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On and Off the Beaten Path: Transferring Knowledge through Formal and Informal Networks

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Abstract

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Keywords: knowledge transfer, formal networks, informal networks.

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On and Off the Beaten Path: Transferring Knowledge through Formal and Informal Networks¹

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Abstract: Informal networks are often emphasized as facilitating knowledge transfer. However, we find that formal networks also contribute significantly to knowledge transfer, and in fact contribute more than informal networks. This is particularly the case when knowledge is transferred between units. Additional analysis shows a synergetic effect between formal and informal ties, which suggests that knowledge transfer effects that in previous studies were attributed to informal networks only, may in fact be caused by the combination of both formal and informal networks. We conclude that there is more than one path to transfer knowledge effectively.

Keywords: Knowledge transfer, Formal networks, informal networks, multi-unit organizations.

On and Off the Beaten Path: Transferring Knowledge through Formal and Informal Networks

Knowledge is frequently considered to be the most valuable asset of an organization (Grant, 1996) and a key source for competitive advantage (Teece et al., 1997). Yet at the same time it is one of the most difficult resources to manage: for instance, knowledge usually is spread throughout the organization and may not be available where it might best be put to use (Cross et al., 2001; Moorman and Miner, 1998; Szulanski 2003). Thus, transfer of knowledge within the organization has gained considerable attention in the literature (Hansen, 1999; Powell et al., 1996; Argote et al., 2003). Scholars have emphasized that effective transfer of knowledge between employees within an organization indeed increases the organization's innovativeness (Davenport and Prusak, 1998; Tushman, 1977; Moorman and Miner, 1998; Perry-Smith and Shalley, 2003; Tsai, 2001; Moran, 2004; Hansen, Mors and Lovas, 2005). However, such transfer is not automatic (Szulanski, 1996). Some potential difficulties in knowledge transfer lie in its incompatibility with incentive structures, threat to existing strategic positions, incompatible frames of reference (Amabile et al., 1996; Davenport and Prusak, 1998; Carlile, 2004). Another important barrier is the lack of information regarding the knowledge that exists in other divisions, the individuals who possess this knowledge and how to transfer this knowledge once it has been located (Hansen, 1999; Szulanski, 2003; Hansen, Mors and Lovas, 2005). These latter set of questions have been addressed frequently from a network perspective.

In the literature, different types of intra-organizational networks or relations are generally distinguished: formal, informal, friendship (trust), political support, and advice networks (Krackhardt & Hanson 1993). For knowledge transfer within organizations, informal networks are

often emphasized. Studies mostly tend to investigate one particular type of tie or network (although recently calls have been made to expand this focus, e.g. Hansen, Mors and Lovas (2005)), and in many cases the role that informal ties play in effective knowledge transfer is emphasized (e.g. Granovetter, 1973; Freeman, 1991; Hansen, 1999, Powell et al. 1996; Reagans & McEvily 2003). Formal networks have received much less research attention in this regard and when they have, they are equated with the organization chart and found to be of marginal influence for knowledge transfer (Krackhardt and Hanson, 1993; Cross and Prusak, 2002). However, if we are prepared to conceive of formal networks as broader than just the organizational chart, this dismissal may be premature. Decisions to assign employees to divisions, work units, teams or projects all determine a person's place in the formal network. Such interdependencies will affect knowledge transfer, but have not always been considered as such in studies taking a narrow view of formal structures. These formal decisions put individuals in a certain position in the workflow network, and it seems plausible to expect at least some sort of impact on knowledge transfer processes arising from formal networks (Allen and Cohen, 1969; Stevenson, 1990; Stevenson and Gilly, 1991). Despite assertions that different *types* of ties or networks can be conducive for different purposes or in different circumstances, a comparison between the different networks, for instance to determine which one contributes to knowledge transfer best, has rarely been undertaken to date (see Hansen, Mors and Lovas (2005) for a recent exception). This is where we contribute.

In line with previous research (Carlile 2004; Cummings 2004; Hansen, 1999, 2002; Szulanski, 2003; Tsai, 2001), we focus our attention on multi-unit firms, since this is where the knowledge transfer problem is most pertinent. We review the literature on multi-unit firms, the role of formal and informal networks in the organization, and develop hypotheses. We then describe the setting and methodology of our study in a large European high-tech company. Our analysis shows that both the formal network and the informal network contribute significantly to the transfer of

new, innovative knowledge. We also find that formal networks contribute more than informal networks, particularly in the case of inter-unit knowledge transfer.

Additional analysis shows that the majority of ties between actors have both a formal and an informal component. Ties between actors that are formal only are fairly common, whereas informal ties between actors without a formal component are rare. Furthermore, a combined formal/informal tie between actors is much more likely to lead to the transfer of new, innovative knowledge than either tie separately. This suggests a synergetic effect between formal and informal ties. It also suggests that knowledge transfer effects that in previous studies were attributed to informal networks only, may in fact be caused by the combination of both formal and informal networks.

We conclude by arguing for a more balanced view on the role of intra-organizational networks for knowledge transfer. Formal relations are more purposefully malleable in nature and so we conclude by discussing how managers can enable knowledge transfer through design of such formal networks.

1. Knowledge transfer in multi-unit firms

Multi-unit (or multi-divisional) firms tend to be organized according either to the products they develop and markets they aim for, or on the basis of disciplinary knowledge. In many cases the two overlap. This structure offers units a relatively high level of autonomy. Although a unit structure offers benefits such as focus and specialization, at the same time it may limit the inter-unit knowledge utilization and transfer, because units may be primarily concerned about their own performance. Given Schumpeter's (1934) point of combining and re-combining existing knowledge as a source of innovation (cf. Cohen and Levinthal, 1990), this inherent limitation of the multi-unit structure is problematic and hence, many firms are seeking ways to overcome it.

Unfortunately, combining and recombining knowledge is by no means obvious, especially due to the social dimensions of communication patterns (Szulanski, 1996, 2003). To be able to use existing knowledge, firms need to have sufficient insight in the knowledge actually available and the actual processes of and structures for knowledge transfer (Kogut and Zander, 1992). The structure of the communication patterns within organizations that facilitate the knowledge transfer to take place is believed to be of considerable importance to direct the transfer of knowledge in an effective way (Tsai, 2001; Hansen, 2002).

For instance, finding the person that has the knowledge that one is looking for may be difficult within a large, multi-unit organization (Szulanski, 2003; Hansen, 1999; Hansen and Haas, 2001). The relative autonomy of divisions within a multi-unit organization structure creates a lack of awareness of each other's activities on an individual and a unit level, possibly limiting knowledge-transfer. Also, within a unit that specializes in a certain knowledge field, knowledge tends to be of the tacit kind. The advantage of the tacit nature of knowledge is that imitation by competitors is relatively difficult (Nonaka and Takeuchi, 1995), but at the same time the tacit nature of knowledge requires a high degree of personal contact in order to be effectively dispersed throughout the company (Teece, 1998; Hansen, 1999). Hence interpersonal networks within an organization play a significant role in intra-organizational knowledge transfer (cf. Allen 1977, Tushman and Scanlan 1981).

2. Formal and Informal Networks

Monge and Contractor (2001, p.440) define networks as “the patterns of contact between communication partners that are created by transmitting and exchanging messages through time and space”. A broadly accepted distinction when discussing intra-organizational networks is the distinction between the formal and the informal network (Allen and Cohen, 1969; Allen, 1977;

Madhavan en Grover, 1998). The formal network is the communication structure that is derived from the formal relations as formulated and standardized by corporate management (Kilduff & Brass, 2001). Communication that flows through the formal network is dictated by the planned structure established for the organization (Simon 1976, p.147). This planned structure is only partly reflected in the organization chart, because it also includes formal procedures, schemes and rules deemed important mostly for the execution of daily operations (Adler and Borys, 1996). Formal structures are relatively transparent. Formal networks allocate responsibility, may prevent conflict and can reduce ambiguity (Adler en Borys, 1996), thereby reducing uncertainty for instance regarding the location of expertise and also regarding obtaining the resources for intra-firm knowledge transfer. The formal network also dictates to some extent who interacts with whom. These repeated interactions can build a shared understanding between two parties, and this knowledge base can in turn facilitate transfer of further knowledge (Cohen and Levinthal, 1990). Formal structures also allow for specialization as individuals in particular positions store experience and best practices; the formulation and realization of a common goal is thereby promoted (Adler en Borys, 1996). We thus propose the following hypothesis:

H1a: Formal ties between two actors contribute positively to knowledge transfer between those two actors.

Blau and Scott (1962) observed that it is impossible to understand processes within the formal organization without investigating the influence of the informal relations within that same organization. Adler and Borys (1996) argue that, depending on the task, formal structures may enable or hamper employees' autonomy and creativity, and may thus increase or decrease their commitment (cf. Rogers 1983). Certainly for the kind of non-routine activities related to

knowledge transfer and innovation, highly formalized structures might be problematic (Adler and Borys 1996, p.63). Although altering formal networks may be more easily accomplished than changing informal ones as they are more explicit, intentionally changing formal networks may not yield intended benefits (Krackhardt and Hanson 1993). This is mainly due to neglecting the influence of informal networks that cut through the formal structures and thereby operate as a “communication safety net” (Cross et al. 2002).

When communication via the formal network takes too long, or when the relations required to get certain things done have not been formally established, the informal network (“the grapevine”) may come into play. The informal network refers to the “interpersonal relationships in the organization that affect decisions within it, but either are omitted from the formal scheme or are not consistent with that scheme” (Simon 1976: p.148). Informal networks include friendships, but also the contacts actors have with others within the organization that are not formally mandated. The informal network provides insight into the general way ‘things are getting done’ within the organization, often bypassing and sometimes undermining the formal communication structure (Schulz 2003), because information may be transferred relatively fast in the informal network (Cross et al., 2002). Thus, informal channels provide insight into the *de facto* authority within the organization (Krackhardt and Hanson 1993). Besides this, the informal network provides the opportunity for information and knowledge to flow in both vertical and horizontal directions, which contributes positively to the overall flexibility of the organization (Cross et al. 2002). As such, drawbacks of an inflexible formal network might be mitigated (Kilduff & Brass, 2001; Molina, 2001; Krackhardt & Stern, 1988)

Because of these beneficial effects on information flows, informal networks in particular are believed to drive knowledge-transfer (Cross et al. 2002; Stevenson and Gilly 1991; Jablin and Putnam, 2001; Madhavan and Grover 1998). Compared to the formal network, they may offer a

higher degree of flexibility as the relative ease of knowledge-transfer offers the possibility to adapt quickly to changing market circumstances and to tap into unconventional/new knowledge sources, even when an informal network might be less transparent compared to a formal network (Cross et al. 2002, p.26). Albrecht and Ropp (1984) suggest that employees tend to discuss new ideas with colleagues in their informal network first. Hansen (2002) argues that informal networks allow units to tap into knowledge available outside one's own organizational unit more easily – informal networks allow for flexibility if they do not turn into old boys networks. Hence our hypothesis:

H1b: Informal ties between two actors contribute positively to knowledge transfer between those two actors.

Although we propose that both networks contribute to knowledge transfer, our review indicates that most scholars expect the informal network to be the main driver of knowledge transfer. This is partly because of the flexibility argument mentioned above, but also due to the informal network being the primary basis for the creation of trust. This trust in turn is necessary for knowledge transfer to take place in practice (Kramer et al., 2001; Szulanski et al., 2004). Thus, although formal ties may prove to be helpful to knowledge transfer, its benefits are likely to be marginal compared to those of an informal tie. Hence we propose the following hypothesis.

H1c: Informal ties between two actors contribute more to knowledge transfer than formal ties.

We thus hypothesize that both the formal as well as the informal network contribute to knowledge transfer. These two networks constitute different roads to that end. Informal relations are often seen as allowing for more flexible responses by the organization as a whole to deal with perceived needs

(Krackhardt and Stern, 1988). Informal networks may offer avenues for the exchange of knowledge where no established avenue is readily available. As formal structures follow and in fact partly constitute unit boundaries, inter-unit knowledge transfer presents precisely such a situation of uncertainty regarding the relevance of the sought knowledge and/or the best way of transferring it (Schulz, 2001, 2003). Hence, in such situations in particular, informal relations are more likely to have a beneficial effect on knowledge transfer compared to knowledge transfer within units. Within a unit, there are more likely to be established patterns of workflows (Han, 1996) that provide a basis for knowledge transfer irrespective of the presence of informal ties, so compared to inter-unit knowledge transfer, formal networks are likely to be more effective for intra-unit knowledge transfer. We thus suggest two additional hypotheses that further explore the nature of the differences between the formal and informal network.

H2 The formal network contributes to intra-unit knowledge transfer more than inter-unit knowledge transfer does.

H3 The informal network contributes to inter-unit knowledge transfer more than intra-unit knowledge transfer does.

3. Method

Organizational setting. The setting for our study is a multinational electronics and engineering company headquartered in a European country. The subsidiary studied, operating since the late 19th century, is in a different European country and employs some 4000 employees; worldwide over 400,000 people are employed by this organization, making it one of the world's largest conglomerates. In the business press this organization is sometimes referred to as Europe's most successful conglomerate. Revenue generated by this subsidiary is equivalent to some 6.5 % of total

revenue for the company. At corporate level, over 6.8% of revenues are spent on R&D, emphasizing the importance of innovation for this company, and making this a high-tech company according to OECD criteria. The company is organized according to a unit structure with a high level of autonomy and responsibility for the separate divisions and the divisions are organized according to product-market segmentation. Recently, the company shifted from offering specific products towards offering integrated and innovative solutions to its customers, based on its technical competencies that cross unit boundaries.

As a consequence of the strategic shift, the company has reorganized its activities according to a number of strategic multidisciplinary themes, one of which is the theme ‘transportation’. According to top management this theme has a high priority but at the same time is being insufficiently explored yet. Therefore this study focuses on four functional divisions that all exploit activities related to the transportation theme as well as two main staff functions related to new business development (the innovation department and the market information department). The unit structure constitutes a natural membership boundary (see Hansen, 1999) and it is therefore that employees, sorted by unit membership, form the object of analysis in this study of inter-unit transfer of knowledge. Access to the company was negotiated through the senior innovation manager of the subsidiary who operates directly under the supervision of the board of directors. The selection of these divisions was based on the input gathered during several interviews with the new business managers in the separate divisions and the senior innovation manager, who also secured the commitment of the unit directors.

Data collection.procedure. To test the formulated hypotheses, data on the social relations within the company was gathered, focusing on the formal and informal networks within the organization as well as the inter-unit innovation network. In order to be able to study the formal and the

informal structures in a firm, they need to be defined in comparative terms. We follow Farace, Monge and Russell (1977) to define social networks – formal and informal – as repetitive patterns of interaction among members of an organization. Data on the individual level for each of these networks is collected using semi-structured interviews with managers and other employees and a network survey. The interviews served a two-fold purpose: first, to become familiar with the organizational setting and thus gain input for the proper design of the network survey and second, they served as the first round in our snowball sampling procedure. Snowball sampling is especially useful when the population is not clear from the beginning (Wasserman and Faust, 1994), which is the case in this particular company because of the focus on inter-unit cooperation and the resulting blurring of unit boundaries. Snowball sampling is based upon several rounds of surveying or interviewing where the first round helps to determine who will be approached as a respondent in the second round and so on. The first round of snowball sampling can be totally at random but it can be also based on specific criteria (Rogers and Kincaid, 1981). To reduce the risk of ‘isolates’, i.e. isolated persons within the organization who do possess relevant knowledge to a particular subject, but who are being left out by the study due to the lack of accuracy of random sampling (Rogers and Kincaid, 1981), this study opted for a first round consisting of specifically targeted respondents. The selection of the first round of respondents to fill in the questionnaire was based on the expertise of the innovation management department (one of the two staff departments involved in the study). This department was asked to create an overview of employees who are most active in the field of transportation and who are members of the earlier selected divisions. This resulted in a list of nine employees in four functional divisions. The selection was validated by seeking the judgment of the manager of the market information department (the other staff department involved in the study). These 9 people filled out the survey during a personal interview. They named 42 other employees who formed the second round of targeted respondents and who

were sent the survey by email. Respondents in this second round who did not reply initially, were approached by the first author to fill out the survey during a personal interview, which resulted in an overall response rate of 96 percent. This percentage includes the 63% who filled in the whole questionnaire including the matrix and the 33% who indicated in their opinion not to have any relationship with the transportation theme. 4% did not respond to the first mailing and the later reminder mailings and interview requests. No further surveys were sent out because the responses of the second round indicated that the vast majority of people related to the transportation theme had been identified and surveyed. Thus, we are reasonably sure to have included all relevant actors in the network, which reduces the boundary specification problem common to an egocentric approach (Marsden, 1990, 2002).

The survey was constructed in a digital version that could be distributed by e-mail and every survey form was accompanied by a personalized cover email introducing the project to the respondent, signed by the senior innovation manager to improve response rates. An email survey was chosen to reduce the time needed to complete the questionnaire, thus improving response rates. To further reduce the time needed to fill in the survey, the survey form was constructed in a matrix style, such that names had to be inserted only once in the horizontal column of the survey form by the respondents after which they could automatically be used for all three network questions. We did not opt to fix the number of contacts throughout the survey because the number of employees named partially determines the position of the individual employee in the network (Friedman and Podolny, 1993). However, we did issue a guideline of naming at most six employees to make sure that only the most important contacts per employee were mentioned. To reduce ambiguity regarding the interpretation of the questions by the respondents, the network questions were formulated in the native language.

Variables. The independent variable formal network is operationalized as the workflow network. There are several reasons for choosing this operationalization of the formal network instead of using the more commonly chosen organizational chart measure. First of all, it is well-recognized that the organization chart is a poor indicator of the day-to-day dynamics in an organization (Krackhardt & Hanson, 1993) that are the focus of our study. Second, an organization chart is often focused more on hierarchical, vertical relations, while formally mandated horizontal relations (for instance temporarily created teams) are emphasized less, again rendering it an incomplete measure for the purposes of predicting knowledge transfer. In order to capture these aspects that are missing from the organization chart, we operationalize the formal network as the workflow network. Seeing the workflow as a part of the formal network is consistent with Mehra et al. (2001), who define the workflow network as “the *formally* prescribed set of interdependencies between employees established by the division of labor in the organization” (p.130, italics added). We measured the workflow network by asking respondents to indicate the persons with whom they exchange information, knowledge, documents, and schemes to successfully carry out their daily activities within the organization (Mehra et al. 2001, p.130). Projects, goods and services and relations with customers that had already been established or developed are the focus of communication in such formal networks. The independent variable informal network was operationalized as the communication network and measured by asking with whom one discusses what is going on within the organization (Brass, 1984, p.526). Thus we gain insight in the personal preferences and insights of employees regarding informal communication within the organization. The dependent variable is the network in which individuals indicated with whom they discuss *new* ideas, *innovations* and *improvements* to products and services (Cross and Prusak 2002, p.107; Krebs, 1999). Clearly, this concerns communication that was *not* perceived as related to the

ongoing business of the organization. We refer to this network as the ‘innovation network’, since our focus is specifically on the transfer of innovative knowledge.

Finally, for every name filled in on the survey as their contacts, the respondents were asked to indicate the frequency of communication; this indicates tie strength. This form of valued rating was conducted using a five point frequency measure varying from daily to yearly.

4. Analysis

Using UCINET (Borgatti et al., 2002) the formal network and the informal network can be graphically displayed (where peripheral nodes of individuals who did not have further contacts have been removed for clarity), as in Figures 1 and 2:

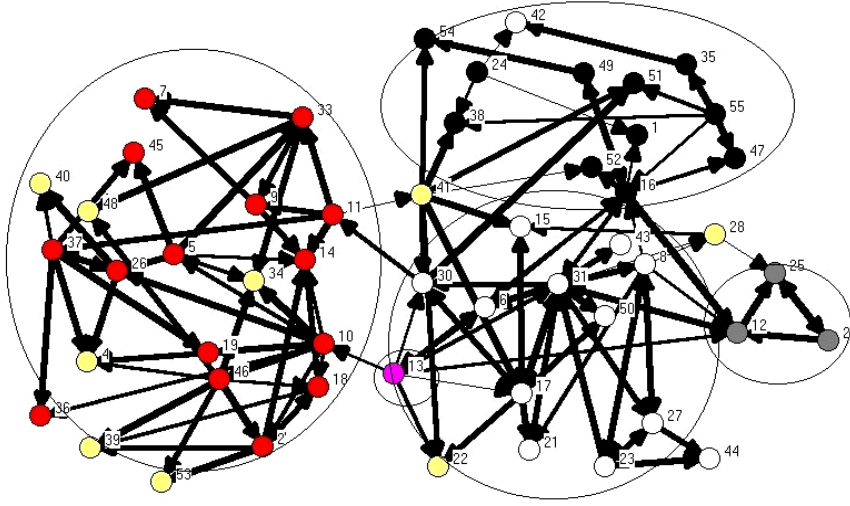


Figure 1: The formal network ($N_{total}=110$, $N_{figure}=52$)

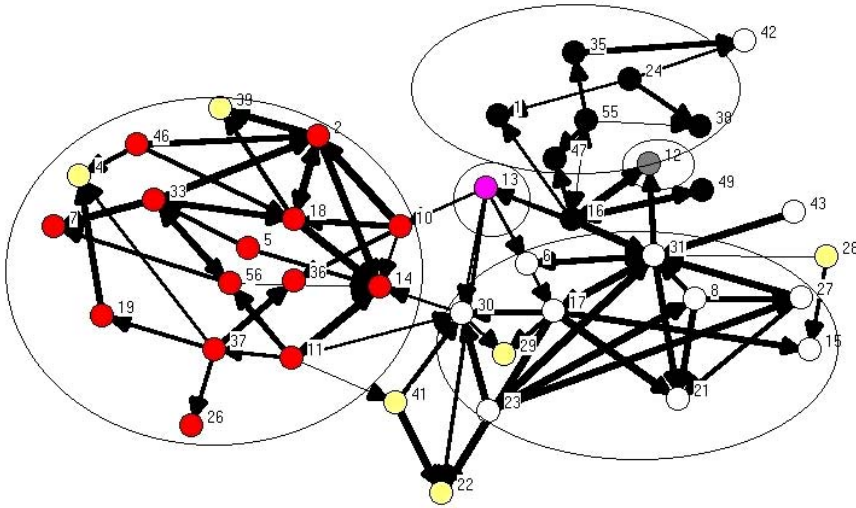


Figure 2: The informal network ($N_{total}=87$, $N_{figure}=41$)

The colors of the nodes represent different organizational units, the circles roughly (although not perfectly) correspond to these units. What is immediately striking is that both the formal and informal network closely follow divisional boundaries.

As discussed above, we hypothesize that formal and informal networks explain the knowledge transferred within this organization. The network where new ideas, innovations and improvements

regarding products and processes are discussed might be called the ‘innovation network’; it is presented in Figure 3.

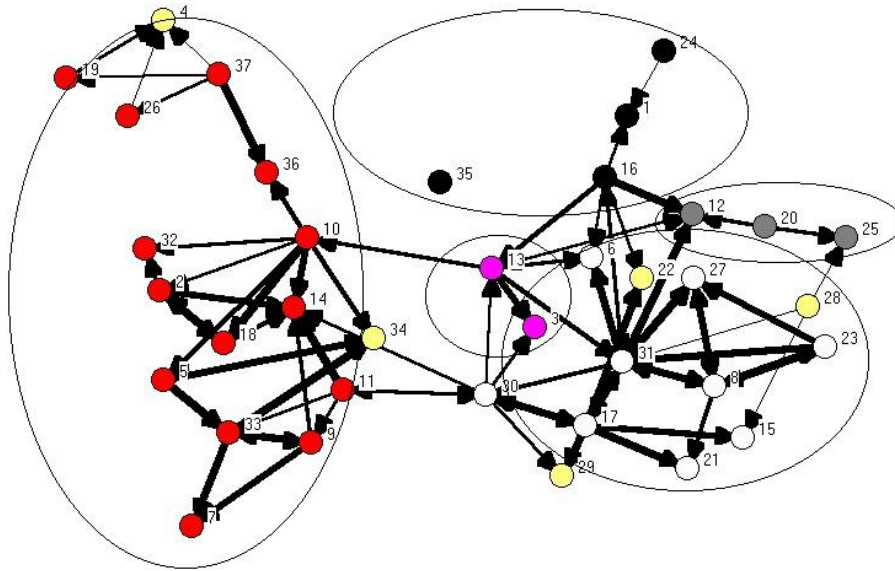


Figure 3: The ‘innovation’ network ($N_{total}=82$, $N_{figure}=37$)

To test hypotheses 1, the correlation between the formal and innovation respectively the formal and the innovation network will be measured using the QAP procedure (Hubert and Schulz, 1976, Krackhardt, 1987) with 2500 permutations. From this calculation the correlation coefficient (r-square) and the standardized regression coefficient (beta) can be derived. The r-square gives an indication of the explanatory value of the informal respectively formal network on the innovation network. The interpretation of the derived beta will be used to interpret the individual influence of the independent variables formal network and informal network. The independent variable with the highest beta-value has the largest influence on the innovation network as dependent variable.

As is to be expected (see e.g. Homans, 1951), the formal and informal communication networks overlap to a certain extent (QAP correlation 0.529, $p<0.001$), but at the same time the two networks are sufficiently different – in line with findings by, a.o., Fernandez (1991) – to be able to

determine their separate effects on knowledge transfer. In addition, even if and to the extent that the formal and the informal network overlap, they may provide separate or alternative avenues for knowledge transfer. The QAP correlation between the formal network and the innovation network is 0.739 ($p < 0.001$). The QAP correlation between the informal and the innovation network is 0.649 ($p < 0.001$). This shows that both the formal and the informal networks separately contribute to knowledge transfer, but to formally test hypotheses 1a, 1b and 1c, a QAP regression analysis was conducted with innovation network as the dependent variable.

The combined model of formal and informal networks explains 59 percent ($p < 0.001$) of the variance in the innovation network. The coefficients for both networks are positive and significant (formal network $\beta = 0.460$, $p < 0.001$; informal network $\beta = 0.360$, $p < 0.001$), supporting H1a and H1b. This emphasizes that *both* the formal and the informal network have a strong positive influence on knowledge transfer, where previous research has often acknowledged only the role of the informal network.

The standardized beta for the formal network is larger than the standardized beta of the informal network. As the size of the standardized beta-score serves as an indicator of the influence of the respective independent variable on the dependent variable innovation network, it seems valid to conclude that the formal network even affects knowledge transfer somewhat more than the informal network. This leads us to conclude that Hypothesis 1c cannot be supported.

To investigate hypotheses 2 and 3, each of the three networks was split in two mutually exclusive sub-networks: one consisting of intra-unit ties and one consisting of inter-unit ties (unit membership for each respondent was obtained from company records) and separate QAP regressions were run with the innovation network as the dependent network for the intra- and inter-unit case. Hypothesis 2 would predict that the QAP regression coefficient for the formal network will be larger in the intra-unit regression than the inter-unit regression. Hypothesis 3 predicts a

larger QAP regression coefficient for the informal network in the inter-unit regression than the intra-unit regression. Note that since we are dealing with network of unequal sizes, the most accurate way to test H2 and H3 would be on the basis of effect size estimates. However, we are not aware of a formula for calculating effect sizes in network regression models, hence we rely on a comparison of the standardized beta-coefficients.

Both the intra- and inter-unit regression models are significant and have a fairly large R^2 (intra-unit $R^2 = 0.671$, inter-unit $R^2 = 0.431$), but the differences between our standardized betas are in the opposite direction from our prediction. The formal network is slightly *more* influential for inter-unit ($\beta = 0.487$, $p < 0.001$) than intra-unit ($\beta = 0.401$, $p < 0.001$) knowledge transfer, thus rejecting H2. Perhaps even more surprising is that the informal network is considerably more influential in intra-unit ($\beta = 0.460$, $p < 0.001$) than inter-unit ($\beta = 0.221$, $p < 0.001$) knowledge transfer, rejecting H3. These results also provide an additional test of H1a-c, only now at the intra- or inter-unit level. They support H1a and H1b and reject H1c for the inter-unit network (but not necessarily for the intra-unit network) and thus are broadly in line with our previous finding for the entire network.

Discussion: the different roles for formal and informal networks

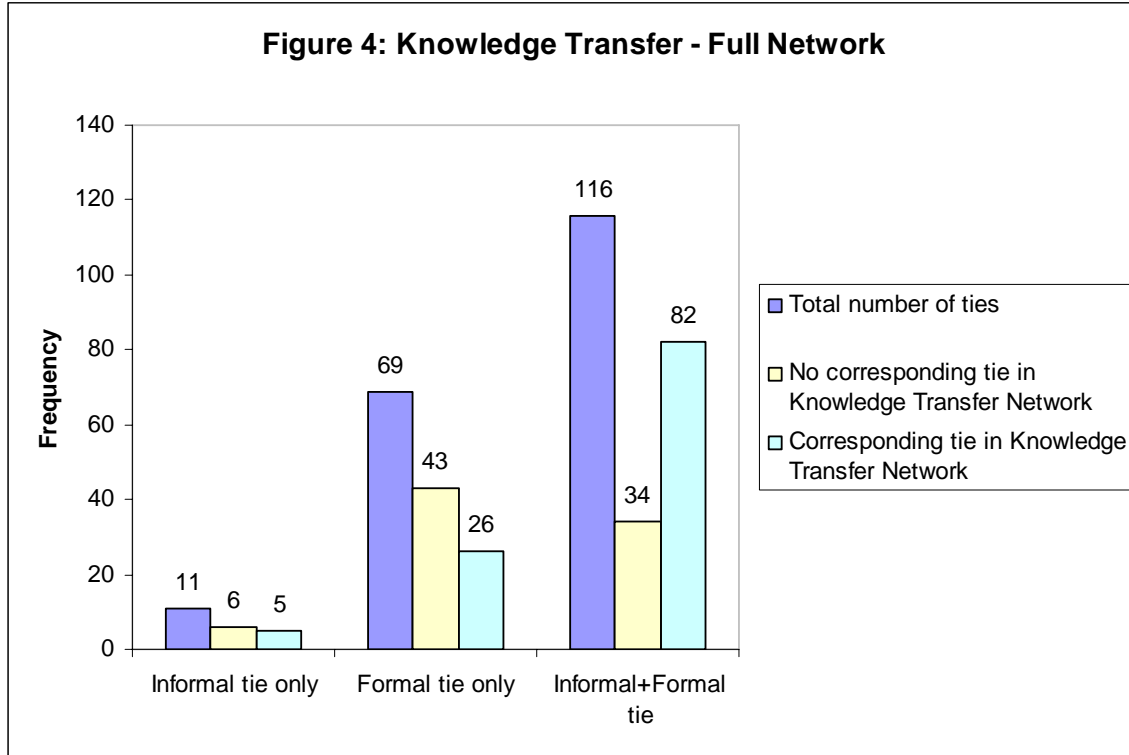
The results of the analysis support our contention that the formal network plays an important role in knowledge transfer – one that has not always been acknowledged. How does the role of the formal network differ from that of the informal network? Our results for hypotheses 2 and 3, suggest that they do, but since the effects were in the opposite direction of what was expected based on the existing theory regarding formal and informal network, it is clear that a refinement to the theory is needed. While more evidence or more specific measures at the tie level would have

been helpful in this regard, the data that we do have allows for some additional analysis that can help to shed some more light on this issue.

First of all, the role of the centrality of the transferring actors in both networks is of importance. Given the organization's explicit goal of promoting inter-unit knowledge transfer, and based on our qualitative data, monopoly power over communication is not an issue in our research setting – thus the measure of degree centrality is opted for (Freeman 1979). Degree centrality scores were calculated per employee engaged in the formal respectively informal network using Ucinet 6.0. (Borgatti et al., 2002).² We analyze the relative number of outgoing relations, or the extent to which an individual communicates across unit boundaries as the share (%) of such communication in relation to his total communication. The relationship between centrality within *either* the formal network *or* the informal network on the *one* hand, and the degree of inter-unit knowledge-transfer regarding innovation on the *other* hand, was analyzed using non parametrical Mann-Whitney tests to correct for the absence of a normal distribution in the dependent variable. The results show that a high degree of centrality within the formal network strongly increases the involvement in inter-unit communication (Mann-Whitney $U=265.0$, $p < 0.001$, effect size³ $r=0.717$). In addition, we found a strong relationship (Mann-Whitney $U=245.0$, $p < 0.001$, effect size $r=0.560$) between the level of centrality in the informal network and the percentage of inter-unit knowledge transfer. The extent to which an individual is central in a network appears to be a useful predictor of the level of involvement in inter-unit knowledge transfer, as underscored by the large effect sizes (Cohen, 1992). This finding is in line with, but gives further specification for the often-found importance of centrality for knowledge transfer (Tsai, 2001). The difference between the effect sizes of the formal and informal network suggests that a central position in the formal

² In line with Freeman (1979) the degree centrality, C^d , for person i , mediating between persons j and k , is: $C^d(n_i) = \sum_j a(n_i, n_k)$; where $i \neq k$, and $a(n_i, n_k) = 1$ only if i and k are connected, and 0 otherwise. See also Marsden (2002).

³ Calculated as $r = Z/\sqrt{N}$ (Rosenthal, 1991).



network might be more important for inter-unit knowledge transfer than a central position in the informal network.

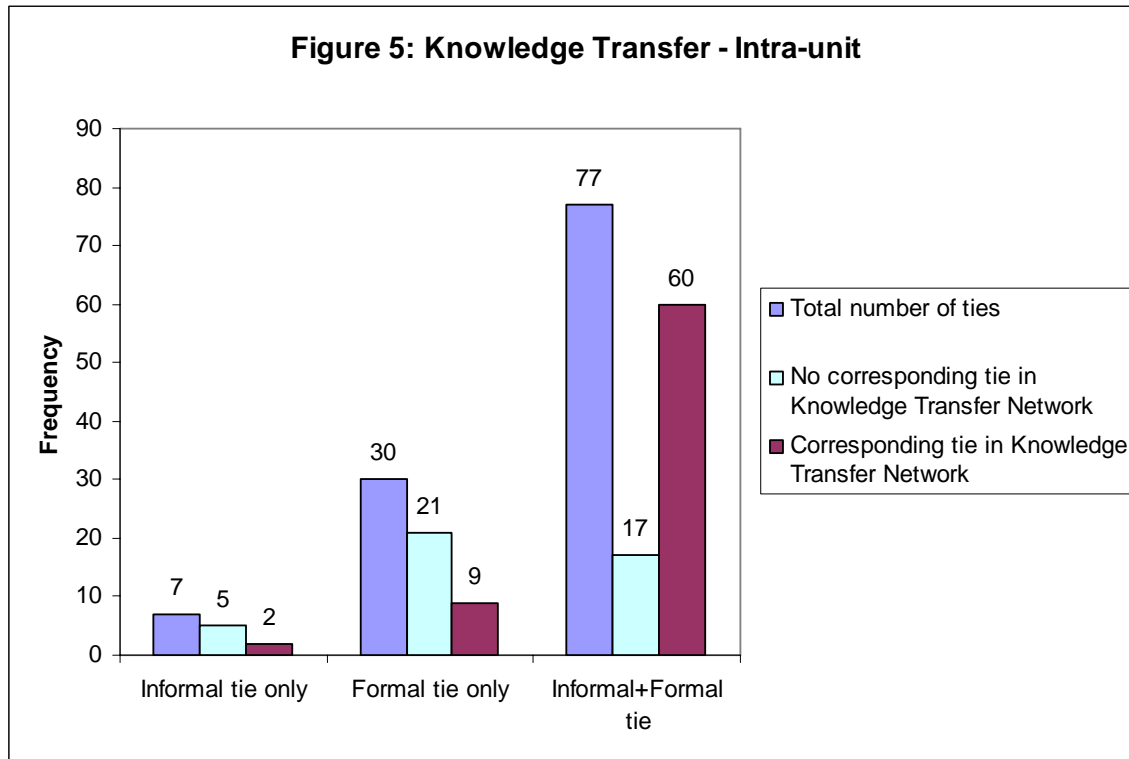
Secondly, a ‘conversion rate’ for ties may be suggested: given a tie between two actors in the formal network only, the informal network only, or a combined formal/informal tie, what is the likelihood of each tie resulting in a tie in the knowledge transfer network? The three categories (informal tie only, formal tie only and a combined informal + formal tie) are depicted in figure 4 with their frequency of occurrence in our data⁴. One of the things that is immediately obvious from the chart, is that informal ties without an accompanying formal tie are very uncommon compared to the other two types (11 vs. 69 and 116). However, when they do occur, they result in a knowledge-transferring tie in 46% of the cases (5 out of 11). Another striking fact is that not only are formal ties without informal ties fairly common, but a considerable portion of those result in

⁴ Strictly speaking, the category ‘No tie’ should be included as well as there are 9 ties in the knowledge transfer network without a corresponding tie in the informal or formal network. However, this is likely to be an artefact of our

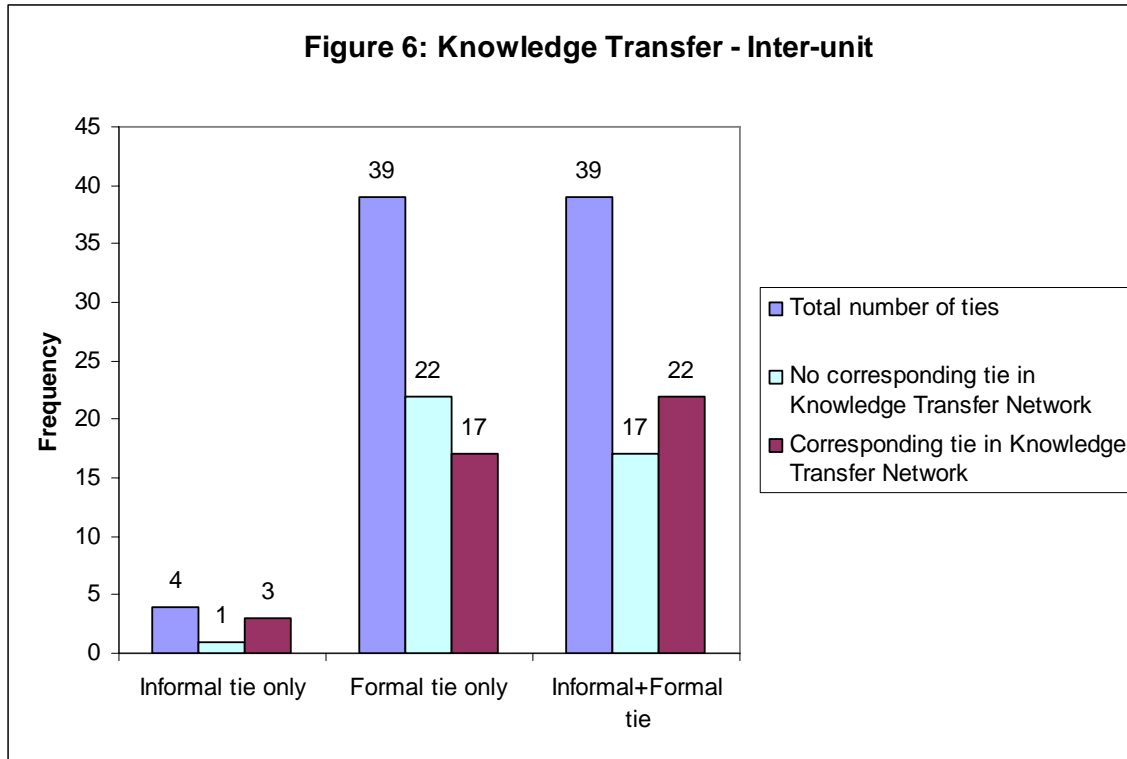
knowledge transfer: 38%. Examination of the most common category (a combined informal and formal tie) shows that there is a strong synergy effect between the formal and informal network when it comes to knowledge transfer: 71% of ties result in a corresponding knowledge-transferring tie. When taken together, these observations, although purely descriptive and not permitting a significance test, are in line with our hypothesis regarding the positive effects of formal ties and informal ties separately (in line with H1a and H1b). However, they paint a more mixed picture when it comes to H1c on the presumed importance of the informal network. On one hand, an informal tie adds considerable value to a formal tie for knowledge transfer (conversion rate 38% → 71%), but on the other hand, so does adding a formal tie to an informal tie (conversion rate 46% → 71%). If one were to compare solely on the basis of whether or not an informal tie adds to knowledge transfer, one would conclude that it does. Interaction effects between the formal and informal network seem primarily to be at work, though. This apparent synergy effect could not have been found, had we measured informal ties only. Focusing solely on informal ties when explaining knowledge transfer in an organization would not only disregard these synergy effects as well as over a quarter of all knowledge-transferring ties that are entirely formal tie.

Figures 5 and 6 show the corresponding charts for the intra- and inter-unit networks respectively. The results are qualitatively similar to those found for the entire network, although it is interesting to note that the synergy effect between the formal and informal network is stronger in the intra-unit case compared to the inter-unit case. In fact, nearly 40% of all inter-unit knowledge transferring ties result only from a formal tie, which seems to run counter to the presumed importance of informal ties particularly for the inter-unit case (Cummings, 2004; Hansen, 1999).

The oft-reported important role of informal ties for knowledge transfer - a role we find as well – contrasts with our finding that formal ties are at least as important. These findings may be



reconciled by taking a longitudinal perspective. While it is certainly possible that informal ties develop between two actors that do not work directly together, it is more likely that such informal ties develop on top of existing formal (workflow) ties. Frequent interaction allows the more social aspects of a relationship to develop, which can then lead to an informal tie (cf. Homans 1951). As Powell et al. (1996, p.121, italics added) state: “Collaboration *becomes* emergent – stemming from ongoing relationships – informal and nonpremeditated.”



Also, formal and informal ties offer different bases for new innovative knowledge to be transferred. Formal ties involve work-interaction regarding domain knowledge and as the interaction continues for a longer period of time, the shared knowledge base between these actors deepens, which in turn offers opportunities for sharing more complex, tacit knowledge (Cohen & Levinthal, 1990; Gabarro, 1990; Hansen, 1999). Informal ties, involving a trust component ensuring an open climate required for transferring complex, innovative knowledge (Szulanski et al., 2004; Hansen 1999, 2002), may subsequently grow. Both the formal and informal networks thus offer distinct and possibly complementary enablers for knowledge transfer.

5. Conclusion & Limitations

Knowledge transfer is necessary to increase the innovative potential of an organization, whether within units of a firm or between them. Recently scholars have argued for the incorporation of multiple networks when studying the transfer of knowledge and competencies (Hansen and Lovas,

2004; Hansen, Morgan and Lovas 2005). This paper has dealt with the question how different networks within an organization influence such transfer, and we make two main contributions. Our first contribution is at the network level. It is often argued that it is especially the informal communication structure within an organization that has great potential to contribute positively to the inter-unit process of transferring knowledge (Cross et al. 2002; Stevenson and Gilly 1991; Jablin and Putnam 2001; Madhavan and Grover 1998). Although our data supports this finding, we *also* find that the formal network forms a significant basis for the innovation network within a unit organization, and even more so than the informal network (see also Allen and Cohen 1969).

Our second contribution is the further specification of the ways in which the two networks – formal and informal – differ regarding knowledge transfer. Most research thus far has focused on establishing the importance of an actor's centrality in the network (Burt, 1992; Tsai, 2001) for knowledge transfer, and our data indeed underscores the significance of centrality for both the informal but especially for the formal network. We find important synergy effects for knowledge transfer between formal and informal ties, especially for intra-unit knowledge transfer. Formal ties without the support of informal ties are comparatively more conducive to inter-unit knowledge transfer than to intra-unit knowledge transfer.

Considering the contribution of the formal network to knowledge transfer, and given that formal relations seem to provide the basis on which informal relations develop (Han, 1996), these findings offer opportunities for management to influence knowledge transfer. Obviously, by mapping organizational networks as indicated an organization can anticipate possible disruptions of both the formal and the informal networks. The consequences of an employee's departure from the organization for communication and knowledge transfer networks can be assessed and dealt with better. Shaping formal networks in ways that are thought to contribute to a company's goals is

feasible and not necessarily in conflict with existing informal networks. Rather, informal relations may draw on formal ones, creating a related but separate path for, e.g., knowledge transfer.

Limitations. Needless to say there are some limitations to our study that should be acknowledged. Our sample size was relatively small, and the centrality measure especially may be skewed to some degree. Although we established the importance of the formal network for knowledge transfer, the actual mechanisms through which this takes place need to be explored more. Further research is needed to explore this issue, for instance by looking at the different brokerage roles that individuals in a network can adopt (Gould & Fernandez 1989; Fernandez & Gould 1994). Finally, there are also some factors that may limit the generalizability of our results. The organization we studied is part of a large multinational and, much like other large firms, has a fairly formal organizational culture (e.g. Pugh et al. (1969)). This may have contributed to our finding of the prevalence of formal ties, but we believe that it has not substantially affected our findings regarding the effect of formal ties on knowledge transfer. This is partly because people in the country where the subsidiary of the multinational is located are known for their aversion to hierarchical relations. Orders based on authority claims without providing supporting arguments are certainly not accepted per se, yet the role of formal networks is evident despite these a-hierarchical tendencies. Thus in our view the finding of the importance of formal networks for knowledge transfer and its synergetic effects with the informal network are not likely to be an artifact of our research setting. In short, we submit that the distinct as well as combined contributions of formal and informal networks and ties to knowledge transfer need to be studied more closely. Our findings suggest that inclusion of both these networks in future research can improve our understanding of what drives a firm's innovativeness.

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