

Analyzing Knowledge Networks in Organizations

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Abstract: Intellectual capital reports usually consist of descriptions of various non-financial capital forms, such as for example “relational capital”. Considering relational capital as knowledge networks we explain the creation, transformation and re-use of knowledge with the help of the theory of social systems where knowledge is seen as a cooperative social construction. As a method for visualizing and analyzing relational capital based on co-authorships and co-content, respectively, we present BibTechMon™ and conclude with suggestions how the results of the knowledge network analysis may be utilized in organizations.

Keywords: Knowledge Networks, Co-operation Structures, Intellectual Capital Report, Relational Capital, Collaboration, Social Systems

Categories: A.0, H.3.1, I.2.4

1 Introduction

Observing knowledge management activities during the last years, it is possible to draw the distinction between two approaches [McElroy 2003]: The first type focuses on knowledge sharing and proceeds from the assumption that valuable knowledge already exists. Its major task is to enhance the supply of existing knowledge to individuals in an enterprise by capturing, codifying and sharing valuable knowledge. “Getting the right information to the right people at the right time” is a common slogan in the knowledge management community. In the context of this approach, we frequently encounter the definition of knowledge as representation of a world independent of the observer. Knowledge is seen as a kind of package: true, objective, isolatable, transferable and storable in documents.

The second type focuses not only on managing the processes of capturing, codifying and distributing knowledge but – additionally – on the organization of knowledge production. It assumes that relevant knowledge does not already exist, but is continuously produced and revised in a social process. It compiles methods to enhance the capacity of an organization to produce and satisfy its demand for new knowledge. Within this approach, knowledge is defined as a dynamic social construction of reality dependent upon the specific experiences made by the individual [Foerster 1993, Glasersfeld 1997]. Relevant knowledge management activities from this epistemological point of view pay attention to existing collective

and divergent constructions of reality in an organization and define a framework to support the interactive process of knowledge production, transformation and reuse [Willke 1998, Krogh et al. 1999, Renzl 2003]. Further on, organizations are considered as complex social systems, which are self-organizing in the way they produce and integrate knowledge.

In this paper we consider knowledge as a social construction as stated in the theory of social systems. As an application we discuss intellectual capital reporting within the Austrian Research Centers describing relational capital in form of knowledge networks. Introducing BibTechMon™ for the analysis of the structure and the characteristics of such networks we will outline how knowledge management activities may benefit from the results.

2 Knowledge as Social Construction

Enterprises as autonomous, self-organizing systems are characterized by their autopoietic organization. Open to matter and energy they are at the same time operationally closed, which means closed to information, instruction, and control. Autopoietic systems adopt no information from the environment and deliver none to the environment, but produce images and conceptions of the reality according to their specific structure [Baecker 1999, Maturana et al. 1998]. One cannot inform a system, it informs only itself: it encounters incoming stimuli from its surroundings and shapes its response by invoking appropriate knowledge contained in its structure or rule sets. [Fischer 1991, Foerster 1993]. Information can't be transferred between systems, therefore information can't 'instruct' a system, but only 'initiates' internal changes. With Bateson, information can be defined as a difference which makes a difference [Bateson 1988] - in this sense information is to be read as the process of forming and shaping of the system.

As information, knowledge can't be seen as autonomous product that can be used and transferred arbitrarily. Knowledge enables to problem-solving actions and is based on the capacity for retrospection, on the discovery of regularities as well as on the embedding in patterns of experience. Heinz von Foerster has demonstrated with his principal of undifferentiated encoding that perception is the computation of descriptions of the world and that knowledge results from recursive loops of computation of computations, constructed by each person on the basis of his or her own experiences in interaction with others [Foerster 1993]. Knowledge can be examined only for its viability for someone in a concrete situation, but not for its universal and objective 'truth' or 'validity' in the scientific sense [Glaserfeld 1997].

In the context of managing knowledge in enterprises it is important to state that not just individuals hold knowledge but the organization itself constructs and stores knowledge. [McElroy 2003] describes the evolutionary process from individual to organizational knowledge: Individual learners co-attract one another on the basis of shared interests. They form communities of interest through which new knowledge of a collectively accepted kind is produced in collaboration. Some of this knowledge may be adopted by the entire organization in an organizational learning process. According to this, anchored organizational knowledge relies on the personal knowledge of their members, but it exists independently of the persons. Therefore, the content of organizational knowledge isn't formed by discrete knowledge particles,

which are explicitly documented or present in the heads of single employees. In contrast, the cross-linking of heterogeneous elements of knowledge, the intelligent shaping of linkage patterns as well as the attention for the necessity of circularity determine the special meaning of organizational knowledge for the enterprise [Willke 1998].

Against this background we can state: Efficient knowledge management has to deal with the supply of already existing knowledge as well as with the establishment of a framework which enhances the process of (re-)constructing shared knowledge. It is confronted with the challenge to find and adopt methods for intelligent creating, promoting and shaping of cross-linked cooperative knowledge structures [Renzl 2003, Reinhardt et al. 2004, Cross 2004].

3 Intellectual Capital Reports as Means of Managing an Organization's Relational Capital

Based on the understanding of knowledge given in the first chapter we will try to point out, how these ideas may be transformed in concrete knowledge management activities. Therefore, first, the issue of managing an organization's relational capital by means of Intellectual Capital (IC-) Reporting will be introduced.

3.1 Relational Capital

ARC Seibersdorf research, the biggest subsidiary company within the Austrian Research Centers, started to report on its IC and developed the ARC IC-model in 2000. It was designed to trace the knowledge production processes and knowledge flows of a research organization and integrates the classification of intellectual capital [Ohler et al. 1999, Schneider 1999]. Intellectual Capital in this model is composed by structural, human and relational capital.

Within the IC-Report of ARC there is a strong focus on the relational capital of the enterprise, which indicates all kinds of co-operations, contacts and alliances of a company as well as of each employee. One critical issue for improving reporting is to figure out crucial and meaningful indicators and the task how to interpret the generated information. Therefore the bibliometric method BibTechMon™ was introduced in the ARC IC reporting to make visible existing relationships of the staff and their extern partners [Kasztler et al. 2002]. BibTechMon™ is based on bibliometric methods for structuring information using co-word analysis [Kopcsa et al. 1998]. It supports the calculation of co-occurrences of words which means the common occurrence of words or groups of words in documents. For an easy interpretation of the derived relations these are depicted in bibliometric networks.

In the following chapters two examples of bibliometric networks representing various kinds of relational capital will be given (fig. 1). The analysis is based on all research-oriented results of ARC systems research (publications, lectures, patents, teaching assignments, theses, dissertations and habilitations).

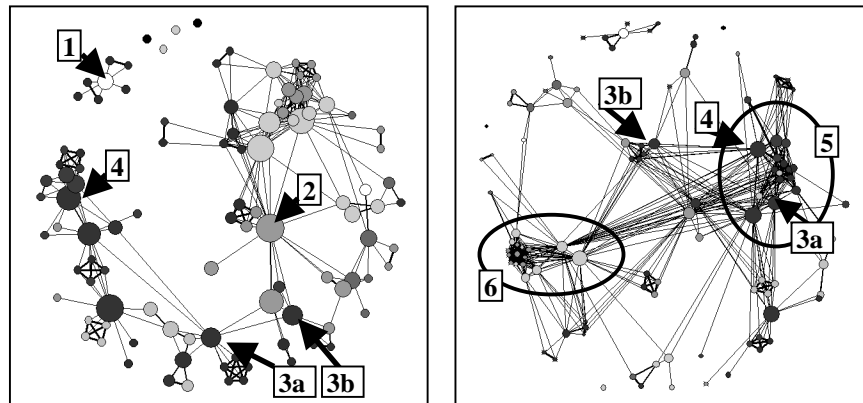


Fig. 1: Networks of authors based on co-authorships (left) and on co-content (right)

3.2 Networks of Authors based on Co-Authorship

The network of co-authors based on co-authorship (fig. 1) reveals the cooperation of authors through publications within ARC systems research and with external partners. As a basis for the co-word analysis authors of articles are chosen as co-words, which means that authors who published an article together are co-authors and therefore have a certain relation. The intensity of their relation depends on how many articles they published together.

The circles of the collaboration network represent authors of ARC systems research and their extern partners as well as those within the ARC holding. The circle size corresponds to the number of publications of the author it represents. The position of the circles and their connections show how intensively authors cooperate with each other. All members of a certain division are marked in a certain grey tone, partner institutes are marked in different colours depending on the type of the partner organization. The structure of the network describes the quantity and quality of co-operations between persons within the company and with their extern partners. Potential questions are e.g.: Who are the most relevant authors? Which differences of collaboration structures can be found within and between departments? How intensively is the organization linked to extern partners? How do the results vary over time?

For instance the author in the upper part of figure 1 (arrow 1) has a lot of extern partners but not a single intern one. He is a new staff member who isn't integrated in internal collaboration networks yet but is still part of his extern network. Arrow 2 marks the most visible author. She has the highest number of publications, partners within almost all intern departments and collaborates with many extern partners which belong to three different types of organization. Therefore she has the most central position within the network. Observing the (non-)interdepartmental co-operation, it can be stated that all authors in the lower left part of the network belong to the same department. They collaborate mainly with extern partners, barely with

each other and only with colleagues of their department. The two visible authors (arrow 3a and 3b) link this department to the rest of the organization by co-operating also with staff members of other departments. We also see that the authors 3a and 4 did not publish together, which will discuss later on.

3.3 Networks of Authors based on Co-Content

A second network (fig.1) describes the connection of authors depending on the vocabulary they use. Authors are linked together when they use the same words or word groups in their publications. This kind of network informs about the expertise of the staff within a company and enables getting in contact with the right person to establish new cooperation structures. These networks may e.g. deliver answers to the following questions: Which research topics are existent within the organization? Which of them are central themes and which are side issues? How broad is the spectrum of topics concerning a certain person or a group of persons? Who works on the same topic and who are the persons who link different topics? In which topics are external partners mostly involved? Can they be assigned to certain types of partners?

Authors 3a and 3b of the network based on co-authorship link their departments to the rest of the organization. From the network based on co-content we find out that one of them (3a) works on the same big topic as the rest of the department. He is therefore part of the important marked topic cluster (5). However, the other author (3b) has a completely different position as he links a lot of different themes within the network. He is not as focused on one topic as author 3a but covers a broader range of topics within his publications. Another ellipse (6) marks a large topic cluster revealing the main issue of the marked authors. It is the main task of their (and only their) department, nearly the whole staff of the department is involved with it. As the core experts of this topic we find a group of RTO partners.

As mentioned, the first type of network delivers information on existing collaboration structures and the second one reveals the topics on which authors work. By combining this information we find out if experts on the certain topic do work and publish together or if there exists parallel scientific work on the same topic. We have learned, for example, from the first network that the authors 3a and 4 do not collaborate. However, the second network shows that they work on the same topic. This may be an indication for parallel scientific work within one department.

4 Consequences for Knowledge Management Activities in Social Networks

The visualized collaboration networks contain much information about the relational capital of the company and can be analyzed from different points of view. In the concluding part of this paper we try to highlight the importance of a better understanding of intra- and inter-organizational networks for further knowledge management activities.

4.1 Relevant Knowledge

With the help of analyzing the network of authors based on co-content it is easy to gain information about active themes and expertise within the organization. At the same time it becomes apparent which fields of knowledge seems to be underrepresented and have to be elaborated from a strategic point of view. According to aspects of social systems theory [Baecker 1999], it lays in the responsibility of the management to enforce collective processes of introspection and self-reference within the organization to obtain knowledge about the self-images, prevailing mental models and constructions of reality in interdependency with other systems. This process of self description is essential to support the identification and selection of relevant organizational knowledge in order to avoid the potential randomness of knowledge creation.

4.2 The Scope of Knowledge

Organizational knowledge is social knowledge which has to be communicated to become effective. Knowledge can attain a kind of "objective" validity within a system when agreement is reached by communication. This implies that the range of knowledge is delimited by the range of communication. To be able to apply relevant knowledge, the problem which should be solved must be situated within the defined space of communication. At the same time relevant knowledge is stored via communication: only knowledge, which is repeatedly communicated, remains valid and effective. The analysis of knowledge networks visualizes the virtual space of communication of specific knowledge domains. This information is essential to decide about the strategic expansion or restriction of the range of communication which controls the access to sensitive knowledge within the organization.

4.3 Reconstructing Individual Knowledge

In order to enable communication of knowledge between partners it is inevitable to reconstruct individual knowledge. The network of authors based on co-content identifies generalists, specialists and key players of certain fields. On the other hand the network of authors based on co-authorships informs about the preferences of selected persons in working together with other colleagues: in the network they are depicted as single and rather isolated nodes (individualists) or as one node in a group of other nodes (team player). This might be useful information to identify the potential for cross-linking within the organization and to recruit staff members for a special task. It allows considering both intellectual as social competencies of the potential team members.

4.4 Multidisciplinary and Internal Variety

Visualizing the scope of knowledge points out to which degree the cooperation between organizational units in a specific field is common. Recent studies about underlying structures of outstanding international research centres show that a high variety in relation to the number of represented research disciplines leads to innovative and emergent research results [Hollingsworth et al. 2000]. In the case of projects, raising variety through people who hold experiences in different fields

improves the ability to recognize, observe and translate different mental models. “Constructive non conformity” as a positive force in business impacts the perspectives and experiences available for an organization.

4.5 Redundancy Enables Communication

To reinforce multidisciplinary thematic co-operations - spreading beyond departments or hierarchies - it may be one option to identify employees which are able to assume intermediary bridging functions by initiating and enabling communication between different knowledge domains and knowledge carriers. Those employees hold redundant knowledge about experts or processes in other organizational units. Redundancy raises variety and enables the coordination of members of these units. Shared experiences generate overlapping knowledge which provides the basis for communication. The carriers of redundant knowledge resemble something of a missing link between knowledge domains. In the case of the networks of authors these people may be identified as bridge spanning circles: two identifiable groups of authors are linked only by a single person. This may be the person who personally holds contact between two different organizational units by publishing articles together or he/she is the only person who works in a field which combines the specific terminology of one domain with another domain.

4.6 Internal and External Linkage

Information about important external partners highlights the strategic necessity of this cooperation in specific knowledge domains. Comparing the degree of internal and external linkage in selected fields, it becomes obvious which of these fields are treated as internal competencies and which of them are dependent on the help from outside. An organization gains valuable and even crucial knowledge through interpersonal relations between individuals in the organization and individuals in other organizations. This might be a great opportunity for hiring new employees, but also a critical instance of brain-drain by losing employees who find better jobs through the same contacts and networks with individuals in other organizations.

4.7 Time Perspectives

Observing the above presented applications over a longer period provides essential insights in the dynamical change of organizational knowledge networks. It will be obvious how topical competencies evolve in the organization and how contexts of individuals will change over time. Perhaps they appear in new knowledge fields, perhaps they attach to other knowledge networks inside or outside the company or perhaps they adopt a new role in the organization: being a team player becoming an expert, being an expert becoming an intermedator between different knowledge networks or vice versa.

5 Conclusions

Network structures as a result of the aggregation of co-operations and the interplay between them resemble the relational or social capital of an organization. In the

context of reporting and managing intellectual capital, relational capital is seen as an asset that can be actively and consciously accumulated and used by the organization. As relational capital is a critical resource the organization needs to be sensible of the factors necessary to create, nurture and govern it. The presented method shall be seen as a first approach to analyze a single segment of the social capital of an organization. It is obvious that besides this, social relations between the members of an organization rely on various processes and activities which proceed for other reasons.

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