrating degree centrality

Discussion

The research question of this paper was whether team level knowledge networks differ from each other in routine tasks, development tasks and idea generation tasks, and if so, how. The results of the case study indicate that these networks are different - there are many types of knowledge networks between employees in teams, not only one.

Researchers have applied different perspectives to network analysis: for example trust networks, advice networks and communication networks have been studied (Krackhardt & Hanson, 1993). This paper has focused on the last mentioned topic: more specifically, it has concentrated on networks linked to knowledge flows in different types of work tasks. It has taken the tasks of routines, development and idea generation as the starting point – a viewpoint that has not been applied previously in social network analysis focusing on knowledge flows.

The network structures identified in the case team seem to be in line with the existing network research. According to the theories presented above, the structure of knowledge flow in routine tasks should have characteristics of vertical hierarchy, because there the task uncertainty is low (Blau & Scott, 1962; Scott, 2003). The present study supported this, as in the case team the employees in the role of a manager were generally more central compared to employees in specialist or secretary roles.

The idea network was sparse, which is in line with Burt's brokerage argument (1992), while the routine network and development network, by definition involving more complex and tacit experience-based knowledge, seemed to have characteristics of closure (c.f. Hansen, 1999). The development network resembles the core-periphery structure, because there some employees have reciprocal knowledge ties with each other while some employees stay in the periphery and

have only one-way ties. By taking a closer look at the idea network, the direction of the knowledge flows makes the structure seem hierarchical, because the knowledge flows from the core of the network towards the periphery. This may indicate that the legitimacy to present ideas in a team is related to a formal role. However, a specialist was recognized as central in the idea network although he was not very central in other work tasks.

It was also found out that the routine network, development network and idea network may entail each other. This means that the employees share their knowledge on development and new ideas only with those individuals with whom they have a first degree connection in routine work tasks. Since the routine work tasks are well defined in advance, communication in those tasks describes the formal workflow of the team. Communication in development and idea generation tasks build on formal workflow and constitute more informal type of communication. In the sense of the theory of the firm, development and idea networks entailing a routine network is a logical outcome if it is presumed that the competitive advantage is based on existing routines and on knowledge accumulation with the routines (Nelson & Winter, 1982; Penrose, 1959). In this line of logic, the routinized work flow should build ground for more informal communication between the employees.

A notion based on QAP analysis of the three knowledge networks studied was that the routine network was structurally quite different from the development and idea networks. This highlights the difference between routine and non-routine work tasks. It can be presumed that development tasks and idea generation tasks have much in common as work tasks – both development tasks and idea generation involve high task uncertainty, whereas routine tasks entail a low amount of uncertainty.

The network data for the case study was gathered with a web-based sosiometric (Wasserman & Faust, 1994) survey method. In this method, the boundaries of the network are defined, and the respondents are given a roster of names for the survey. The method requires a high response rate, and fortunately 80% of the team members answered the survey. The non-respondents were omitted from the data that was used to illustrate the differences between the three task-related network structures of knowledge flow.

The limitations of this case study are as follows. The case study was limited to only one team from one industry and the three tasks taken into account in this study do not represent the full plethora of activities in an organization. Also, individual variables such as gender, education level and age, which were not taken into account in this case study due to privacy issues, may influence the network structures. Furthermore, the effect of tenure was not fully dealt with. Therefore, the low tenure of director YS may have affected his position in the networks.

An obvious variable in the formation of the knowledge network structure in the three tasks was the formal role of an individual. A formal role has been recognized as a major factor in explaining individuals' network positions (ie. Ahuja, Galletta, & Carley, 2003). In this case study, the effect of the formal role obviously explained for example the position of secretary ZS in the networks. In the routine network, she was central because she takes care of many day-to-day practicalities of the team. Despite of that, she did not reportedly participate in idea generation in a weekly basis although she had the highest tenure in the company.

The generalizability of case studies is always limited. The case results are, however, in line with the theoretical notion that network structures are different in routine tasks, development tasks and idea generation tasks. Based on this case study, it is not possible to define what knowledge network structure is the most suitable in

different work tasks. In order to find evidence for some network structures being better than others, performance measures related to the outcome of the work tasks should be gathered and more research conducted. The performance measures could be for example variables describing the number of ideas generated, or a timely delivery of certain routine tasks.

All in all, the results of this case study are encouraging. Methodologically, examining task-related knowledge networks has one big benefit compared to earlier studies dealing with the dimensions of social networks: social status, power, friendship or legitimization, for example. The benefit is that the employees answer more openly to questions related to their work tasks than to personal questions. Some respondents may feel offended if they are asked to name their personal friends in the office, and this may result in lower response rates. In addition, work-related networks reveal at least partially the underlying informal relationships, since individuals are probably more apt to share their knowledge, especially in non-routine tasks, with those who they feel are close to them at personal level. One future strategy in conducting network analysis surveys would be to put the questions concerning work-related contacts first, and then confirm the nature of the relationships with ethnography or separate surveys to reveal the more informal relationships.

Theoretically, the present study gives a reason to presume that there is no one ideal knowledge network structure for a team, but many. They are related to the uncertainty of the tasks, among other things. Therefore, the well recognized Burt vs. Coleman -debate could turn out to be unnecessary. The issue is not whether a sparse or dense network structure is better. Preferably, the issue is in separating between the network structures in routine –type work with low task uncertainty, and non-routine types of work with a high level of task uncertainty. In essence, Burt's

research on brokerage (Burt, 1992, 2004) has been conducted with innovative tasks, not with routine tasks. To show the task-relatedness and the ideal network structures requires more rigorous and maybe also deductive research, which takes into account also relationships between teams and includes more data on different types of companies.

The lesson that this paper offers for managers is to start to think of the flows of knowledge differently. A manager can for example aim to encourage hierarchical, core-periphery or ego-centric knowledge network structures in teams in their companies. If the goal of the firm is related to producing well specified products or services in a stable market environment by utilizing the existing capabilities efficiently, then the hierarchical team structures are worth reinforcing. Respectively, if the firm functions in high-velocity and turbulent markets, ego-centric structures are probably the best choice. The key point for managers is to realize the nature of their business strategy and spur the existing work group structures towards that goal, at the same time consciously taking care that all three kinds of structures are, in some respect, present in the organization. The case in this study showed that even a well established team functioning in a relatively stable market environment has distinguishable knowledge networks in development tasks and idea generation tasks in addition to routine work.

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APPENDIX A

Outline of the network survey questions used in the case study

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 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 quarter of a year or more). 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 to timesheets or reports
- Routine work can be something done for the customer that you feel is routine of 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 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 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 who 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 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 to** 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 B

Characteristics of the employees in the case team

ID	Tenure in the company	Tenure in the team in the current role	Role	Answered the survey
YS	5.3	0.8	Director	Yes
SJ	9.0	9.0	Manager	No
MM	7.2	7.2	Manager	Yes
TJ	7.8	7.8	Manager	Yes
OT	5.8	5.8	Secretary	No
ZS	10.2	8.3	Secretary	Yes
TL	7.3	7.3	Secretary	Yes
SD	5.0	4.0	Specialist	Yes
ZT	8.0	8.0	Specialist	Yes
YL	6.0	5.0	Specialist	Yes

APPENDIX C

Network matrixes of the case team

Routine work tasks –giving knowledge to:

	SJ	SD	OT	ZS	ZT	MM	TJ	TL	YS	YL
SJ	0	0	0	0	0	0	0	0	0	0
SD	4	0	4	4	4	4	4	3	4	4
OT	0	0	0	0	0	0	0	0	0	0
ZS	3	3	4	0	3	3	3	4	4	3
ZT	3	4	2	4	0	2	2	2	4	2
MM	4	4	3	3	3	0	3	4	4	3
TJ	4	4	3	3	1	3	0	4	3	4
TL	3	0	3	3	0	4	4	0	0	0
YS	4	4	3	4	3	4	4	3	0	0
YL	4	4	4	4	2	4	4	3	4	0

Routine work tasks –getting knowledge from:

	SJ	SD	OT	ZS	ZT	MM	TJ	TL	YS	YL
SJ	0	0	0	0	0	0	0	0	0	0
SD	4	0	3	4	4	4	0	2	4	4
OT	0	0	0	0	0	0	0	0	0	0
ZS	3	3	3	0	4	3	3	3	4	3
ZT	3	4	2	4	0	2	1	1	4	2
MM	3	3	3	2	2	0	2	4	3	3
TJ	3	4	2	3	1	2	0	4	3	3
TL	3	0	3	4	0	4	4	0	0	0
YS	4	4	3	4	3	4	4	3	0	4
YL	4	4	3	4	2	4	4	1	4	0

Development work tasks –giving knowledge to:

	SJ	SD	OT	ZS	ZT	MM	TJ	TL	YS	YL
SJ	0	0	0	0	0	0	0	0	0	0
SD	4	0	0	4	0	4	0	0	4	2
OT	0	0	0	0	0	0	0	0	0	0
ZS	1	1	1	0	1	1	1	1	2	1
ZT	2	2	1	2	0	1	1	1	2	1
MM	2	3	1	1	1	0	2	3	3	3
TJ	3	4	1	2	1	3	0	3	3	3
TL	1	1	1	1	1	1	1	0	1	1
YS	1	1	0	1	1	2	1	0	0	1
YL	2	2	1	2	1	2	2	0	2	0

Development work tasks –getting knowledge from:

	SJ	SD	OT	ZS	ZT	MM	TJ	TL	YS	YL
SJ	0	0	0	0	0	0	0	0	0	0
SD	0	0	0	0	0	0	0	0	0	0
OT	0	0	0	0	0	0	0	0	0	0
ZS	1	1	2	0	1	1	1	2	2	1
ZT	1	2	1	1	0	1	1	1	2	1
MM	2	2	2	1	1	0	2	2	3	2
TJ	2	3	1	2	1	2	0	1	2	1
TL	1	1	1	1	1	1	1	0	1	1
YS	1	2	0	1	1	2	1	0	0	2
YL	2	2	0	1	1	2	2	0	2	0

Idea sharing work tasks –giving knowledge to:

	SJ	SD	OT	ZS	ZT	MM	TJ	TL	YS	YL
SJ	0	0	0	0	0	0	0	0	0	0
SD	4	0	0	0	3	3	4	0	4	2
OT	0	0	0	0	0	0	0	0	0	0
ZS	1	1	2	0	1	1	1	2	2	1
ZT	1	2	1	1	0	1	1	1	2	1
MM	3	4	2	2	2	0	2	3	4	3
TJ	1	2	1	1	1	2	0	1	2	1
TL	1	1	1	1	1	1	1	0	1	1
YS	1	1	0	0	1	1	1	0	0	1
YL	1	1	0	1	0	1	1	0	1	0

Idea sharing work tasks –getting knowledge from:

	SJ	SD	OT	ZS	ZT	MM	TJ	TL	YS	YL
SJ	0	0	0	0	0	0	0	0	0	0
SD	4	0	0	0	3	3	3	0	4	3
OT	0	0	0	0	0	0	0	0	0	0
ZS	1	1	2	0	1	1	1	2	2	2
ZT	2	2	1	1	0	1	1	1	2	1
MM	3	3	2	2	2	0	1	2	3	3
TJ	1	2	1	1	1	1	0	1	1	1
TL	1	1	1	2	1	2	2	0	1	2
YS	1	1	0	1	1	2	1	0	0	2
YL	1	1	0	1	0	1	1	0	1	0