A Social Network Approach to Examining Leadership

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Abstract

The social network approach provides both the theory and methodology for a detailed examination of the characteristics of the social environment of leadership in an organizational context. This chapter presents the central characteristics of the social network approach and examines how they relate to leadership research. Thereafter, it considers the methodology of the social network approach, including the research design, sampling and data collection methods, and central measures of networks for use in data analysis. It also provides examples from leadership research that has capitalized on social network theory and methodology. Finally, it presents a detailed research example that includes the collection of network data and application of network analysis to understand the characteristics of social networks.

Introduction

For many leadership scholars, leadership is essentially a social phenomenon. For example, “most definitions of leadership stress social or interpersonal influence processes as key elements” (Zaccaro & Klimoski 2001, p. 10), and central theories of leadership focus on social exchange between leaders and their followers (Dinh et al., 2014). However, although leadership as per its definition is a relational process that includes relations with other people, leadership research has primarily focused on leaders' attributes and behaviour—particularly others’ perceptions of their attributes and behaviour—rather than on the network of relations in which leadership is embedded. Further, research focusing on relationships has typically examined dyadic relationship characteristics, such as the quality of the working relationship between a leader and her or his followers, whereas the wider social environment around leader-follower dyads has gained much less research attention.

The social network approach provides both the theory and methodology for a detailed examination of the characteristics of the social environment of leadership (for reviews, see Balkundi & Kilduff, 2005; Carter et al., 2015; Sparrowe, 2014; Sparrowe & Liden, 1997). Theories related to the social network approach provide concepts to help define and perceive this social context, and they further argue that the social context provides both opportunities and constraints for individual and group behaviour and related success (e.g., Kilduff et al., 2006; Tichy et al., 1979; Wellman, 1988). Specifically, the social network approach argues that social interaction and exchange within and between organizations includes not only formal channels but also informal social relations and interactions that affect how actors access resources and accomplish their organizational goals (e.g., Granovetter, 1985). In other words, “both formal and informal organizational elements generate a web of interactions connecting actors. These interactions, whether formally designed or informally emergent, are conduits through which organizational actors coordinate efforts, share goals, exchange information, and access resources that affect behaviours and performance outcomes” (McEvily et al.,

2014, 302-303). For example, opinion leaders do not necessarily have a formal leader position; rather, they often are people who are well-connected between social groups through their social networks (e.g., Burt, 2005). Scholars adopting the social network approach further argue that by focusing on informal social contexts, i.e. social networks, researchers can examine "how work really gets done in organizations" (Cross & Parker, 2004).

Similarly, the social network approach provides a tool to examine central research questions in leadership, since leadership is embedded in organizational environments that are characterized by both formal and informal relations and interactions (e.g., Balkundi & Kilduff, 2005; Fernandez, 1991). First, many leadership scholars argue that leadership is centrally related to social influence among people and the coordination of people's efforts toward a common goal (e.g., Kaiser, Hogan & Kraiger, 2008). In this regard, the social network approach argues that to understand social influence and the coordination of common efforts, one has to examine how people are connected to each other and to focus on the wider social environment rather than formal dyadic relations between a leader and her followers (e.g., Fernandez, 1991). For example, research on social networks indicates that the way in which people are connected to each other in a team affects team performance (Balkundi & Harrison, 2006). Second, a central part of leadership concerns access to resources in order to enhance the performance of work groups (e.g., Kaiser, Hogan & Kraiger, 2008). In this respect, the social network approach suggests that leaders' ability to acquire resources depends on not only their formal position but also their informal relations within and outside the organization (e.g., Fernandez, 1991). For example, earlier research on social networks and leadership has shown that leaders' position in internal and external social networks of their work groups is related to how well their work groups perform (Mehra, Dixon, et al., 2006). Third, a central research question among leadership scholars is related to leadership development, i.e., how leadership evolves over time between a leader and his/her followers (e.g., Day et al, 2014). Again, the social network approach suggests that in order to understand leadership development, a researcher

should focus on not only the connections between leaders and followers but also their relations outside their focal work group (Balkundi & Kilduff, 2005). For example, earlier research has shown that leaders' position in social networks of the workplace is related to others' perceptions of them as leaders (e.g., Venkataramani et al., 2010). In this regard, the social network approach thus provides theories and concepts to examine leadership that often is characterized by both formal and informal aspects.

The methodology of the social network approach provides tools to measure and analyse social environments in detail, and in the social network approach, specific measures have been introduced to examine the attributes of social networks and individuals' positions in these networks. These network measures can relate to the individual, dyadic, triadic, group, and whole network levels (Wasserman & Faust, 1994), and these characteristics of social networks have important consequences for leadership. For example, earlier research has shown that leaders' position in social networks (i.e., the individual level) is related to others' perception of the leaders' helpfulness (Galunic et al., 2012), and the network structure of a work group (i.e., the group level) is related work group performance (Sparrowe et al, 2001). Furthermore, a central methodological question for a researcher engaged in social network research is whether to use a whole or personal network design. A whole network design refers to a bounded social environment, such as a department in an organization, in which all or most of the people report their relations or connections to each other (e.g., Wasserman & Faust, 1994), whereas a personal network refers to a focal individual's direct ties and her or his perceptions of the relations among these ties in the network. These networks are often called "ego networks", and the focal actor who reports his or her ties is called the "ego" in the network literature. Thus, social network methods offer possibilities to examine how leadership manifests in different levels of a social environment depending on the research questions.

In this chapter, I will first briefly present the central characteristics of the social network approach and discuss how they might relate to leadership research. Thereafter, I consider the

methodology of the social network approach, including the study design, sampling and data collection methods, and methods to measure social networks. I further discuss central measures of networks for use in data analysis and statistical inference for network data. I also provide examples from the leadership research that has capitalized on social network methodology and theory. Finally, I present a research example in detail that includes the collection of network data and application network analysis to understand the characteristics of social networks.

Social network approach and leadership research

The social network approach focuses on the relations between actors, such as leaders' relations in the organization and how these relations, or lack of relations, have important consequences for their actions (e.g., Wellman, 1988). Actors may be individual persons, social groups, organizations, or other collectives. A relation can include different types of interaction or exchange between actors, such as "gives support to", "asks advice from" or "discuss with". A relationship can be directional when an actor gives or sends something to another actor or nondirectional when actors mutually contribute to the interaction or exchange. Furthermore, the general pattern of relations between actors constitutes the structure of the network, and each actor has his or her personal relations and position within and between networks. Overall, actors and their actions are viewed as interdependent rather than independent (e.g., Wellman, 1988).

The social network approach further argues that the network structure of the individuals and groups have important consequences for their goal-directed action. First, the network structure affects how actors coordinate their action toward common goals (e.g., Coleman, 1988; Oh, Labianca & Chung, 2006). Moreover, the characteristics of network ties define how group's members are able to form "bonding ties" (e.g., Adler & Kwon, 2002) and related trust with each other and to coordinate their action toward their goals. Second, individuals' positions and relations affect how they are able to acquire resources through their network ties to accomplish their goals (e.g., Burt, 2005). That is, social

networks are important channels for resources such as information and credentials (e.g., Lin, 2001). Third, an actor's position in the network is related his or her reputation in the group and how she or he is perceived by others (e.g., Kilduff & Krackhardt, 1994; Mehra, Dixon et al., 2006). For example, a central position in the network is often related to prestige within the group (Mehra, Dixon et al., 2006).

These central consequences of network structure and position, i.e., coordination and social influence, access to resources, and reputation, also play important roles in the leadership literature, as noted above. First, many leadership scholars argue that leadership involves coordinating and influencing people to attain common goals (e.g., Kaiser, Hogan & Kraiger, 2008). Influencing and motivating others is in many ways a social process, and earlier research on social networks has shown that a group's network structure can foster the leader's efforts to motivate and coordinate group members' behaviour to achieve group goals. For example, research shows that how group or team members are connected to each other affects team performance (Balkundi & Harrison, 2006): when more people in the team are connected to each other, i.e., a high density network, the team achieves higher performance. One argument why this group network structure benefits group performance is that when people in the network know each other, it enhances the maintenance of group norms and trust and eases the monitoring of whether group member behaviour is in accordance with group goals (e.g., Coleman, 1988).

Second, leadership involves acquiring the resources needed by the group to achieve their goals—often in a competitive environment (e.g., Kaiser et al., 2008). Social capital theory in particular argues that personal and group success depends in many ways on network-based resources, i.e., social capital (e.g., Burt, 1992, 2005; Lin, 2001), such as information, advice and credentials. In addition, as mentioned above, people's networks can enhance group norms and trust between people, which in turn enhance goal attainment (Coleman, 1988). Most of the earlier research on social networks and

leadership appear to have used social capital theory as a theoretical framework (for a review, see Carter et al., 2015).

Among network scholars, two primary explanations have been used to explain why the characteristics of social networks are important channels for resources, i.e., network structure and social resources (e.g., Burt, 1992). First, network scholars have argued that resources such as information are more homogeneous within the group rather than between groups (e.g., Burt, 1992; Granovetter, 1973). Thus, to obtain additional resources, one often must reach outside one's typical social circle. How one does this depends in turn on one's network structure and related ties. Specifically, Granovetter (1973) famously argued that weak ties, such as acquaintances, often provide a bridge between different social groups and, consequently, enable access to information and opinions that are not available in one's own social circles. Along similar lines, Burt (1992) argued that when a person's network includes people who do not know each other, this supports access to resources. Specifically, when a network includes people who do not know each other, there are "structural holes" (i.e., missing connections between persons) in the network. Furthermore, when there are structural holes in a person's network, that person is in a brokerage position between the people who often represent different groups. Figure 1 presents a network diagram to illustrate weak ties and structural holes in a network. In the network diagram, actors are typically represented by dots, and relations between actors are indicated by lines. For example, Heather is in the middle of the diagram, and she has structural holes in her network, because she has connections, for example, to Jan and Gretel, who themselves are not connected. Furthermore, in the network literature the argument has been that these types of relations that connect different groups are often weak ties, called "bridging weak ties" (Granovetter, 1973, p. 1371).

Second, social resources theory (Lin, 1982, 2001) emphasizes that the resources available through social networks depend on the social contact's position or rank. That is, a social contact's

position in the societal or organizational hierarchy is important, because it enables access to resources, such as credentials and social influence (Lin, 1982, 2001). In addition, social resources theory postulates that actors' own status and weak rather than strong ties in the network are related to high status contacts (Lin, 2001). Earlier research on leadership and social networks also supports the argument that the characteristics of social networks are related to leadership and group outcomes, presumably because they enable access to resources. For example, earlier research on leaders' positions in social networks found that the position of work group leaders in external and internal networks is related to the effectiveness of their work group (Mehra, Dixon et al., 2006). Another study showed that a focal group's ties to other group leaders are related to group effectiveness (Oh et al., 2004). Earlier research has also established that a relationship exists between network position and power (Brass & Burkhardt, 1993).

Finally, a central question in leadership research concerns how leadership evolves over time, that is, how an individual develops as a leader and how leadership evolves between leaders and followers within a social environment (e.g., Day et al., 2014). This leadership development process is inherently a social phenomenon, because the focus is on how the social exchange between leaders and followers evolves over time and how others perceive the leader's characteristics and behaviour. The social network approach can be used to examine, for example, how leadership evolves as leaders' connections with others change in social networks over time. Earlier research on leadership and networks has shown that leaders' position in a social network is related to their reputation as a leader (Mehra, Dixon et al., 2006), others' perception of their charisma (Balkundi, Kilduff, & Harrison et al., 2011), their status in the organization (Venkataramani et al., 2010), and their promotion to a leader role (Parker & Welch, 2013). For example, Balkundi and colleagues (2011) found that a leader's central position in a social network is related to others' perception of his or her charisma as a leader. Earlier research also indicates that perceptions of leader charisma tend to be contagious through network ties

(Pastor et al., 2002), that is, employees' perceptions of leader charisma are affected by the perceptions of their network ties. Thus, the characteristics of leaders' social networks play an important role in how others perceive them as a leader and in their promotion to a leadership role.

The social network approach has also focused on how one perceives relations between people and the antecedents and consequences of the accuracy of these perceptions, i.e., cognitive networks (e.g., Krackhardt, 1990; Kilduff & Krackhardt, 1994; Krackhardt & Kilduff, 1999). For example, Kilduff and Krackhardt (1994) argued that "the performance reputations of people with prominent friends will tend to benefit from the public perception that they are linked to those friends" (p. 89). Thus, they measured people's perceptions of friendship ties in the organization: "Who would this person consider to be a personal friend? Please place a check next to all the names of those people who that person would consider to be a friend of theirs" (p. 91). They also measured actual friendship ties; i.e., they asked participants to report their personal friendship ties in the workplace. A friendship tie was indicated when both parties of the reported friendship tie agreed that they were friends. A focal participant's performance reputation was rated by other study participants. Friends' prominence was indicated both by network measures (to what extent others asked him or her for advice) and formal status. The results showed that the perceived prominence of the focal person's friend was related to the person's own reputation. Interestingly, the actual prominence of the person's friend was not related to performance reputation.

After this brief presentation about the relevance of the social network approach in leadership research, I next focus on network methodology: network and research design; methods for sampling and collecting network data and measuring social networks, and data analysis methods (see also Appendix for central network concepts and terms).

Methodology of the social network approach

A central question for a researcher engaged in social network research is whether to use whole or personal network design. Whole network design refers to a bounded social environment, such as a school class or a department in an organization, in which all or most of the people report their relations or connections to each other (e.g., Wasserman & Faust, 1994). For example, a researcher asks all employees to indicate their relationships with people at their department in terms of interactions, such as "advice-seeking" ("who are the people you ask for advice?") and social support ("who are the most important people to you as a source of personal support?"). Because all or most of the people in the focal unit report their ties to each other, it is possible to define who relates to whom in the focal network. The result of whole network design is a network of relationships between all study participants in a given set (e.g., Borgatti et al., 2013).

A personal network refers to a focal individual's direct ties and her or his perceptions of the relations among these ties in the network. These networks are often called "ego networks", and the focal individual who reports his or her ties is called the "ego" in network literature. Each named network person or tie is an "alter" (e.g., Wasserman & Faust, 1994). For example, a survey could ask study participants to name persons with whom they have discussed important matters during the last six months. These named persons (alters) would then represent the participants' personal networks. In addition, typical personal network surveys also asks participants to report their perceptions about the extent to which alters in the network are related to each other (alter-alter ties). Thus, in personal network design, the aim is to collect data on each participant's personal social environment, and there is typically no information about how study participants are connected to each other.

Whether whole or personal network design is being used has consequences for data collection, sampling, network measures and data analysis. Because whole network design aims to represent all ties among study participants, it requires a higher response rate among participants than a study based on personal network design (see, e.g., Costenbader & Valente, 2003). However, a whole network design

enables a researcher to more fully use social network analysis as a statistical method, and many important network measures assume a whole network design (e.g., Wasserman & Faust, 1994).

Sampling

Boundary specification

A sampling issue specifically related to whole network design is called "boundary specification" (e.g., Wasserman & Faust, 1994). This specification defines who the actors are who can be part of a particular network, i.e., network boundaries, and what types of relations between these actors are relevant to examine (Laumann et al., 1983). The research questions somewhat indicate how to define the study sample. However, this sampling problem is highlighted in network research, because network ties may not be limited according to formal boundaries, such as by organization, department, or workplace. For example, a researcher may be interested in examining who people discuss important work-related matters with. Bounding network ties to include participants' work groups in the workplace, for example, may leave many network ties outside the study, because people may discuss their work with many people outside their work group. Thus, defining who to include for the network study is important to obtain valid information about social networks and related resources. Borgatti and colleagues (2013) suggest that if the research question does not define clear boundaries regarding who could be possible network ties, a personal network design is an option. Study participants are then free to name their network ties according to the research question and related study instructions. For example, Carroll and Theo (1996) used a personal network design in their study examining managers' social networks. They were interested in discovering how managers' and non-mangers' social networks differ from each other. They used data based on a General Social Survey that is a representative sample of the U.S. population. However, most of the studies on social networks and leadership have capitalized on convenient samples (review, Carter et al, 2015).

In general, Laumann and colleagues (1983) suggest two basic strategies for approaching boundary specification issue. The realist strategy for boundary specification argues that social units or groups have boundaries that are often recognized by all of the members. Formal social units such as an organization, workplace, school class are examples of units with clear boundaries for their members. Thus, a researcher sets network boundaries according to the boundaries perceived by the members of a social group or unit. A researcher using a nominalist strategy sets boundaries for a network according to her or his theoretical approach and related research questions, i.e., the researcher defines the network boundaries. For example, a researcher may be interested in examining communication networks within work groups in an organization. Thus, she or he may limit the network boundaries to include ties within work groups.

Research design

A main task of the research design is often to identify supporting evidence for the causal claims between study variables; for example, the higher the quality of working relationship between a leader and a follower is, the higher the follower's job satisfaction (e.g., Shadish, Cook, & Campbell, 2002). In other words, through the research design, the researcher tries to minimize threats to his claim about the argued relationships between study variables, i.e., threats to internal validity. A basic classification between research designs is between cross-sectional, longitudinal, and experimental study designs. In a cross-sectional design, study variables are measured at the same time. A study based on cross-sectional design cannot make causal claims between study variables, because causal claims require that the possible cause should precede the consequence in time (e.g., Shadish, Cook & Campbell, 2002). For example, Goodwin and colleagues (2008) used a cross-sectional design and found that both the leader's and the follower's network position was related to the quality of the working relationship with the leader. In longitudinal research design, study variables are measured several times over time. A longitudinal design offers the possibility to examine associations between variables over time. For

example, Balkundi and colleagues (2011) found that a leader's central position in a social network affects how others perceive their charisma as a leader. Because they used a longitudinal design, they also argued that network position has an effect on leader charisma rather than charisma explaining a central position in the network. In addition, a longitudinal design is particularly useful in modelling change over time, such as to whether the characteristics of a social network change over time (e.g., Snijders et al., 2010). However, the problem with a longitudinal design is that it cannot exclude the possibility of confounding variables that may explain the relation between two variables.

Many scholars regard an experimental research design as the "golden standard" (West & Thoemmes, 2010) for research, because it can rule out possible confounding variables for a causal relationship between variables (Shadish et al, 2002). A typical experimental design first includes a baseline measurement for all of the study participants. Then, study participants are randomly assigned to experimental and control groups. Participants in the experimental group receive a "treatment" such as leadership training, and the control group continues without treatment. Finally, a researcher compares the experimental and control groups to determine whether there are differences of interest between the groups according to the study outcome such as leadership quality. For example, Lam and Schaubroeck (2000) conducted a quasi-experimental field study in which they examined whether service-quality leadership has an effect on unit-level service effectiveness and quality. They had two experimental groups and a control group. The first experimental group included front-line employees who received service-quality training; the second experimental group consisted of employees who were perceived to be opinion leaders by their managers and who also received service-quality leadership training. For participants in the control group, no leadership training was provided. The results showed that the group that was led by opinion leaders who received service-quality leadership training was rated the most effective in service delivery by customers. Opinion leaders who act as service-quality leaders may have more credibility when implementing new practices among employees than those who

are not perceived as opinion leaders. Network scholars further argue that opinion leaders typically have central position between network ties, which enhance their social influence (e.g., Burt, 2005).

Unfortunately, the majority of research on social network and leadership is still based on cross-sectional research. Thus, causal claims about the effects of social networks on leadership, or vice versa, need more elaboration with stronger research designs. There are an increasing number of longitudinal studies that offer better support for the role of social networks in leadership and its outcomes (e.g., Balkundi et al., 2011). However, scholars in the field have rarely capitalized on experimental research design to improve the evidence regarding the causal processes between social networks and leadership.

Network methods for data collection

There are different methods for acquiring network data: surveys (review, Marsden, 2005), registers (e.g., Galunic et al., 2012), electronic sources such as email communication (Kossinets & Watts, 2006), electronic tags (Ingram & Morris, 2007), and archives (e.g., Padget & Ansell, 1993). Surveys are the most widely used method (e.g., Marsden, 2005). Below, examples of these methods are presented. I will present these methods according to whole and personal network study designs, although the same kind of network content instructions can be used in both designs. However, a whole network design typically uses name rosters of the all study participants, since the network boundaries are known to the researcher. Instead, in a personal network design, possible network ties are not known to the researcher beforehand.

Whole network design

In a whole network design, the sociometric method is the typical way to collect data. In this method, a survey often provides a name roster of all study participants, on which study participants indicate who they interact or communicate with. Specifically, a study participant sees a roster including the names of all people in the given unit, such as an alphabetical list of all employees in the department, and she indicates, for example, who she “discusses important matters with” or “who she asks for advice”. The

whole network instrument can also measure ties outside the organization, such as interorganizational collaboration among organizations. For example, Figure 2 presents an example of a roster from a study in which the leaders indicated interorganizational collaboration and communication ties of their organization (Jokisaari & Vuori, 2010). This survey asked organizational leaders to note both their collaboration and communication with other organizations in the field. Other examples of instructions used in whole network instruments are provided in Table 1.

Insert Figure 2 around here

Insert Table 1 around here

There are also free-recall instruments in whole network design in which participants are asked to report their network ties with open answers; i.e., no name roster is available. However, using a name roster makes reporting easier for respondents by suggesting possible network ties and reducing measurement error due to forgotten relations (Marsden, 2011). That said, respondent fatigue can be a problem if the name roster includes a high number of names. In that case, it could be wise to divide the roster, for example, according to department or hierarchy. For example, in a study with 260 potential names for the name roster, the authors divided the name roster according to departments and work groups to avoid respondent fatigue (see Sparrowe & Liden, 2005).

Personal network design

A personal or ego network measurement survey typically involves three parts: 1) a name generator; 2) name and relationship interpreters; 3) questions related to ties between alters (network structure). First, the name generator refers to instructions in a survey by which the researcher encourages study participants to report their social relations, such as "who you discuss important matters about work with". There are many options for the content of the name generator, i.e., what types of networks a researcher wants to examine, depending on the research questions. In addition, a survey can include one or multiple name generators (e.g., Burt, 1997). Figure 3 presents an example of an ego network

survey, and Table 2 provides examples of name generators in leadership and management research. For example, Rodan and Galunic (2004) examined the role of managers' social networks in their job performance. They used a personal network design and four name generators to obtain information about managers' advice ties, innovative ties, buy-in ties and confidant ties (see Table 2).

Insert Figure 3 around here

Insert Table 2 around here

The position generator method asks directly whether a respondent knows people in certain occupations (e.g., Lin et al., 2001). For example, "Here is a list of jobs. Would you please tell me if you happen to know someone (on a first-name basis) having each job? (Lin, 1999, p. 477). This method has often been used to examine the role of social capital in career success (for reviews, see Lin 1999, 2001).

Second, a personal network measurement includes name and relationship interpreters which acquire information about the characteristics of each named network person (alter) and the nature of the relationship between the respondent (ego) and the named network person. A typical question related to the characteristics of the alter concerns his or her occupational status or position in the organizational hierarchy. In social capital theory, the status of the alter indicates resources in the network: the higher the status of the network connections, the more resources such as influence and credentials are potentially available to the focal person. Relationship quality questions typically relate to the strength of the ties between the ego and the alters (Marsden & Campbell, 1984). A typical way to assess tie strength is to ask about "closeness" of the relationship between the ego and the alter such as "how close do you feel to this person?" In addition, the frequency of contact between persons has also been an indicator of tie strength, as well as the duration of the relationship, and some researchers use a combination of these measures. The interpretation is that the closer the relationship is, or/and the higher the meeting frequency is, the stronger the tie strength will be. In contrast, researchers typically

operationalize the number of “weak ties” by counting those ties that are rated to have low closeness and/or meeting frequency. Furthermore, researchers often ask about the content of the relationship between the ego and the alter, such as “what is your relation to this person (e.g., co-worker, friend)?” Answers to this question can also be used to categorize strong (e.g., friend) and weak ties (acquaintance). Table 3 provides examples of questions related to the characteristics of the relationship and the alter.

Insert Table 3 around here

Finally, a personal network survey includes questions about relations between alters: participants are asked to evaluate the extent to which named network persons interact with each other or know each other. These questions about alter-alter ties enable a researcher to define the characteristics of the network structure. For example, "network density" refers to how well people in a focal individual's network are connected to each other. The more they are connected to each other, the higher the network density. Figure 4 gives an example of questions related to alter-alter ties.

Insert Figure 4 around here

It is also important to note that reporting personal networks can be time consuming for the respondent depending on how many name generators and related alter, relationship, and alter-alter ties questions a researcher uses. For example, if a researcher asks respondents to name five alters, this would mean that he or she has to evaluate 10 alter-alter ties (i.e., $N(N-1)/2$; N = number of ties); if a respondent names 10 alters, there would be 45 alter-alter ties to evaluate, and with 20 alters, the number of alter-alter ties would be 190. Thus, the researcher must be careful when planning the personal network design, because the time and cognitive demands made on respondents can increase rapidly with an increasing number of network ties. Furthermore, there have been discussions about how well people remember relevant ties when asked to recall their network ties (e.g., Adams & Moody, 2007; Kogovsek & Ferligoj, 2005). In general, people tend to remember rather well their relations with

those who they interact regularly with or who represent their important network ties (for reviews, see Brewer, 2000; Marsden, 2011).

Data Management and Analysis

Matrices and network diagrams

Social network analysis is an analytical technique that is used to represent relations among actors and to explore the characteristics of networks and actors' positions in the networks (e.g., Knoke & Yang, 2008; Scott, 1991; Wasserman & Faust, 1994). There are also social network analysis software programs for social network analysis, such as Multinet, Netminer, Pajek, Siena, and Ucinet (for a review, see Huisman & van Duijn, 2005). Network scholars represent whole network data using specific data matrices. In other words, in network analysis, data are represented differently from traditional research data, in which rows represent observations such as study participants and columns represent variables such as tenure and job satisfaction for each participant. In network analysis, both rows and columns represent nodes in a network, such as people, and the cells of the matrix contain information about the ties or relations between nodes. For example, if ties are dichotomous, i.e., the tie between two nodes exists or does not exist, the cells contain "1" or "0", respectively, depending on the presence or absence of the tie. Furthermore, a data matrix typically contains the same number of rows and columns, and the order of actors in rows and columns is identical. Thus, the data matrix, or sociomatrix, contains information about the all possible ties between nodes. It is common for a row to represent a focal actor and the column cells represent those with whom she has ties or relations. In other words, a matrix can be read as "who to whom" (Monge & Contractor, 2003, p. 36) information about networks. In the case of nondirectional ties, such as who discusses with whom, the matrix is symmetrical; i.e., the value representing a tie from node i to node j is the same as the value representing a tie from node j to node i. As an example, in Figure 5, there is a symmetric data matrix between 12 nodes; thus, the value of a tie from node i to node j is the same as the value of a tie from node j to node

i. In other words, the values of the cells above and below the matrix diagonal are the same. In addition, the values in the diagonal are omitted from the network analysis, because diagonal represents a tie from a node to itself. The network diagram of these data is shown in Figure 1.

Insert Figure 5 around here

It is quite common for a researcher to perform data transformation with network data. That is, network software programs such as Ucinet (Borgatti et al., 2002) provide different procedures for working with data matrices. The common transformation procedures are symmetrizing, dichotomizing and combining data matrices (e.g., Borgatti et al., 2013). By symmetrizing, a researcher can create a data matrix in which all of the relations are reciprocated. For example, a researcher has network data on friendship ties and defines that friendship tie as existing only when both parties indicate that the other is a friend. By symmetrizing the data matrix, a researcher can create a new data matrix in which a friendship tie exists only if the friendship tie is reciprocated. Dichotomizing includes a procedure in which the valued tie is transformed to be dichotomous. For example, a researcher could ask study participants to indicate how often they seek advice from their network ties on a scale of "1 = seldom, 2 = now and then, and 3 = often", and she might want to include only those ties where advice seeking happens "often". Thus, she might dichotomize the data matrix by including only ties that have value greater than 2. Furthermore, researchers often ask about multiple relations, such as friendship and advice ties, and may want to combine these into one data matrix. For example, a researcher might want to explore networks based on multiplex ties, i.e., a tie including different roles such as friendship and advice seeking. This is made possible by combining friendship and advice seeking data matrices into one data matrix.

Network diagrams, also called as graphs and sociograms, are also a common way to represent networks. A network diagram is a visualization of a network showing relations between nodes (e.g., Wasserman & Faust, 1994). Nodes are typically labelled by their name, number or another identifier. A

relation between two nodes is represented by lines. Directional ties are represented by arrows. For example, if node A asks advice from node B, then there is a line from node A with arrow pointing to node B in the graph. If node B also asks advice from node A, there is another arrow from node B to node A or a line with arrows at both ends. If a network diagram represents nondirectional ties, such as friendship ties, the line describing that tie would be without an arrowhead or arrowheads at both ends. Figure 1 shows a graph of 12 nodes and the relations or links between them. Because this network diagram has only lines with arrowheads at both ends, it is a nondirectional graph. A researcher typically has leeway to decide how she or he places nodes and lines in a graph. In addition, software programs for network visualization such as Gephi, Netdraw, NetMiner and Pajek offer many options that a researcher can use to visualize networks. In all, "the precise placement of nodes and lengths of lines in a network diagram is somewhat arbitrary, although some versions might be clearer than others. Constructing insightful sociograms is as much an artistic as a scientific activity" (Knoke & Yang, 2008: 46).

Measures of networks

The network approach has introduced specific measures for examining the attributes and characteristics of social networks and actors' positions in these networks. Whole network concepts and related measures can relate to the actor, dyadic, triadic, group, and whole network levels (Wasserman & Faust, 1994). Personal network measures relate to the characteristics of the focal actor's network and can characterize ego-alter ties, alters, and network structure.

Whole network design

Actor-level measures

Network research on leadership has often concentrated on the actor level and measured how leaders' positions in the networks are related to leadership outcomes and development. The concept perhaps most often used to indicate position in the network is network centrality and its indices (in-degree, out-

degree, closeness, eigenvector, and betweenness centrality; Borgatti et al., 2013; Freeman, 1979; Wasserman & Faust, 1994). In-degree centrality and out-degree centrality refer to how many ties a focal actor has in the network. Specifically, *in-degree centrality* relates to how many others in the network name or indicate that they are related to the focal individual, such as those who ask for advice from him. In turn, *out-degree centrality* indicates from how many nodes a focal individual asks for advice, for example. *Closeness centrality* tells how "reachable" all others in the network are to a person—in other words, how easily an individual can access resources or communicate, directly or via intermediaries, with all others in the network. *Eigenvector centrality* takes into account the centrality of the network nodes to whom a focal actor is connected. In other words, eigenvector centrality sums the focal actor's ties to others by weighing them by the centrality of those others (e.g., Borgatti et al, 2013). For example, Mehra, Dixon and others (2006) found that leader's (eigenvector) centrality both in the friendship network of leaders and among friendship networks of their work group are related to group performance.

Betweenness centrality is also an important centrality measure that indicates brokerage roles in the whole network and takes into account both direct and indirect ties, that is, the extent to which actors connects actors that themselves are not connected to each other. For example, Galunic and colleagues (2012) found that employees whose leaders' showed high betweenness centrality in networks, i.e., a brokerage role, were rated as being more useful and helpful by others than employees whose leaders did not have brokerage role. In addition, young professionals whose supervisors were active in their work groups' internal and external communication ties showed higher promotion likelihood and less turn-over than others (Katz & Tushman, 1983). It is important to note that researchers often standardize the values of the indices of centrality so that they are comparable between networks of different size (e.g., Knoke & Yang, 2008). This is also an option available in network analysis software such as Ucinet.

As an example, Table 4 shows the degree, closeness, betweenness and eigenvector centrality measures (non-standardized) among persons in the network shown in Figure 1. These were analysed by using Ucinet (Borgatti et al., 2002).

Insert Table 4 around here

As seen, Heather has the highest value for degree centrality (5). As this network is symmetrized, degree centrality is the same as the in-degree and out-degree centrality measures. Thus, Heather has the highest number of network ties. Heather also has the highest betweenness centrality value. As seen in Figure 1, Heather is in a brokerage role between three groups of people. For the closeness centrality measure, Chrissie, Teresa, Peter, and Ed show the highest values, and Heather, Gretel, and Jan show the lowest values. These values mean that Heather, Gretel, and Jan have best opportunities to access others in their network, and Chrissie, Teresa, Peter and Ed have rather peripheral positions in the network. In other words, low closeness centrality values indicate "high centrality" in the network, as provided by the Ucinet-program. This can also be seen in Figure 1. However, if a researcher uses normalized values of closeness centrality, this would change the interpretation of closeness centrality values, i.e., high values would indicate high closeness centrality (e.g., Borgatti et al., 2013).

Dyadic level

At the dyadic level of networks, structural equivalence is an often used measure to indicate the extent to which actors have ties to similar others (Wasserman & Faust, 1994). Actors are said to be structurally equivalent when they have the same relations to others in the network, and they do not have to share relation with each other. For example, in the network shown in Figure 1, Peter and Teresa are structurally equivalent, i.e., they have ties to the same people in the network. Network theory argues that structurally equivalent actors in a network are often dependent on the same social ties and related resources and are motivated to monitor each other's behaviour (e.g., Burt, 1987). In leadership

research, Liden and colleagues (2005) made innovative use of the measure of structural equivalence to operationalize sponsorship in the networks: sponsorship was indicated when the leader and the follower had the same relationships in the networks of trusted relations. The trust network included people with whom they "discuss confidential issues or problems at work". In other words, when a focal leader and a follower had structurally equivalent position in the trust network that indicated sponsorship. Furthermore, for a follower, sponsorship increases legitimacy and assimilation into networks, as the leader shares her trusted network ties with her (Liden et al., 2005). The results showed that sponsorship moderated the relation between leader-member exchange and member influence in the workplace as perceived by others. If sponsorship was high, leader-member exchange was related to member influence, but when sponsorship was low, leader-member exchange was not related to member influence.

There are also others measures to indicate similar positions in the network between two actors, such as regular equivalence. The regular equivalence measure is not as strict measure as structural equivalence when indicating a similar position in the network (e.g., Wasserman & Faust, 1994). For example, structural equivalence requires that two supervisors have relationships with the same subordinates, but regular equivalence requires only two supervisors who have subordinates.

Triadic level

One way to analyse whole networks is to examine triads of actors or triadic relationships. There are 16 possible ways in which three actors can form triadic relationship (e.g., Wasserman & Faust, 1994). Typically, a researcher examines the extent to which a network includes transitive triads. For example, if person A names person B as a friend, B names person C as a friend, and person A names person C as a friend, then they form a transitive triad.

Particularly in research on cognitive networks, scholars have used theory based on the transitivity principle. The transitivity principle states that a perceiver will assume consistency in triadic

relations, i.e., assume a transitive triad. A related concept is a balance schema, which argues that people tend to perceive positive relationships such as friendship or liking as reciprocated by those involved in that relationship (e.g., Krackhardt & Kilduff, 1999). If a focal person perceives that person A considers person B to be a friend, she also assumes that person B will recognize person A as a friend. In other words, both balance schema and transitivity state that cognitive consistency is a prime motivation in perceptions of social networks (e.g., Wasserman & Faust, 1994). For example, Krackhardt and Kilduff (1999) asked study participants from four organizations to evaluate who they thought were friends in their workplace. In other words, participants were instructed to name friendship ties between people in their workplace as they perceived them: "Who would this person consider to be a personal friend? Please place a check by the names of those who that person would consider to be a friend of theirs." (perceived friendship network; Krackhardt & Kilduff, 1999: 773). In addition, participants were instructed to indicate their own friends in the workplace (actual friendship network). An actual friendship ties was indicated when two people both named each other as a friend. The results showed that the actual friendship network was a poor predictor of perceived network ties. The results further showed that study participants tended to perceive their close and distant ties as being balanced.

(Sub)groups level

Often within a social network are subgroups of people who spend more time with each other or are otherwise more connected to each other compared to non-group members in the network. For example, a workplace holds subgroups of people who socialize. In the network literature a cohesive subgroup, i.e., a clique, is characterized by following attributes: mutuality or reciprocity of ties between people, reachability or closeness of all group members, high frequency of ties between people, and a higher relative density of the network within the subgroup compared to the rest of the network (Wasserman & Faust, 1994). In a cohesive group, people typically share opinions, attitudes, and views, and group

norms are easy to maintain. For example, a study found that subordinates' proximity in networks related to similarity in the perceptions of their leader's charisma (Pastor et al., 2002).

Whole network level

Whole network measures capitalize on the characteristics of the complete measured network. The most common measures at the whole network level are density and centralization. Density refers to how many actual ties are present in the network compared to all possible ties in the network. For example, a meta-analysis showed that teams with high network density showed better performance and willingness to stay together than teams with low network density (Balkundi & Harrison, 2006). Network centralization concerns the extent to which the centrality of actors varies within the network. If there are few central actors in the network, i.e., network relations are concentrated among a few individuals, the whole network shows high centralization. When individual centrality scores are rather evenly distributed among actors in the network, the whole network is decentralized (Wasserman & Faust, 1994). Sparrowe and colleagues (2001) examined individuals' network centrality and work group centralization effects on individuals' job performance and on group performance. The results indicated that individuals' advice network centrality related to their job performance, whereas group-level network centralization negatively related to group performance. The authors reasoned that at the group level networks that are concentrated among a few individuals hinder co-operation among people in the group so that information is not equally shared (see also, Mehra, Smith, Dixon & Robertson, 2006). Thus, network structure may also hinder collaboration, and group performance may then suffer. Researchers adopting the social network approach have also argued for the use of multilevel analysis to combine different levels of network research into multilevel models in order to examine how separate levels may relate to each other (e.g., Monge & Contractor, 2003). However, earlier research has rarely capitalized on multilevel network models, since "most network data are either transformed to a single level of analysis (e.g., the actor or the dyadic level), which necessarily loses some of the richness in the

data, or are analysed separately at different levels of analysis, thus precluding direct comparisons of theoretical influences at different levels" (Contractor et al., 2006, p. 684).

Personal network measures

Personal network measures can be divided into three categories: measures of named network persons (measures of alters), characteristics of the relationships between the ego and alters (measures of relationship), and characteristics of ties between named network persons (alter-alter ties, measures of network structure).

Measures of the alters can indicate network-based resources. In social capital theory, the alter's social status or position in the organizational or social structure indicates network-based resources that an ego can access through his or her network ties (e.g., Lin, 2001). Social status can be indicated by the alter's educational level, socioeconomic status, or organizational rank, for example. Lin (2001) used three indicators of network-based resources based on the alter's social status. "Upper reachability" indicates the resources at the highest position or status that the ego can reach through his or her network. "Resource heterogeneity" indicates the variation between highest and lowest social status or position in the network. "Extensity of resources" indicates how many different social statuses or positions a person can access through his or her social ties. "Network range" is also used to indicate diversity in the network in terms of different statuses or group memberships of the network ties. In addition, depending on the research question, other alter characteristics, such as ethnicity or gender, can be used. A researcher can then calculate the proportion or number of alters in each category. Alternatively, a researcher can evaluate the variation or dispersion of categories in the network.

Measures of relationships typically refer to the relationship type and quality between the ego and alters. The relationship type between the ego and alter typically refers to the proportion or number of ties of a given type, such as the number of leaders, colleagues or friends in the network. Some researchers also count multiplex ties, such as whether a relation type is both a friend and a colleague.

For example, Carroll and Teo (1996) examined managers' personal networks and used a classification related to their relations with named network contacts. For example, the number of co-workers was a count of co-workers named as network ties. The proportion of co-worker ties was calculated by dividing the number of co-workers by the total number of the network ties (network size). Relationship quality between the ego and an alter is typically indicated by the strength of the tie (Granovetter, 1973). Tie strength can be indicated by counting the type of ties, such as the number of weak ties, or by averaging the tie strength between an ego and all of her alters. For example, Carroll and Teo (1996) indicated tie strength by the number of close ties, which was measured by asking respondents to indicate whether they were close to each of the people they named. The proportion of close ties was measured by dividing the number of close ties by the network size.

Finally, network density and brokerage role in the network are basic measures for network structure based on personal network design. As noted above, network density indicates the number of alter-alter ties divided by the total number of possible alter-alter ties in the network. Thus, it is typically calculated by excluding ego-alter ties. For example, the relationship between a pair of named network persons can be coded 0 if participants report that these persons do not or seldom discuss things with each other, 0.5 if participants indicate that they discuss things with each other every now and then, and 1 if participants report that they discuss things with each other often (e.g., Jokisaari, 2013). Network density is then the mean of the strength of ties between all named network persons, i.e., the average level of interconnection between named network ties. For example, Parker and Welch (2013) found that the density of collaboration networks was negatively related to scientists' leadership position in academia. They argued that low density network indicates that network ties are from different social groups, which helps to acquire additional resources that support a promotion to a leadership role.

A set of measures has been used to indicate a brokerage role in the personal network. As mentioned above, a person in a brokerage role connects people in the network who are not themselves

connected to each other. In other words, a person who is in the brokerage role has structural holes in her network (e.g., Burt, 2005). A brokerage role is assumed to offer the following benefits for a person: heterogeneous information and point of views, opportunity for control of what information one's shares to others, and early access to new opportunities (Burt, 1992). Perhaps the most often used measure to indicate brokerage role, i.e., structural holes, based on personal networks is the network constraint measure (for a review, see Burt, 2005). In fact, the network constraint measure indicates network closure, i.e., a lack of brokerage opportunities or structural holes (Burt, 1992). There is a lack of brokerage opportunities when a personal network is dense (high network density) or when network ties are connected to each other through a central mutual contact (Burt, 1992). As an example, Table 5 presents values for both network density and network constraints for the people in Figure 1. As seen, Gretel (0.33) and Heather (0.38) have lowest value for network constraints as well as the lowest network density values (Gretel: 0.0, Heather: 0.2) and thus the best opportunities for having a brokerage role in the network. In contrast, Les, Ed, Chrissie, and Bernard have the highest values for both measures. For example, they have the highest network density value (1.0), which indicates that all of their network ties are connected to each other, as can be seen in Figure 1.

Insert Table 5 around here

Earlier research has also shown the benefits of brokerage roles. For example, Burt (2007) examined supply-chain managers' brokerage opportunities by using their personal networks. In the network procedure, managers were asked to name persons with whom they most often had discussed matters related to supply-chain issues. Then, they were asked to indicate the perceived discussion between each pair in their personal network about supply-chain matters, i.e., how often each pair discussed supply-chain issues ("often," "sometimes," or "rarely"). The less that the pairs of network contacts discussed with each other, i.e., low network constraints, the more likely the focal manager was to play a brokerage role. The results showed that managers whose networks were characterized by high

network constraint had a lower salary and lower performance evaluations than managers who had brokerage opportunities (low network constraint) in their networks. In addition, Rodan and Galunie (2004) found that structural holes in managers' personal networks related to their performance.

I have presented above measures of social networks based on both whole and personal network designs. Although network scholars typically use different measures depending on whether they used a whole or personal network design, there is a debate among network scholars regarding to what extent measures of network that were developed based on a whole network design are suitable to characterize personal networks (e.g., to what extent the measure of betweenness centrality gives similar results based on whole and personal network data, Marsden, 2002).

Statistical inference

Besides providing descriptive statistics for the characteristics of social networks and actors' positions in these networks, the social network approach offers methods for statistical inference based on social network data. These statistical procedures include Quadratic Assignment Procedure (QAP), exponential random graph models (ERGMs; also referred as p* models), and actor-oriented models (e.g., Borgatti et al., 2013; Wasserman & Faust, 1994). It is important to note that the assumptions of general or traditional statistical analyses, such as the independence of observations, are not valid when statistical inference is based on whole network data. The main reason is that whole network data consist of nonindependent observations, and thus, traditional significance tests do not apply for testing the statistical significance of estimates (e.g., Wasserman & Faust, 1994). Instead, statistical significance tests related to social networks are often based on non-parametric permutation tests, i.e., the use of randomized samples (e.g., Wasserman & Faust, 1994). That is, the observed estimate, such as a correlation, is compared to estimates based on the distribution of simulated random samples in order to conclude whether its occurrence is more likely than one would expect to observe by chance. Statistical inference based on QAP correlation and regression analysis is based on these permutation tests, i.e.

randomized samples (e.g., Krackhardt, 1987). These tests provide statistical information to examine relations among networks or between networks and individual attributes. For example, a researcher may be interested in examining whether people are more likely to ask for advice from friends than one would expect by chance. She could examine this research question by using QAP regression, i.e., whether advice seeking and friendship network matrices are related to each other. QAP regression can be used when the dependent variable is a binary variable (e.g., whether people share a relation: yes/no; e.g. Borgatti et al., 2013). For example, Gibson (2004) examined the role of friendship and advice networks in professional values. The research questions focused on, for example, the extent to which people seek advice from people whose professional values converge with their own values over time and the extent to which friends' values converge over time. The study data included whole network data based on friendship and advice-seeking ties in workplaces, as well as information on the study participants' professional values. She examined study hypotheses by using QAP regression, and the results showed that friendship networks were related to changes in professional values and that changes in professional values were related to changes in advice-seeking ties. General programs for social network analysis such as Ucinet provide procedures for QAP correlations and regression analysis.

The general rationale behind using ERGMs is that "the observed network is seen as one particular pattern of ties out of a large set of possible patterns. In general, we do not know what stochastic process generated the observed network, and our goal in formulating a model is to propose a plausible and theoretically principled hypothesis for this process" (Robinson et al., 2007, p. 175). In other words, ERGMs offer tools for a researcher to examine what kind of social processes as indicated by the substructures of a network could explain the current patterns of the whole observed network. Thus, the question is often whether certain network properties or characteristics in the network occur more likely than one would expect by chance (e.g., Robinson et al., 2007). For example, a researcher can ask whether the level of triads or reciprocity in the network is higher than one would expect by

chance in a given network. For example, Lazega and Pattison (1999) examined substructures within collaboration networks in an organization and asked, among other questions, whether resource exchanges among employees show regular interaction patterns that are not limited to the dyadic level. They found, for example, that network triads are more likely to occur than one could expect based on chance. The estimation of an ERGM requires specific software, such as Pnet and Statnet.

Actor-driven or actor-oriented models provide tools to examine network changes and changes in covariates over time (e.g., Snijders, 2005). With these models, both the role of network characteristics and actor choices (initiation of a new tie, dissolving a tie) in network changes can be modelled. For example, a researcher can examine whether an advice network develops towards increased reciprocity over time. Furthermore, network characteristics and actor attributes are often interdependent, and it is important to model how network characteristics and actor attributes co-evolve over time. Furthermore, it is possible to analyse models on how changes in social networks and changes in actors' attributes and behaviour are related to each other (Snijders et al., 2007). For this purpose, SIENA (Simulation Investigation for Empirical Network Analyses) software is available for statistical analyses to examine network changes over time (e.g., Snijders, 2005). For example, Emery (2012) examined whether an actor's attributes (i.e., emotional abilities) are related to others perceptions of her leadership characteristics over time. In the study, participants were asked to nominate who they considered to be leaders among their group members. According to these nominations, a leadership network matrix, i.e., who nominates whom as a leader, was constructed. In addition, the study participants evaluated their own emotional abilities. These measures were assessed three times during the study period. By using actor-oriented models, it was possible to examine both network effects (e.g., reciprocity, transitivity) and actor effects (emotional abilities) on the emergence of others' perceptions of leadership over time. There have been also studies on network changes in the organizational context related to how/why people have certain network positions (e.g., Kossinets & Watts, 2006; Lee, 2010),

changes in work group ties (Schulte et al., 2012) and network changes during transition (Jonczyk et al, 2016), among others (for a review, see Tasselli et al., 2015).

Case example of collecting and analysing whole network data[1]

This case example focuses on leaders' interorganizational collaboration networks (Jokisaari & Vuori, 2010) to illustrate how to apply network measures with a whole network design. Specifically, the network measures in the case example include direct ties in the network, structural equivalence, and brokerage roles. This example also illustrates how social influence plays an important role in the decision making of organizational representatives, such as leaders. For example, when leaders have to make adoption decisions about a new organizational or work practice, i.e., the adoption of an innovation, they have not yet experienced the consequences and fit of the innovation in the focal environment. The social network approach argues that in this kind of situation, leaders' use information about the innovation available through their network ties, such as those with colleagues (for a review, see Burt 2005). Specifically, the literature on social networks and the diffusion of innovations argues that the responsiveness of the representatives of the organization to a new practice is in many ways related to their social proximity to other actors in the field and their adoption behaviour. For example, earlier research has shown that exposure to the adoption behaviour of others through network ties influences the focal actor's adoption of new practices (review, e.g., Burt, 2005).

Jokisaari and Vuori (2010) examined the role of both relational (direct ties) and positional (structural equivalence, brokerage positions) characteristics of interorganizational networks in the adoption of a new practice over time. In the network questionnaire, leaders of the organizations were first asked to identify organizations with which they have (1) collaborated and (2) regularly communicated about matters related to employment services. Information on collaboration was elicited

[1] This example is adapted from Jokisaari & Vuori (2010) with the permission of Oxford University Press.

as follows: "Please indicate the employment offices with which your office has or has had collaboration in employment services. Collaboration may include shared projects, services or development activities related to employment services." Regarding communication, participants were asked the following: "Please indicate the employment offices with which your office has or has had regular communication regarding employment services. The communication may include, for example, face-to-face discussions, meetings, or e-mails". A roster with the names of all employment offices in Finland in alphabetical order was provided to indicate both collaborative and communication partners. This name roster is shown in part in Figure 2. In addition, participants were asked to indicate the timeframe of the relationship and whether it was still ongoing. Communication ties were almost identical to collaboration ties, which is why we decided to use only collaboration ties in the analyses.

Adoption among *direct ties* was measured by the percentage of organizations among the focal organization's collaborative ties that had previously adopted the new innovation (group training program: “Työhön program”), i.e., during the previous month or earlier.

Adoption among *structurally equivalent ties* indicated the percentage of structurally equivalent organizations that had previously adopted the innovation. Structural equivalence was examined using the block-modelling procedure (CONCOR) of the UCINET 6 program (Borgatti et al., 2002). This method identifies groups of actors with similar ties based on the correlations between the ties and divides them into blocks. The number of partitions in this hierarchical clustering method is examined. The goal is to obtain blocks that show highly correlated patterns of ties between actors within a block and low correlations with actors outside the block (Wasserman & Faust, 1994). We ran CONCOR procedures with three, four and five partitions. When three partitions were used, the procedure created 7 blocks with an average within-block density of 0.18. When four partitions were used, 13 blocks were constructed, and the average within-block density was 0.75. When 5 partitions were used, 24 blocks were created, and the average within-block density was 0.87. However, 25 % of the blocks included

only single or dyadic actors. The existence of blocks with a single or two actors is often an unstable solution, and partitions with such blocks should be avoided (Wasserman & Faust, 1994). Consequently, in this data set, four partitions gave the most appropriate solution, which was then used in the subsequent analyses.

The brokerage position in the network at the whole network level was indicated by *betweenness centrality* (Freeman, 1979) and at the local level by *network constraint* (Burt, 1992). As noted above, betweenness centrality measures the extent to which an organization is directly connected only to the organizations that are not directly connected to each other in the network (Freeman, 1979). It takes into account both direct and indirect ties in the network and reflects the actor's brokerage position in the whole network. The square root of betweenness centrality was used in the analyses because of the non-normality of this measure. The network constraint accounts for the immediate network of an organization, and it measures the extent to which the organization has network ties with other organizations that are connected with one another or indirectly connected via a central actor. In other words, a low network constraint means a greater likelihood of a local brokerage role.

The analyses were conducted by using discrete-time survival analysis to estimate "whether" and "when" (Singer & Willett, 2003) the adoption of a new practice occurs. This analysis takes into account the time-sensitive nature of the data, i.e. whether the values of variables may vary with time. The results showed that during the early phase of the diffusion process, the adoption behaviour of collaborative organizations and local-level brokerage position were related to adoption among employment offices in the diffusion of the job search program. Furthermore, the results showed that adoptions among structurally equivalent organizations contributed to differentiation, i.e. non-adoption.

Conclusion

The social network approach argues that to understand leadership development, behaviour and outcomes, we have to see them to be essentially depending on the social environment. The social

network approach provides both the theory and methodology to examine the characteristics of the social environment of leadership (Balkundi & Kilduff, 2005; Carter et al., 2015; Sparrowe, 2014; Sparrowe & Liden, 1997). Specifically, theories related to the social network approach such as social capital theory argue that the social environment provides both opportunities and constraints for leadership, its outcomes, and its development. The methodology of the social network approach provides means to measure and analyse this social environment in detail in order to empirically examine the role of social networks in leadership, and there are many methods to gather network data, such as survey and registers, and different ways to define the content of networks (e.g., advice seeking, social support, friendship), depending on the research questions. Furthermore, there are many network measures to characterize social networks from the individual level, such as network centrality, to the whole network level, such as network centralization. Finally, social network analysis as a statistical method provides methods to examine the characteristics of social networks.

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Table 1. Examples of instructions in whole-network designs

Types of relations	**Instructions**
Advice	[In the column following each person's name, participants were asked to] "Check the names of individuals to whom you go for help or advice about work-related matters."
Friendship	"Check the names of individuals you consider to be your personal friends"
Trust	"Check the names of individuals to whom you go to discuss confidential issues or problems at work"
Influence	"This person is influential: he/she has clout in this company."
Respect	"Who are the individuals at [organization] you most respect for ability to deal effectively with people?"

Table 2. Examples of name-generating questions in personal network designs

Name generator	**Questions**
“Discuss important matters”	"People often discuss their important matters with others. If you think of the people in your workplace and look back over the last few months, who are the people with whom you have most often discussed important matters related to your work or workplace?”
“Advice”	“Getting your job done on a daily basis as a manager often requires advice and information from others. Who are the key people who you regularly turn to for information and work-related advice to enhance your ability to do your daily job?” “Over the last six months, are there any work-related contacts from whom you regularly sought information and advice to enhance your effectiveness on the job?”
“Support”	“Most people rely on a few select others to discuss sensitive matters of personal importance i.e., ‘confidants’ on whom they rely for personal support. Who are the key people in your work environment that you regard as your most important people as source of personal support?”
“Buy-in”	“New ideas often require support from others without which you cannot proceed. Who are the key people that provide essential support to new initiatives?”
“Professional ties”	“List anyone that you feel is a significant part of your professional network. One way to identify these people is to go through your address book, and ask ‘is this person significant in my professional network’?”

Table 3. Examples of name and relationship interpreters

Name interpreters	
Relationship type	"What is your relationship with this person (e.g., co-worker, supervisor)?"
Status	Is this person's rank 1) Higher than yours; 2) Equal to yours, 3) Lower than yours? "Person's occupation:"
Demographics	"Gender of the person"; "Ethnicity of the person"
Relationship interpreters	
Tie strength	"How close are you to this person?" "How often do you meet?"

Table 4. Network Centrality Measures of Network in Figure 1.

	Degree	Closeness	Eigenvector	Betweenness
1 Jan	3.000	25.000	0.215	18.000
2 Gil	3.000	27.000	0.317	8.000
3 Heather	5.000	19.000	0.448	39.500
4 Chrissie	2.000	34.000	0.104	0.000
5 Gretel	3.000	21.000	0.353	28.333
6 Bernard	2.000	28.000	0.247	0,000
7 Teresa	3.000	34.000	0.308	0.333
8 Peter	3.000	34.000	0.308	0.333
9 Ed	2.000	34.000	0.104	0.000
10 Paul	3.000	27.000	0.317	8.000
11 Les	2.000	28.000	0.247	0,000
12 Ann	3.000	27.000	0.308	0.500

Table 5. Network constraint and density measures of network in Figure 1.

		Network Constraint	Network Density
1	Jan	0.611	0.333
2	Gil	0.611	0.333
3	Heather	0.382	0.200
4	Chrissie	1.125	1.000
5	Gretel	0.333	0.000
6	Bernard	1.125	1.000
7	Teresa	0.840	0.667
8	Peter	0.840	0.667
9	Ed	1.125	1.000
10	Pau	0.611	0.333
11	Les	1.125	1.000
12	Ann	0.840	0.667

Figure 1. An example of Network diagram

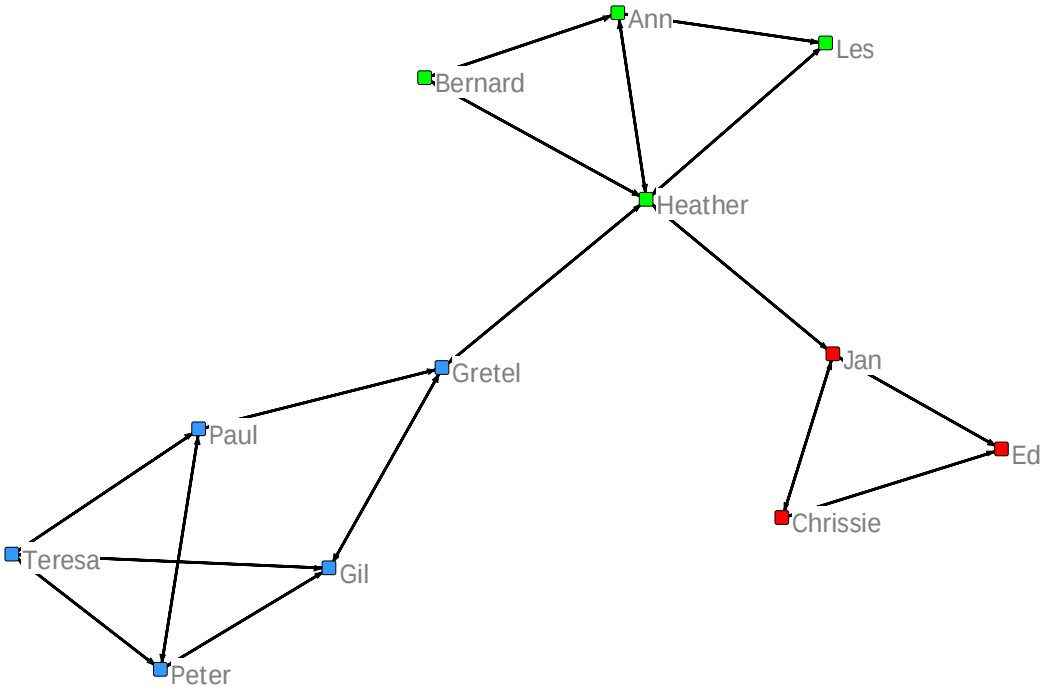


Figure 2. An example of whole network survey.

Instructions

Below you will find a name roster of organizations in alphabetical order. Please indicate the organizations with which your organization has collaboration and/or regular communication related to employment services. In other words, please answer questions below by marking organizations that fit the questions, otherwise leave your answer blank.

(A) Please indicate the employment offices with which your organization has or has had **collaboration** in employment services. Collaboration may include shared projects, services or development activities related to employment services.

(B) Please indicate the employment offices with which your office has or has had **regular communication** regarding employment services. The communication may include, for example, face-to-face discussions, meetings, or e-mails.

Organization:	**A** **Collaboration** 1=formal, e.g., based on contract 2=informal 3=multiplex	**B** **Communication** 1=daily 2=weekly 3=monthly 4=seldom
Alajärvi	1 , 3	1 2 3 4
Alavus	1 2 3	1 2 3 4
Anjalankoski	1 2 3	1 , 3 4
Eno	1 2 3	1 2 3 4
Enontekiö	1 2 3	1 2 3 4
Espoo, keskus	1 2 3	1 2 3 4
Espoo, Tapiola	1 2 3	1 2 3 4
Eura	1 2 3	1 2 3 4
Forssa	1 2 3	1 2 3 4

Figure 3. An example of personal network survey

People often discuss their important matters with others. If you think of the people in your workplace and look back over the last few months, who are the people with whom you have most often discussed important matters related to your work or workplace?

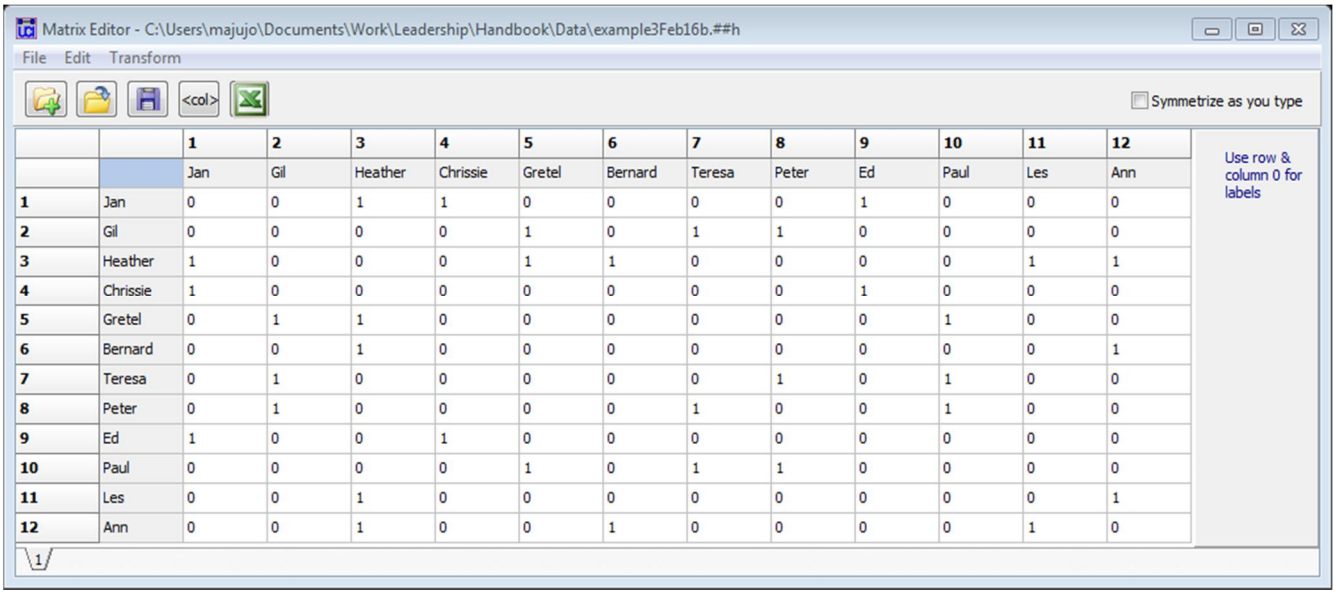
	PERSON 1	**PERSON 2**	**PERSON 3**	**PERSON 4**	**PERSON 5**
1. First name of the person?					
2. What is your relationship with this person (e.g., co-worker, supervisor)? 1=coworker 2=supervisor 3= Other, what?	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
3. How close you are? (1=Distant, 5 = Very close)?	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
4. His or her rank 1=employee 2=supervisor 3=leader 4=other, what?	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4

Figure 4. An example of question how to ask alter-alter ties.

Please indicate whether or not the persons in your network discuss important work-related matters with each other (in each pair; e.g., "Do Person 1 and Person 2 discuss important matters with each other?") (1 = don't discuss or seldom; 2 = every now and then; 3 = very often).

		Person2: Gretel			**Persons3: Jan**			**Person4: Ann**			**Person5: Steve**		
Person1: Heather		1	2	3	1	2	3	1	2	3	1	2	3
Person2: Gretel					1	2	3	1	2	3	1	2	3
Person3: Jan								1	2	3	1	2	3
Person4: Ann											1	2	3

Figure 5. An example of data matrix.


Matrix Editor - C:\Users\majujo\Documents\Work\Leadership\Handbook\Data\example3Feb16b.##h

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Symmetrize as you type

		1	2	3	4	5	6	7	8	9	10	11	12
		Jan	Gil	Heather	Chrissie	Gretel	Bernard	Teresa	Peter	Ed	Paul	Les	Ann
1	Jan	0	0	1	1	0	0	0	0	1	0	0	0
2	Gil	0	0	0	0	1	0	1	1	0	0	0	0
3	Heather	1	0	0	0	1	1	0	0	0	0	1	1
4	Chrissie	1	0	0	0	0	0	0	0	1	0	0	0
5	Gretel	0	1	1	0	0	0	0	0	0	1	0	0
6	Bernard	0	0	1	0	0	0	0	0	0	0	0	1
7	Teresa	0	1	0	0	0	0	0	1	0	1	0	0
8	Peter	0	1	0	0	0	0	1	0	0	1	0	0
9	Ed	1	0	0	1	0	0	0	0	0	0	0	0
10	Paul	0	0	0	0	1	0	1	1	0	0	0	0
11	Les	0	0	1	0	0	0	0	0	0	0	0	1
12	Ann	0	0	1	0	0	1	0	0	0	0	1	0

Use row & column 0 for labels

1

Appendix: Concepts and terms relevant to a social network approach (after Brass, 1995; Kilduff & Brass, 2010)

Actors: Individuals, social groups, organizations or other units that are part of a network.

Alter: An actor named as a member of a focal actor's network.

Brokerage: A role in a network in which an actor connects others who are not directly connected to each other (see structural hole).

Centrality: A network concept that indicates different central positions in a network. *Degree centrality* indicates an actor's number of network ties (with in-degree referring to the number of ties to the actor from other actors and out-degree referring to the number of ties from the actor to other actors). *Betweenness centrality* measures the extent to which a focal actor brokers or connects actors who are not connected to each other. *Eigenvector centrality* indicates the extent to which a focal actor is related to central actors in a network. *Closeness centrality* reveals how well an actor can reach all other actors in a network.

Centralization: An indicator of the extent to which network ties are concentrated around a small number of actors.

Closure: A network in which actors are connected to each other. Network density is a typical indicator of network closure.

Density: A network measure that indicates the extent to which alters in a network are connected to each other. In particular, density is calculated by dividing the number of network ties between alters by the maximum number of possible ties between alters.

Egocentric network: An actor's direct ties in a network and relations between these ties, i.e., the actor's personal network (cf. whole network).

Homophily: Actors' tendency to have relations with those similar to themselves with respect to personal and social attributes, such as ethnicity, organizational rank, and/or socioeconomic status (SES).

Multiplexity: A relation between two actors that includes different types of connections. For example, A and B could be both friends and coworkers.

Personal network: An actor's direct ties in a network and relations between these ties, also known as the actor's egocentric network.

Reciprocity: A relation between two actors in which both actors indicate that the relation exists. For example, A asks B for advice, and B asks A for advice.

Social capital: An actor's network-based resources, such as information, advice, and recommendations, that advance goal attainment. At the group level, social capital is often indicated by network closure that enhances norms and trust among group members.

Strength of tie (weak or strong ties): A concept used to characterize a relation between two actors based on attributes such as emotional closeness or intimacy, meeting frequency, and reciprocity. Weak ties, such as acquaintance relations, are often characterized by low intimacy, low meeting frequency, and/or low reciprocity. Strong ties are characterized by emotional closeness, high meeting frequency, and reciprocal services; for instance, friendship relations tend to be strong ties.

Structural equivalence: The extent to which two actors have similar network positions, i.e., have ties to the same actors in a network.

Structural hole: A missing relation between two actors; a third actor can play a broker role between these two actors.

Transitivity: A concept used to describe network triads. For example, if A names B as a friend, B names C as a friend, and A names C as a friend, then a transitive triad exists**.**

Upper reachability: An indicator of social resources in a network. Upper reachability is often indicated by the highest occupational prestige or socioeconomic status of network ties (e.g., Lin 2001).

Whole network: A network derived from reports from all or most of the actors in a given unit indicating these actors' ties with each other (cf. personal network).