Leveraging Boundary-spanning Knowledge Community Building

- Interventions from a Social Network Analysis in Inter-organizational R&D Environments -

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Abstract. *Knowledge exchange across organizational boundaries is of primary relevance for the success or failure of organizations, especially in R&D environments. Using methods of social network analysis, 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. The paper aims at exploring possibilities for interventions to facilitate and strengthen community building processes based on the results of the social network analysis.*

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1. Background

Social network analysis is a sociological method to undertake an empirical analysis of the structural patterns of social relationships in networks (see e.g. [Sco91], [WaF94], [WeB88]). 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 (see also [Mül05b], [MüF04]).

Various empirical studies support the basic idea to institutionalize social networks as intermediaries for knowledge transfer, particularly in the field of research and development (R&D) and innovation processes. Researchers in business science started investigations in network structures of R&D laboratories in the 1960s and 1970s already (see e.g. [AlC69], [All77]). In the 1980s and 1990s, research on intra-organizational networks in industrial enterprises excessively increased and lead to the general consensus that networks matter. Nevertheless, there is a lack of studies strongly focused on knowledge sharing through communities within very specific domains that are of critical relevance to success and failure of R&D organizations (on similarities and differences of the concepts of networks and communities see also [Mül05a]). 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, e.g. [Bie92], [GaZ98]).

2. Case Study

2.1 About

Here, the authors explore 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, in an empirical case study by means of social network analysis (see also [MSF05]). The Fraunhofer-Gesellschaft started activities for the sharing of expert knowledge by establishing a Knowledge Management (KM) Community with experts from all the different research institutes.

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. The patterns of communication structures between the community members are studied with regard to 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 cooperation,
- relevance of community activities with regard to individual tasks of the community members and with regard to networking activities across organizational boundaries.

2.2 Network Characteristics

The case study takes into account whole network properties, structural characteristics and individual roles with a specific focus on internal versus external orientation of relationships. 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. Here, a summary of selected results is presented to explain basic approaches for possible interventions.

In our case study, we distinguish between (1) the analysis of general communication relationships, based on frequencies of contacts and (2) communication patterns related to eight different domains, e.g. including special-interest topics, discussions of new ideas, plans, and developments, joint project acquisition or joint research.

The general communication network in t1 integrates all actors, except for three isolates. In t2, we can find a dyadic component and two isolates besides the main component (see figure 1). Network centralization of the main component marginally decreases from 0.4672 in t1 to 0.4282 in t2 and density marginally increases from 0.4311 in t1 to 0.4585 in t2, both on a

medium level.[4] Indicated by the measure of the E-I index as introduced by [KrS88], internal linkages within the research institutes clearly dominate the external linkages between the different institutes, with a marginal shift to more inter-organizational relationships from t1 to t2 (see table 1).[5]

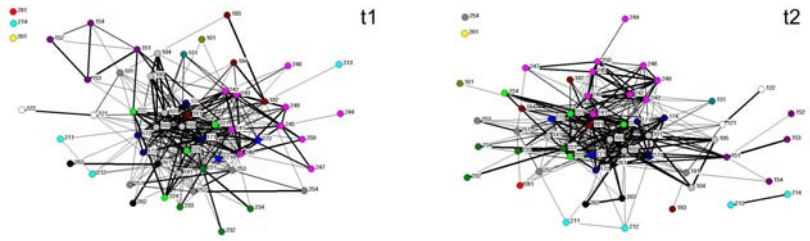

Figure 1: Communication Networks in t1 and t2

	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 size the range of the E-I index may be restricted and therefore it is re-scaled to a range from -1 to +1

Table 1: E-I Index in t1 and t2 (isolates excluded)

The networks related to a specific domain include different actors and vary in size, density, and centralization. Here, we must note that domain-related network relationships significantly gained importance during the period from t1 to t2, especially with regard to joined research activities. Taking a closer look at central regions and actors, we find 9 members from 5 different institutes and the headquarters within the k-cores of 6 or more different domains and 9 members from 4 different institutes and the

[4] 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].

[5] [KrS88] 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.

headquarters who have a central position based on degree and betweenness centrality (degree and betweenness centrality ≥ 0.95 quantile).[6]

2.3 Insights and Interventions

In our case study, we explore inter-organizational formation and utilization of expert knowledge, their social relationships and corresponding knowledge flows through means of social network analysis. Our findings suggest that community building may prove as an effective measure to overcome organizational boundaries. The overall communication network integrates almost all members and specific domain-related network activities especially gained importance during the period of observation of approximately 4 months. Nevertheless, institutionalization of inter-organizational relationships takes time, as the marginal changes indicate. Results of the network analysis can contribute to the development of clearly focused interventions to further facilitate the network relationships and strengthen the community building process across organizational boundaries.

Based on these insights, interventions could include

- better integration (or exit) of isolated and marginally involved members—or, alternatively, their exploitation in their role as "lurkers";
- promotion of central members within the community and with regard to specialized topics as coordinators or moderators;
- putting a stronger focus on topics of primary relevance;
- strengthening domain-related core-groups by providing additional resources.

Various follow-up activities, based on the results of the analysis, are undertaken already to further leverage the boundary-spanning knowledge community building process. The first, very basic but nevertheless very useful kind of intervention is to present the results at a follow-up meeting

[6] 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 [Sei83]. 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" [Mül05b]. 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 [Fre77]. "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" [Mül05b].

and discussed them with the community members themselves. As [CPB02] wrote, simply ask people to spend five minutes on their network visualisations and "to identify what they 'see' in the map, the structural issues impeding or facilitating group effectiveness, and the performance implications for the group". The presentation of results impressively demonstrated the integration of almost all community members, the primary role of a few central actors, and the strong connections established through a project of joint research, integrating a large number of members from different institutes. Thus, the positive feedback of the network analysis is used to develop more cohesion between the community members. Representatives from the different research institutes who have a central position within the network continue their role as active promoters of the community.

The primary importance of joint projects as a driver to strengthen inter-organizational relationships, impressively demonstrated by the results of the network analysis, leads to the initiatiation of follow-up projects and extended acquisition activities. These currently include, for instance, a client's demand for a joint project that involves three different institutes, which is an absolute novelty within the Fraunhofer-Gesellschaft. In addition, joint efforts are made to improve marketing instruments for the specification of the community's profile. These include a common website and printed catalog that describe the involved institutes and their offered services for potential clients. Activities of this kind will facilitate stronger commitment of the community members, create shared interest and help develop self-identity of the community.

The future agenda of follow-up activities based on the social network analysis must include developing rules of inclusion and exclusion. Currently, membership within the community is not regulated. Results of the network analysis show that individual members are not really included in the community's activities. In the future, these marginally involved members should be better integrated or excluded—or, alternatively, actively exploitated in their role as "lurkers", i.e. as external promoters within their institutes and as linkages to other external environments without strong engagement within the community. In any case, the community should become aware of the need to establish rules of membership.

Results of the network analysis also show a prominent role of the headquarters for coordination and facilitation tasks of the community organization. Since the community must become self-sustained in the future, members of the headquarters make efforts to successively withdraw their engagement as community coordinators. Selected community members from the various research institutes are encouraged to take more

initiative on their own. Especially with regard to this process, results of the social network analysis will help to identify the key players from the research institutes within the community and to promote them as coordinators or moderators with regard to their specialized domains of knowledge.

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 in R&D environments. In this paper, we could demonstrate that social network analysis provides a powerful tool to analyze social relationships within inter-organizational community building processes. Based on the insights of the social network analysis, interventions can be derived to facilitate communication processes and community activities, to strengthen boundary-spanning knowledge exchange and to increase the informal inter-organizational relationships. Therefore, we can conclude that social network analysis should become an integral method of organizational design and strategy to support processes of inter-organizational community building, communication and knowledge exchange.

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