Web 2.0 driven Open Innovation Networks

A Social Network Approach to Support the Innovation Context within Companies

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1 Introduction

Traditionally, almost all innovation related activities were located in a research and development (R&D) department, where dedicated specialists developed solutions in a more or less closed environment (Chandler 1990). Nowadays, learning to generate, refine, and develop ideas in an open or semi-open manner towards commercially valuable innovations becomes more and more crucial for companies to succeed in their markets (McGrath 2001). Trying to raise flexibility and to leverage external know-how, companies increasingly opened their innovation management in recent times to integrate external partners and customers into their innovation networks and value creation (Chesbrough 2003, von Hippel 2005, Reichwald & Piller 2006). The open source software industry stands for a very popular and successful example of implementing the Open Innovation (OI) paradigm, in the sense of distributed co-development (West & Gallagher 2006).

Nevertheless, one important group of potential innovators has been quite neglected in research and practice so far, namely the employees of c company. Those, at present, often only have the possibility to submit an idea to a physical or virtual mailbox. There hardly is any further interaction with the idea initiator or other contributors. In our approach, we seek to integrate all employees of a company into an open innovation network, which we refer to as internal open innovation network. An adequate information technology (IT) support system most likely allows for productivity growth (Bartel et al. 2007). So far, substantial knowledge and a considerable number of IT systems for traditional innovation management arose from both research and practice (Cooper & Kleinschmidt 1990, Ardilio et al.

2004). Additionally, user-centred and cooperation-oriented social software concepts and applications – like social networks and wikis (O'Reilly 2005, Ma & Agarwal 2007) – are promising for fostering open innovation. However, none of the existing web-platforms targeted towards OI explicitly addresses the unique challenges and potentials of internal open innovation. To fill this gap of knowledge the paper addresses the following research question: "*How can company internal open innovation be effectively supported with IT using social networking concepts and applications?*"

Building on, adapting and extending key results from the stream of prior research, we employed a design science approach. This allowed us to develop a productively used prototype of a social network based open innovation platform for internal OI. We proceeded in iterative loops to reduce aberrations and ensure the matching of our solution with the given problem. Describing this research, the paper is structured as follows: the next section positions our research against prior literature. We then describe our research methodology. Finally, we present our results – a validated concept and a prototypical implementation. We conclude by discussing the paper's findings and implications.

2 Theoretical Background

2.1 Innovation Management

With regard to the scope of collaboration in view of new product- or service-innovations, we distinguish between four approaches for innovation management. We classify these approaches along two dimensions: (1) The underlying paradigm which spans from closed (within one single domain of knowledge) to open (knowledge domain spanning) innovation, and (2) the sourcing decision which ranges from internal (within own company) to external (outside company boarders) innovation. These approaches and the associated key stakeholders are illustrated in Figure 1.

Originally, the research and development department of the own firm executed almost all innovation management activities (Chandler 1990), relying on dedicated specialists and their cooperation in an insular manner (*internal closed innovation*).

More recently, external research partners got attention (Gerpott 2005). These are located outside the company's borders and often involved as contractual network partners (*external closed innovation).*

Over the last years an opening of the innovation process occurred, which led to increasing innovation activities across the boundaries of enterprises and stakeholders. This phenomenon is described by terms like "interactive value creation" (Reichwald & Piller 2006), "democratizing innovation" (von Hippel 2005) and "open innovation" (Chesbrough 2003). It aims at value-creating collaboration with further stakeholders of a company in the view of creating, developing, distributing

and commercializing innovations in an interactive, distributed and *external open innovation* environment.

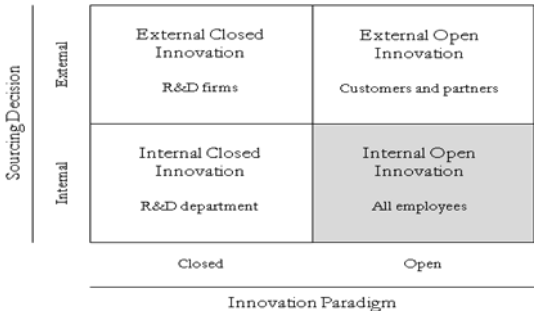

Figure 1: Scopes of Innovation Management

Prior research revealed a huge potential for innovation at the interfaces between classical organizational boundaries and between the spheres of single actors (Tsai 2001). It can be argued that the employees, as a major group of stakeholders, received too little attention in this discussion yet. Integrating all employees of a company and enabling them to contribute their comprehensive solution knowledge into the innovation process seems promising. They are familiar with the company and its culture. They form the link between internal R&D and external partners. Finally, studies of internal incubators and venturing organizations indicate substantial potential to influence a company's innovativeness (O'Connor & Ayers 2005). Hence, we focus our research on the IT support of *internal open innovation* management.

2.2 Innovation Context

Discontinuous new product and service innovations enable enterprises to grow and diversify (Tushman & Anderson 1986), but also show specific characteristics and requirements: They are characterized by a high technological and target market uncertainty, long development durations – often 10 years and more (Rice et al. 1998) – and high expenditures in research and development. Further uncertainties and risks arise from usually unknown time to market and insufficient market research, which is mostly limited to qualitative data (Gerpott 2005). Consequently, the innovation processes for these innovations are hardly linear. They occur rather sporadically and are affected by frequent stops and gos, where random changes in the environment and changes in the operating persons have a high influence. Additionally, there is not only one initial, but rather a recurring idea generation (Rice et al. 1998). There are often "[…] no clear rules […] high tolerance of ambiguity […] fuzzy, emergent selection environment […] operating patterns emergent and "fuzzy" […] weak ties and peripheral vision important" (Phillips et al. 2006, p.181). Taking all these factors into account, discontinuous innovation projects resemble

more a trial-and-error-process (Gerpott 2005), than a linear stage gate process (Cooper & Kleinschmidt 1990). Discontinuous innovations also have a higher degree of context sensitivity and context dependency. This context – manifesting in shared stories, experiences, enterprise culture, personalities and informal networks – has high influence on the project success (Rice et al. 1998).

Thus especially discontinuous innovation processes can profit from enabling interactive, collaborative, but geographically distributed cooperation of multidisciplinary actors. Flexible and iterative process phases, supported by situated tools for the creation, development and evaluation of an innovation concept are required, instead of linear, pure workflow driven models. An IT system supporting this interaction must model and incorporate the shared context of the innovators. For example, it is reasonable to assume that the innovation environment for discontinuous open innovations can profit from an evolving model of the (social) innovator network. This shall foster the awareness of the participants (Richter & Koch 2008), empowering effective open innovation networks within companies.

2.3 Context Support Model

The consideration of the social context and social software paradigms, especially Social Networking Services (SNS), offer huge potential for open innovation systems, which aim at supporting the development of discontinuous innovations within a company. Richter and Koch (2008) developed a model to illustrate six basic functionality groups in SNS-applications, which can basically also be found in our application: *Identity management* enables a user's self-presentation to a broad community and (together with *contact management,* which addresses functionalities to manage the personal network) is beneficial with respect to a browsing based creation or supplementation of innovation networks. *(Expert)search* enables both searching the network for explicit criteria and pro-active recommendations from the system. According to Richter and Koch (2008) as well as Kramer (1999) *context awareness* aims to strengthen mutual confidence among the users through the creation of sensitivity for a common environment. (Push or pull-based) *Network awareness* encompasses the knowledge of and sensitivity for states, activities and needs of colleagues, which is an important aspect in the OI-support setting. Finally, *common exchange* aims at providing spaces and technological tools for all users to interact, which needs to be further adapted for the OI support case.

3 Research Methodology

Given the lack of prior research on IT support for internal open innovation, we decided to use a design science approach, which seeks according to Hevner et al. (2004, p.75) "to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts." Our goal is to fill this gap of knowledge

with the contribution of a purposeful IT artifact – a productively usable prototype for the described problem domain of internal open innovation – and "to bridge practice to theory rather than theory to practice" (Holmström & Ketokivi 2009, p.65). To thereby ensure its scientific value added, Hevner et al. (2004) proposed seven guidelines, which are related to steps of our approach in Table 1.

Table 1: Design Science Research Guidelines and Descriptions (Hevner et al. 2004) and Corresponding Research Project Activities

Guideline	Description	Corresponding Activities
Design as an artifact	Design science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.	Prototypical implementation of an open innovation platform; instantiation productively used within a company environment.
Problem relevance	The objective of design science research is to develop technology-based solutions to important and relevant business problems.	Integration of all employees into open innovation with IT (e.g. to stimulate creativity and support the innovation context).
Design evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.	Data (e.g. log-files, business data) and experiences (e.g. workshops, interviews), gathered from a pilot group of users within a company piloting the prototype.
Research contributions	Effective design science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.	Design artifact in the sense of a validated open innovation IT system (social network based web-platform).
Research rigor	Design science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.	Distributed prototype development coordinated through version control system (Subversion) and developers' wiki; Grounded Theory and desk research to elicit requirements; interviews, workshops, questionnaires for validation.
Design as a search process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.	Iterative loops for elicitation, refinement and validation of requirements and prototypical instantiation.
Communication of research	Design science research must be presented effectively both to technology-oriented as well as management-oriented audiences.	Continual presentation to and discussion of business and the technological solutions with industry and research partners.

Initially the grounded theory method helped us to define the boundaries and scope of our research, guiding the search for relevant categories and concepts in the empirical data to be translated into software components. The implementation of this method is characterized by an iterative process (Pandit 1996). This is particularly reflected in our procedure for data collection and analysis as well as the collateral iterative development of the prototype. Theory served for the purposes of

conceptualization and practical problem solving, guiding and enabling our intended theory building process (Glaser & Strauss 1967, Holmström & Ketokivi 2009).
The developed and described IT system is part of a university-spanning common research project, which aims at providing a holistic concept to enable and support open innovation within companies. This paper deals especially with the IT-based context support, which proved to be highly relevant for the creativity and development phases of an idea. For these aspects activities and results with regard to the platform development are described.

Over the whole project duration of 19 months (state August 2009), we conducted so far *20 dedicated in-depth interviews* with our partner company to gather, refine and validate our requirements and to align our partners with the overall project.

During this period, *four project meetings* with the whole project team and (industry-spanning) company partners were held, addressing two major goals. First, we aimed to build a detailed understanding of the business domain and elicit specific requirements. Second, we presented and discussed potential solutions, in the form of concrete concepts and prototypical implementations. This helped us to establish a common understanding, central guidelines for further development and to ensure that the project remains on track, by defining and reviewing milestones.

Furthermore, we came together for *four internal research and concept workshops* within the project team. Taking both technical and business perspectives, we discussed and enhanced our concepts and prototype, matching business needs with methodological concepts and their implementation.

After our prototype was mature enough, we implemented an instantiation to be used by one of our partner companies, engaged within the IT service sector. Here, we work with an internal team of approximately 20 multidisciplinary employees, seeking to develop innovative solutions for a new business field. We held *three tool workshops* with a pilot group of users. Our goals were to introduce the platform, mitigate starting barriers, train the users on the software and receive feedback on the overall usability as well as on concrete functionalities. The feedback helped us to further enhance the quality and performance of our prototype.
During the whole project we conducted *several (partially virtual) internal workshops*, which we used to test and evaluate the logic and functionality of our prototype. This helped us to discover and solve technical issues as well as to develop new concepts and solutions. In addition to this data, we continually collected and analyzed *further data for triangulation purposes*. This included workshop materials, log files and meeting protocols. Further, we received project and status presentations as well as tool documentations. This helped to increase the reliability of our findings.

4 Open Innovation Platform

4.1 Elgg –Framework

After analyzing several case studies in the field of Social Networking Systems (e.g. Bryant 2006), we decided to use the open source web-based social networking framework Elgg (Elgg 2009) as core for the application's prototype. It proved to be a stable and productively usable framework, with a structure flexible enough to adapt it to our requirements.

Following our design science approach we selected, modified and enhanced components of Elgg's data model and basic functionalities. This allowed us to experiment with different settings and to quickly implement new concepts and functionalities acquired from the workshops.

4.2 Context Functionalities

Adapting the core system to support the open innovation context within companies, we identified application scenarios and transferred them into concrete functionalities. As central component of the OI-platform, the concept of shared workspaces called "innovation" is introduced. From our conceptual point of view, an innovation is associated with a group of employees (innovators) and a common thematic context (comparable to a profile), which provides further functionalities to search and co-develop ideas. An innovation encompasses several metadata attributes (e.g. textual descriptions, tags). Within an innovation, creativity is supported by a virtual whiteboard (referred to as "creativity tool") that allows for the synchronous appliance of multiple collaborative creativity techniques within separate sessions. As supported creativity techniques we chose, due to practicable application in business environment (Fernald and Nickolenko 1993), (anonymous) Brainstorming, Assumption Reversal, Brainwriting 6-3-5, the Morphological Analysis, the Osborn checklist and the Random Stimulus technique. On the whiteboard, an idea is represented in a card-like style, containing texts, images and drawings. A basic set of operations (create, modify, resize, move, copy, delete) can be used on the ideas. When a session is completed, the generated ideas can be pushed on demand into the innovation workspace.

To further develop the innovation (as well as its allocated ideas and problems) and foster collaboration, a set of supplementary development- and (global) awareness tools is provided. An overview and categorization, according to the functionality groups of SNS (compare section 2.3), is shown in Figure 2.

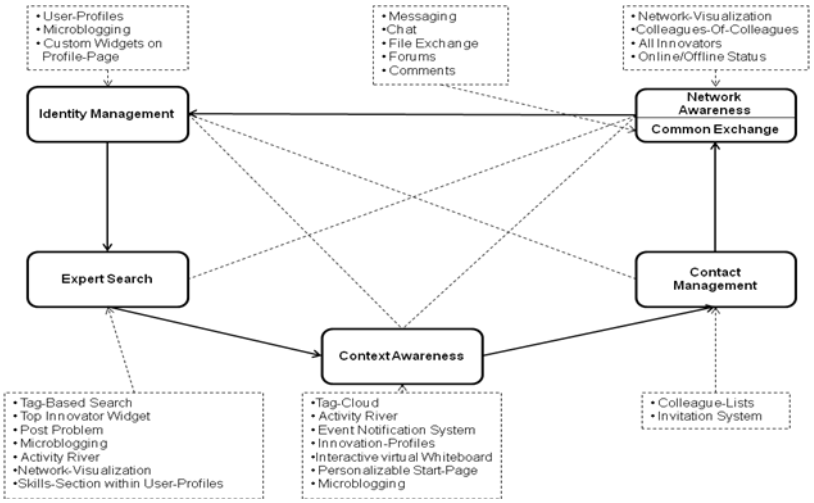

Figure 2: Overview of Context Functionalities on the OI-Platform (in the style of Richter & Koch 2008)

Context awareness

A *tag cloud* widget visualizes assigned tags and links them directly to related search results. The importance of tags is visualized by their display-size, dynamically increasing relative to their frequency, which supports (content related) context awareness. Furthermore, colleagues' and groups' activities are listed by the *activity river*, facilitating the sense for "what's going on" around an individual. These events are also propagated by the *event notification system* to interested users. Each innovation has one central *innovation profile*-page, where all related information is integrated (Figure 3), supporting awareness for a common topic related context. This sense for a common workspace is also facilitated by the *interactive virtual whiteboard* for applying creativity techniques. As many creativity techniques for idea generation often induce a rather tight temporal process, the context awareness mechanisms in our whiteboard aim predominantly on giving synchronous feedback to the participants (e.g. via real-time visualized user activities). Further mechanisms create mutual transparency during editing or moving ideas (e.g. portraits of editing people, fading in of new ideas, visualization of idea movement). Thereby we try to counteract the phenomenon of social loafing, where group members engage less than they could, due to feeling isolated or too submerged (Shepherd et al. 1995). The *personalizable start-page* enables users to customize the information displayed according to their contextual needs. *Microblogging* allows providing own and watch others' current state and thereby spanning a common context.

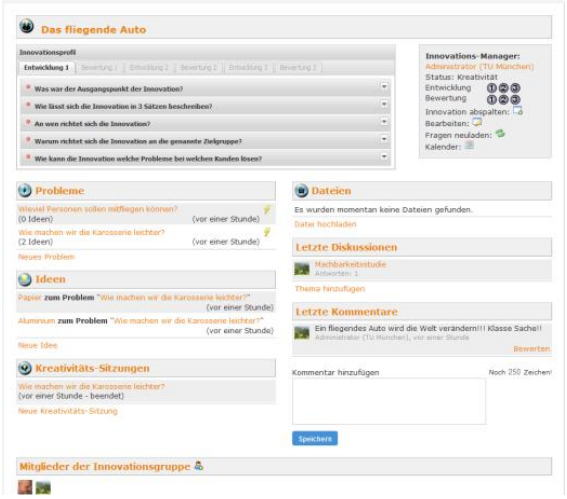

Figure 3: OI-Platform, Innovation Profile

Contact Management

In regard to contact management a *list of colleagues* and the related colleague-list-widget are implemented. Here, as well as within an innovation, an *invitation and membership system* regulates confirmations and access. Users wanting to see content or contribute to an innovation need to get members at first, joining ("open" groups) or accepting an invitation ("closed" groups with confidential content).

Network awareness

Supporting network awareness on a global level a tool called "NetStream" (Figure 4, images anonymized) *visualizes global network structures*, like user-to-user and user-to-innovation relationships, in a graph-like view. It is based on the spring-embedder paradigm and indicates own and others' contacts as well as the strengths of the relationships between them. Furthermore, a centrality measure, the shortest path betweenness centrality, is calculated for users (vertices) and their (*colleagues-of-colleagues*) relationships (edges). More central nodes are drawn bigger then less central ones. The usefulness of showing such values in the visualization is shown at Dwyer et al. (2006, p.1), as "it measures the importance or prominence of the actors in a social network". Micro-profiles provide direct links to the users' personal profile-pages. In addition to user-user relationships, several other elements, like innovations, related ideas and problems can be switched on. All these measures are intended to support social context sensitivity as well as another display, showing a list of *all innovators* (employees) on the platform, as well as their individual *online/offline status*. Thereby relevant co-developers can be found (e.g. according to their expertise and interests) and initially contacted.

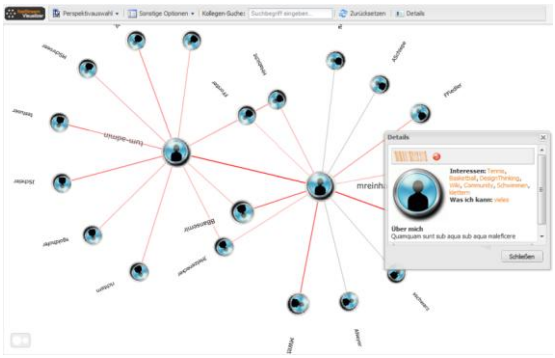

Figure 4: Social Network Visualization with Edge and Vertex Centralities

Common exchange

To support common exchange an internal user-to-user *messaging system* is integrated. The system also allows to forward messages to other customized channels like e-mail or SMS. During creativity sessions on the virtual whiteboard, direct synchronous communication in form of a *chat* feature is available to all active users. Within an innovation, the *exchange of digital information* like files and documents is supported. This innovation related exchange and storage is especially important for companies, as they need to attach existing documents to the workspaces. Therefore we created an innovation-specific file-pool. As the development of an innovation is, compared to the generation of ideas, more an asynchronous and pensive process, discussion *forums* serve as topic-related instrument for users to exchange thoughts and opinions. For allowing to a more direct influence on the innovation itself in form of the expression of thoughts and hints, a *comment system* is implemented on the profile-page. Every user is allowed contribute up to 250 character long comments. Further, it proved to be valuable to rate the other employees' comments, as this mechanisms helps to ensure a standard of quality.

Identity Management

Many requirements with regard to identity management could be met by adopting functionalities from the Elgg-framework itself. We added custom profile-parameters for business information (e.g. department, personal skills, personal interests, and contact information). *User Profiles* allow people to present themselves, their interests and skills – valuable data for colleagues searching for co-developers' support. To ensure privacy, each user can set fine-granular access restrictions on each profile parameter. Further, *microblogging* enables current personal status information (e.g. "mulling over…"). Customizable mini-applications, so called *widgets*, allow for individualizing the *start- as well as profile-page* according to personal interests, via a drag and drop mechanism.

Expert search
A core function in addressing expert search is the *tag-based search* mechanism already included in the Elgg-framework, e,g supporting searching for colleagues by their competencies and skills. A *top innovator widget* displays recent information about the most productive users in the community. Within an innovation, the possibility to *post problems* (e.g. through *microblogging* or comment system) gives people the ability to explicitly search for helpers. Simultaneously, each user can post important questions or needs, visible for others (e.g. by the *activity river system*) through a personal status widget. Furthermore, the *network visualization* (e.g. based on their connection to colleagues or ideas) and the skill section within the user profiles can be used to identify experts.

5 Discussion

This approach shows how open innovation management within companies can profit from supporting the social context of innovations, using customized Web 2.0 social networking services. Building on prior literature as well as concrete requirements from practice, we employed a design science approach to develop a prototype of an open innovation platform. Addressing this prior gap in research, our research leads to theoretical and practical implications for supporting the company wide innovation management with social network based applications:

A shared context is notably important for the co-development of discontinuous innovations and can be effectively supported through IT, especially social software. To make a valuable contribution, employees must be aware of situation specific needs and developments in multiple environments (e.g. projects, company, customers).

Further, even though IT holds significant potential to leverage information integration and sharing, transparency and location spanning collaboration, it shall neither replace nor supersede offline activities and events. Depending on the company culture, those might be equally important, e.g. to initially motivate and build trust within the network and its single actors.

These implications for practice must be viewed in light of some limitations of the paper:

First, seeking to generalize our findings, the developed software platform should be instantiated into further company contexts. Creating concrete use cases and putting it to the test in other companies shall help to clarify, if the approach is general enough, to work in different industry environments.

Next, it will be interesting to measure, which tools are used at certain points during idea creation and innovation concept development. So far, we deliberately provide all tools at any time during the innovation process to allow the user for the opportunity to select the personal best liked and situated tool. It remains to be

clarified, if a restricted set of tools enhances the focus, by guiding through a more structured process.

Third, our evaluation involved a group of 19 employees plus approximately 10 researchers. We assume from several interviews that an increasing number of active users will further enhance the usefulness of the social network, as the system will unfold its full potential (e.g. searching co-developers based on their skill profiles) with a larger number of users. Accompanying to this user growth, it is necessary to observe, if awareness and performance can be still assured.

Finally, the privacy mechanisms are crucial, answering to questions as: do employees feel observed by the provided tools? People could feel observed by collegues that are higher in the companys hierarchy. As one of the interviewees stated "Sometimes I wish more anonymity for myself".

Respecting these limitations, our prototypically validated concept for the social network based context support contributes to the company internal creation and development of discontinuous open innovations. It shapes an IT supported collaborative environment, in which ideas of multidisciplinary and geographically distributed actors can incubate and grow into innovation concepts. Simultaneously, it fosters transparency with regard to the innovation centered integration of people and information flows. Thus our work addresses both companies and researchers, as it enables an interactive and open innovation management, offering an integrative and flexible web-based platform.

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