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Inter-Organizational Knowledge Community Building: Sustaining or Overcoming Organizational Boundaries?

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Abstract: Various studies focus on general networks within and between organizations, but strongly focused studies on knowledge sharing through social networks and communities within specific domains that are of critical relevance to the R & D organization are hard to find. Therefore, the argument presented here is explored through an empirical case study on inter-organizational knowledge community building between different research institutes of the Fraunhofer-Gesellschaft, a large German organization for contract research in all fields of the applied engineering sciences. Expert knowledge communication and networking processes are evaluated by a multi-level approach. Institutionalization of knowledge transfer is studied with regard to the development of the informal contacts between the community members and the inter-organizational linkages on an aggregated level. The main focus is put on the relationships of knowledge exchange between the formal organizational boundaries and the informal inter-organizational network structures. Finally, this case study aims at further supporting the adaptation of methods from social network analysis for purposes of organization and management practice.

Key Words: knowledge communities, communities of practice, community building, knowledge networks, distributed knowledge management, knowledge sharing, social network analysis, empirical
Category: A.0, A.1, J.4

1 Background

Research into understanding expert knowledge communication within innovation processes has become a primary interest. Increasingly, the focus is put on inter-organizational settings and forms of network organizations. Hereby, the social perspective has emerged as a dominant paradigm in studies on organizational and inter-organizational knowledge sharing. A growing literature focuses on the socially-derived concepts such as communities and knowledge networks; see e.g., [Brown and Duguid, 91], [Collinson and Gregson, 03], [Lesser

et al., 00], [Liyanage et al., 99], [Powell, 98], [Seufert et al., 99], [Swan et al., 99], [Wenger et al., 02], on differences and similarities between these concepts see [Müller-Prothmann, 05b]. Basically, all these concepts assume that communities and networks provide a social context for the sharing of knowledge.

The basic idea of the institutionalization of social networks as intermediaries for knowledge transfer, particularly in the field of research and development (R & D) and innovation processes, is supported by various empirical studies. In the 1960s and 1970s already, researchers in business science started investigations in network structures of R & D laboratories; see e.g., [Allen and Cohen, 69], [Allen, 77]. In the 1980s and 1990s, research on intra-organizational networks in industrial enterprises excessively increased and lead to the general consensus that networks matter. While there are various studies on general networks within and between organizations, strongly focused studies on knowledge sharing through social networks within very specific domains that are of critical relevance to success and failure of R & D organizations are hard to find. Moreover, studies of social networks in the field of applied research are rare (only few studies can be found in the field of product development; see e.g., [Biemans, 92], [Gabbay and Zuckerman, 98]).

In this paper, inter-organizational community building in an R & D environment is explored through means of social network analysis, a sociological method to undertake empirical analysis of the structural patterns of social relationships in networks; see e.g., [Scott, 91], [Wasserman and Faust, 94], [Wellman and Berkowitz, 88]. It provides a set of methods and measures to identify, visualize, and analyze the informal personal networks which exist within and between organizations according to structure, content, and context of knowledge flows. Thus, social network analysis helps to deepen our understanding of knowledge creation, use, and sharing between experts in inter-organizational settings. The methods of social network analysis prove not only useful for academic purposes, but for analysis and support of knowledge communication in organization and management practice as well; see also [Müller-Prothmann and Finke, 04], [Müller-Prothmann, 05b].

2 Case Study

2.1 About the Case Study

The argument presented here is explored through an empirical case study on inter-organizational knowledge community building between different research institutes of the Fraunhofer-Gesellschaft, a large German organization for contract research in all fields of the applied engineering sciences. The Fraunhofer-Gesellschaft started activities for the sharing of expert knowledge by establishing a Knowledge Management (KM) Community. The patterns of communication

structures between the community members are studied through methods of social network analysis, including the following dimensions:

- intensity and relevance of contacts between the members,
- domain-related communication patterns,
- use of information and communication tools,
- importance of community activities with regard to general information exchange, transfer of specialized knowledge and expertise, joint projects and co-operation,
- relevance of community activities with regard to individual tasks of the community members and with regard to networking activities across organizational boundaries.

Data for the network study was collected through two on-line surveys at different points in time, the first shortly after a community meeting in October 2004 (=t1), and the second at the end of February 2005 (=t2). 38 of 56 people answered the questionnaire in the first network survey (t1), which equals a high return rate of 67.9 per cent. In the second network survey (t2), 35 of 56 people participated, which amounts to a return rate of 62.5 per cent. Names of network members have been replaced by numbers, grouped by affiliation to the different research institutes (headquarters and 17 research institutes). Expert knowledge communication and networking processes are evaluated by a multi-level approach taking into account whole network properties as well as specific structural characteristics and individual positions. A selection of the findings from this study is outlined in this paper to examine processes of inter-organizational community building and its contributions to sustaining or overcoming organizational boundaries.

2.2 Subjective Relevance of Knowledge Sharing

Relevance of the KM Community for knowledge sharing was rated by its members with regard to (1) general exchange of information and knowledge, (2) exchange of specialized knowledge and expertise, (3) joint project acquisition, and (4) co-operations and joint projects. Relevance of the KM Community is considered in t1 as being important on a medium level with regard to all four dimensions on a scale from 0 = “unimportant” to 4 = “very important” (mean 2.592). A slight decrease of relevance must be noticed during the evolution from t1 to t2 (-0.287), except for the dimension of joint project acquisition which gained some importance, although at a low level as well (+0.310).

Additionally, subjective relevance of co-operation and information exchange within the KM Community was explored (1) in general, (2) with regard to the personal work of the individual member, and (3) with regard to inter-organizational networking. With regard to these dimensions, the study points

to significant differences. While the participants rate the relevance of the KM Community with regard to their personal work on a medium level (mean 2.579), its importance in general (mean 3.211) and for inter-organizational networking (mean 3.447) is scored significantly higher. Here again, we notice a decrease at a low level from t1 to t2 with regard to all three aspects (-0.218).

Estimation of relevance of the KM Community for joint project acquisition and co-operations and joint projects are highly positively correlated (0.480^{**})[1] and thus indicate a closely related dimension. Moreover, relevance of the KM Community for general knowledge exchange is positively related at a significant level with relevance of co-operation and information exchange in general (0.553^{**}), exchange of specialized expertise with regard to information exchange in general (0.423^{**}) and with regard to individual work (0.446^{**}). And finally, relevance of co-operations and joint projects is positively correlated with co-operations and knowledge exchange in general (0.369^{*}), with regard to individual work (0.384^{*}), and with regard to inter-organizational networking (0.382^{*}). These correlations are intuitively plausible and prove validity of the answers. The latter especially points to the basic interest of the KM Community members into developing co-operations and joint projects across organizational boundaries.

2.3 Communication Media Use

Examination of the communication channels used within the KM Community clearly indicates a rank of media use as follows: 1. personal email, 2. telephone (including tele-conference), 3. meetings (including face-to-face communication), 4. mailing list, and 5. on-line platform. A more detailed look on communication media shows that daily communication is dominated by the use of telephone (21 per cent), followed by personal email (11 per cent), weekly communication is dominated by the use of telephone as well (42 per cent), followed by personal email (29 per cent), mailing list (26 per cent), and meetings (24 per cent), whereas monthly communication is mainly by the use of meetings (53 per cent), followed by mailing list (32 per cent). The on-line platform is rarely used (never used by 66 per cent). Frequency of contacts between the community members in terms of media use increased from t1 to t2 for personal email, telephone and meetings, while use of the community mailing list and on-line platform, although on a very low level in t1 already, decreased.

[1] ** significant at the 0.01 level (2-tailed); * significant at the 0.05 level (2-tailed)

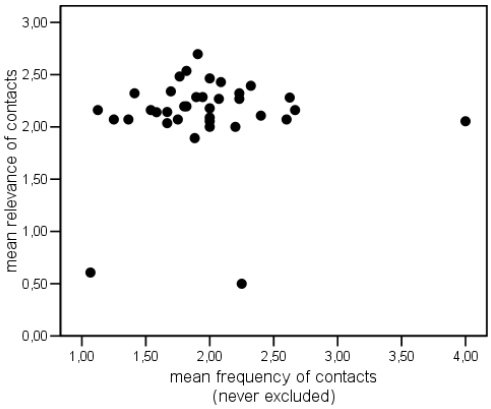

Figure 1: Frequency and Relevance of Contacts

2.4 Communication Network Characteristics

The network analysis of the KM Community distinguishes between (1) general communication relationships, based on frequencies of contacts, and (2) domain-related communication patterns. Analysis of the general communication network includes intensity and relevance of contacts between the members. Intensity of contacts between the members was measured in terms of frequency of contacts (0 = "never", 1 = "half-year", 2 = "monthly", 3 = "weekly", 4 = "daily"). Relevance of contacts was rated on a scale from -2 = "not relevant" to +2 = "highly relevant" (recoded for computational purposes to a scale with values from 0 to 4). Frequency and relevance of contacts are positively correlated with each other, except for two cases (mean 0.4909, std. dev. 0.2650). Generally, individual contacts are considered relevant on a medium to high level (see figure 1).

The general communication network in t1 integrates all actors, except for

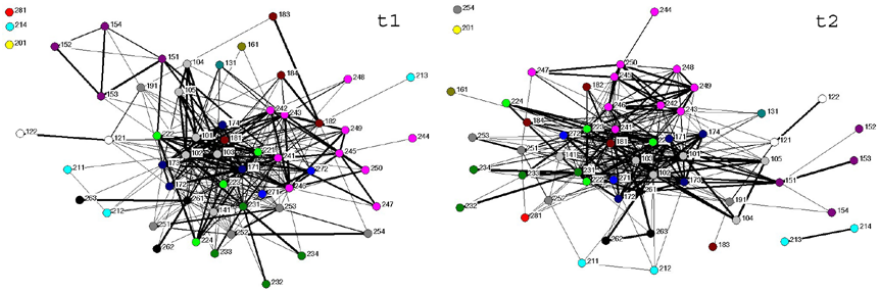

Figure 2: Communication Networks in t1 and t2

	t1	t2
centralization overall dichotomized network	0.4525	0.4114
centralization main component	0.4672	0.4282
density within main component	0.4311	0.4585

Table 1: Communication Network Centralization and Density

three isolates. In t2, the main component consists of all actors besides a dyadic component and two isolates (see figure 2). Centralization is on a medium level, decreasing marginally from t1 to t2, density within the main component is on a medium level, too, with a marginal increase (see table 1).[2]

Focusing on the ratio between internal (within the same research institute) and external (between the different research institutes) linkages, figure 3 clearly indicates internal dominance of more frequent contacts and external dominance of less frequent contacts. Nevertheless, we can identify a marginal shift to more frequent inter-organizational contacts from t1 to t2. Increase of boundary-spanning relationships is also supported by a marginal increase of the E-I index from t1 to t2 (see table 2).[3]

	t1	t2
E-I index	0.532	0.546
expected value	0.856	0.862
re-scaled E-I index*	-0.455	-0.434

* For given network density and group sizes the range of the E-I index may be restricted and therefore it is re-scaled to a range from -1 to +1.

Table 2: Communication Networks: E-I Index in t1 and t2 (isolates excluded)

[2] Network centralization, i.e. global centrality within a network, measures the degree to which relationships within a network are focused around a single or a few central network members; see [Freeman, 77], [Freeman, 79]. Density describes the global level of linkage of a network. Even if fully saturated networks are empirically rare (where all possible ties are actually present), measures of density look at "how closely a network is to realizing this potential" [Hanneman, 01].

[3] [Krackhardt and Stern, 88] introduced the E-I index as a normalized measure of the ratio between internal and external relationships. It measures the ratios between external and internal ties and normalizes them to a value within the range of -1.0 to +1.0. An E-I index of -1.0 would indicate that only internal relationships exist, while all relationships would be external for an E-I index of +1.0.

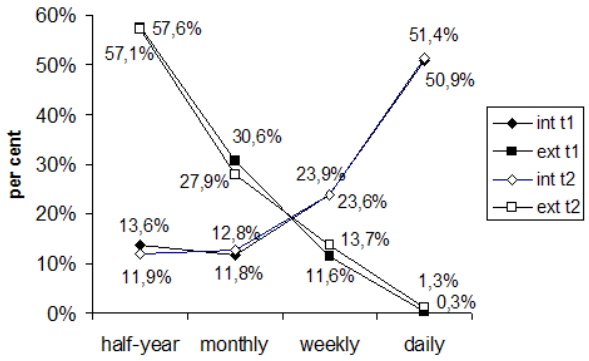

Figure 3: Frequencies of Internal and External Communications

2.5 Domain-related Knowledge Networks and Central Actors

In addition to the communication relationships in general, network characteristics were explored with regard to eight domains:

1. joint organization of events (e.g., Fraunhofer Forum, CeBit),
2. joint participation at events (e.g., conferences),
3. special-interest topics (e.g., research, dissertations),
4. new ideas, plans, and developments,
5. experience from finished projects (e.g., development of methods and solutions),
6. joint project acquisition,
7. working groups (e.g. "knowledge mapping", "co-operations"),
8. joint research (e.g. "market research")

Visualizations of the domain-related networks in t2 are presented in figure 4. Besides the main component and some isolates, actors 213 and 214 build an independent component in all domain-related networks in t2. Centrality of the domain related networks is in the average on a medium level (mean 0.4641, std. dev. 0.1243), while density is low (mean 0.1725, std. dev. 0.0250). According to our findings, domain-related network activities significantly gained importance during the period from t1 to t2: while only 17 members were present within the main component of eight different domains (and 21 people were not a member within the main component of any domain-related network) in t1, a multiplex main component consisting of 29 members (and only six people who were not part of any domain-related main component) can be identified in t2 (see figure 5 for the multiplex domain-related network in t2 collapsed to organizational blocks, i.e. members are aggregated to blocks by institutional affiliation, in principal component layout).

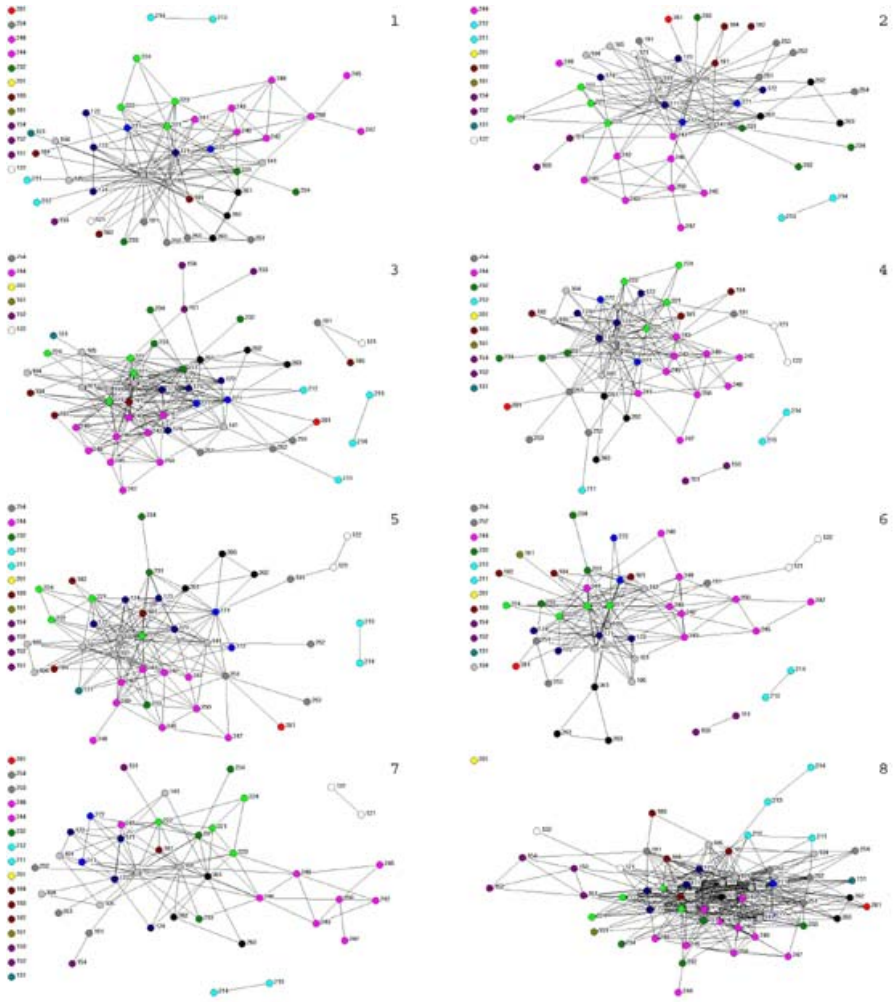

Figure 4: Domain-related Networks in t2

Taking a closer look at the characteristics of the domain-related networks and their network regions, we find 9 members from 5 different institutes and the headquarters within the k-cores of 6 or more different domains.[4]

[4] A k-core in an undirected graph is a connected maximal induced sub-graph which has minimum degree greater than or equal to k, i.e. every person within a k-core is connected to at least k other people; see [Seidman, 83]. (Cut-point positions are occupied by a variety of different members and build bridges between sub-groups that would otherwise have been cut-off and split into separate, unconnected components; but their analysis exceeds the scope of this paper.)

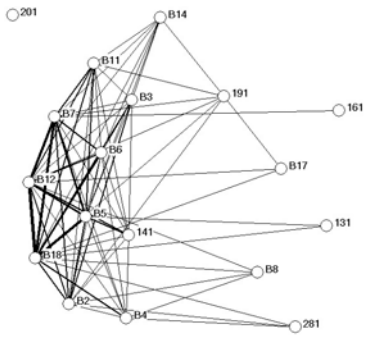

Figure 5: Multiplex Collapsed Domain-related Network in t2

In a next step, the central members of the domain-related networks are identified as those actors who have high scores of centrality according to degree and betweenness (degree and betweenness centrality $\geq$ 0.95 quantile).[5] We can find a small number of 9 actors from 4 different research institutes and the headquarters who have a central position according to these criteria within one or, for most cases, even more different domains.

The ratio between internal and external ties, measured by the E-I index again, varies strongly with regard to the different domains (see table 3). While internal orientation can be found for all domain-related networks, it is on a low level only for the case of joint research, followed by joint participation and organization of events and working groups, and on a higher level especially for the case of special-interest topics (based on the re-scaled E-I indices).

	domain							
	1	2	3	4	5	6	7	8
E-I index	0.407	0.343	0.412	0.358	0.367	0.380	0.271	0.231
expected value	0.854	0.847	0.860	0.853	0.846	0.856	0.844	0.782
re-scaled E-I index	-0.159	-0.114	-0.512	-0.342	-0.370	-0.294	-0.148	-0.077

Table 3: Domain-related Networks in t2: E-I Index

[5] Degree centrality is a measure of the incoming and outgoing connections held by an individual network member. "Degree centrality is a measure that helps to purposefully support individual members within a community" [Müller-Prothmann, 05b]. Betweenness centrality is a measure of the extent that a network member's position falls on the geodesic paths between other members of a network; see [Freeman, 77]. "Thus, it determines whether an actor plays a (relatively) prominent role as a broker or gatekeeper of knowledge flows with a high potential of control on the indirect relations of the other members" [Müller-Prothmann, 05b].

3 Conclusion

The results of the case study presented here focus on the integration of knowledge sharing within innovation processes into organizational practice. Through means of social network analysis they explore inter-organizational formation and utilization of expert knowledge, their social relationships and corresponding knowledge flows. Results presented here especially concentrate on the relationships of knowledge exchange between the formal organizational boundaries and the informal inter-organizational network structures.

Above all, findings suggest that community building may prove as an effective measure to overcome organizational boundaries, although relationships largely remain internally oriented. Institutionalization of inter-organizational relationships takes time, as the marginal changes within a period of approximately 4 months indicate. Nevertheless, the general communication network integrates almost all actors. A marginal shift to more frequent inter-organizational contacts and increase of boundary-spanning relationships can be identified. Furthermore, domain-related network activities significantly gained importance during the period of observation, although the ratio between internal and external ties varies strongly with regard to the different domains. Moreover, a small number of members is of critical importance and key to knowledge flows within the different domain-related networks. Findings of media use suggest, although at a low level only, to suppose that relationships between community members tend to be based on individual personal ties (personal email, telephone) rather than on institutionalized communication channels established for the sole purpose of the KM Community (mailing list, on-line platform).

To conclude, observed community evolution shows approaches toward boundary-spanning relationships. Based on the results of social network analysis, interventions and follow-up activities will be derived and discussed at the next KM Community meeting to further contribute to overcoming organizational boundaries through inter-organizational knowledge community building. These could include, for instance, integration (or separation) of isolated and marginally connected members, strengthening the positions of central actors as domain-related network co-ordinators, putting a stronger focus on primarily relevant domains, and providing network cores with additional resources.

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