Leveraging customer knowledge in open innovation processes by using social software

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1 Introduction

“Never do anything yourself that others can do for you” Hercule Poirot once said to his capable valet, George. In search of a breakthrough during a very demanding case, Hercule was referring to what he does to pay for his living: investigate crime. Today, the applicability of this saying is not restricted to situations similar to the one the Belgian detective found himself in, when he was in need of other detectives to solve a certain case. It is also very much applicable to the way how an increasing number of organizations are handling their search for the next breakthrough in innovation.

Why should an organization spend time trying to understand the demands its customers have, when some of those customers can provide a direct answer to it? Why should an organization create a suitable supply to such demands, when there are customers who are willing to do that for them? For decades, innovation has been a closed task, achieved by experts in internal R&D facilities. Nowadays, only few organizations can maintain their competiveness and innovativeness by focusing only on internal sources (Powell, Koput, & Smith-Doerr, 1996).

Involving customers in the creation and design process of new products and services has been discussed in practice and research since the early 1980’s. As one of the first researchers, von Hippel (1986) shed light on the concept of Lead Users, a group of users who are able to provide most accurate data on future needs for organizations. Subsequently, many scholars emphasized different areas of contribution for customers and how they provide assistance to the process of innovation.

First of all, customers may contribute to product innovation (Cooper & Kleinschmidt, 1987; Driessen & Hillebrand, 2013; Füller & Matzler, 2007; Gruner & Homburg, 2000; Sawhney, Verona, & Prandelli, 2005; Snow, Fjeldstad, Lettl, & Miles, 2011; Yang & Rui, 2009) and service innovation (Abecassis-Moedas, Ben Mahmoud-Jouini, Dell’Era, Manceau, & Verganti, 2012; Alam, 2002; Chesbrough, 2011; Larbig-Wüst, 2010; Magnusson, 2003; Paton & Mclaughlin, 2008; Shang, Lin, & Wu, 2009; Silpakit & Fisk, 1985), e.g., by co-creating values (Prahalad & Ramaswamy, 2004), such as concepts or designs as well as reviewing and testing them throughout the stages of the process of innovation. From the customers’ point of view, being involved in innovation processes and becoming a part of the organization is a desire of an increasing number of them. Customers are demanding more individual and more tailored products. They are increasingly knowledgeable and capable of designing and producing their own products and services. Due to the fact that their influence on product development is positively related to the quality of the new product (Sethi, 2000), more and more organizations appreciate them as innovation actors and are willing to pay them for their input. Today, customers are not only involved in the qualification of products (Callon, Méadel, & Rabeharisoa, 2002; Callon & Muniesa, 2005; Grabher, Ibert, & Flohr, 2009) but also allowed to customize and evaluate them on the path to innovation (Franke & Piller, 2004; Piller & Walcher, 2006; von Hippel & Katz, 2002; von Hippel, 2001).

Moreover, there is an abundance of studies that stress the customers' influence on effectiveness (de Luca & Atuahene-Gima, 2007; Kleinschmidt & Cooper, 1991; Kristensson, Matthing, & Johansson, 2008; Still, Huhtamäki, Isomursu, Lahti, & Koskela-Huotari, 2012) and risk (Bayer & Maier, 2006; Enkel, Kausch, & Gassmann, 2005; Enkel, Perez-Freije, & Gassmann, 2005). While the latter comprises the risk of customer integration as well as the customers' influence on market risks, e.g., during new product development, studies on effectiveness are mostly concerned with customer-orientation and products/services in line with customers' expectations (Atuahene-Gima, 1996, 2003; Fuchs & Schreier, 2011).

The accompanying change in understanding became known as open innovation (OI; first coined by Chesbrough in 2003) and represents a paradigm shift, where organizations switch their focus from internally generated innovation (i.e., ideation, in-house R&D, etc.) toward external knowledge and open innovation processes, thus, allowing them to integrate external ideas and actors, i.e. customers (Chesbrough, 2006) and other external stakeholders (Laursen & Salter, 2006). Since then, OI has been identified as a success factor for increasing customer satisfaction (Füller, Hutter, & Faullant, 2011; Greer & Lei, 2012) and growing revenues (Faems, De Visser, Andries, & van Looy, 2010; Mette, Moser, & Fridgen, 2013; Spithoven, Frantzen, & Clarysse, 2010). In addition to that, by opening their doors to external experts and knowledge workers (Kang & Kang, 2009), organizations cope with shorter innovation cycles, rising R&D costs, and the shortage of resources (Gassmann & Enkel, 2004).

Parallel to the paradigm shift in innovation, another shift has taken place in information and communication technologies (Kietzmann, Hermkens, McCarthy, & Silvestre, 2011). Only a few years ago, when customer integration was still very costly, companies had to fly in customers, provide facilities onsite, permanently assign employees to such activities, and incentivise each task executed by customers. Today, emerging technologies (subsumed under the term 'social software') help integrating customers or other external stakeholders, who are increasingly familiar with such technologies from personal usage experience (Cook, 2008), and grant them access from all over the world in a 24/7 fashion. Examples include blogging tools, social networking systems, or wikis. These technologies help organizations to access customer knowledge, facilitate the collaboration with customers (Culnan, McHugh, & Zubillaga, 2010; Piller & Vossen, 2012) at reduced costs and allow them to address a much larger audience (Kaplan & Haenlein, 2010). On the other hand, customers can now express their needs in a more direct way to organizations. However, each technology or application category may present a completely different benefit to the process of innovation or parts of it and, thus, the innovation itself.

Reflecting these developments, organizations need to know two things: *how can they exploit the customers' knowledge for innovation purposes* and *how may the implementation of social software support this*.

This synopsis summarizes the results of four essays each covering central facets of the above-mentioned thematic area. Together, this synopsis and the four essays form a cumulative dissertation. The essays are each independent but due to the course of research represent interwoven studies:

- Essay 1: The Role of External Knowledge in Open Innovation – A Systematic Review of Literature,
- Essay 2: External Knowledge in Organisational Innovation – Toward an Integration Concept,
- Essay 3: Idea Mining – Text Mining Supported Knowledge Management for Innovation Purposes, and
- Essay 4: How do Tasks and Technology fit? – Bringing Order to the Open Innovation Chaos.

Hence, this research addresses the integration of customers in organizational innovation, i.e. new product development. It addresses how and why firms activate customers for innovation and which contribution customers provide to the process of innovation. Additionally, it investigates which tasks customers may take over in open innovations projects and which strategies organizations may choose to do so. Finally, it also addresses which social software application supports each task best and how organizations may select the most suitable application out of a rapidly growing number of alternatives.

The nature of this research is recommendatory and aims at designing a solution for organizations that are interested in the potential contribution of customers during innovation, already involve customers in innovation tasks or plan to do so. Following the recommendations of this research should result in a more effective organizational exploitation of customer knowledge and their workforce and, thus, a value added to innovation and the outcomes of the process of innovation, e.g., a product that better fits the customers' expectations and demands or consequently a better adoption of the product by the customer.

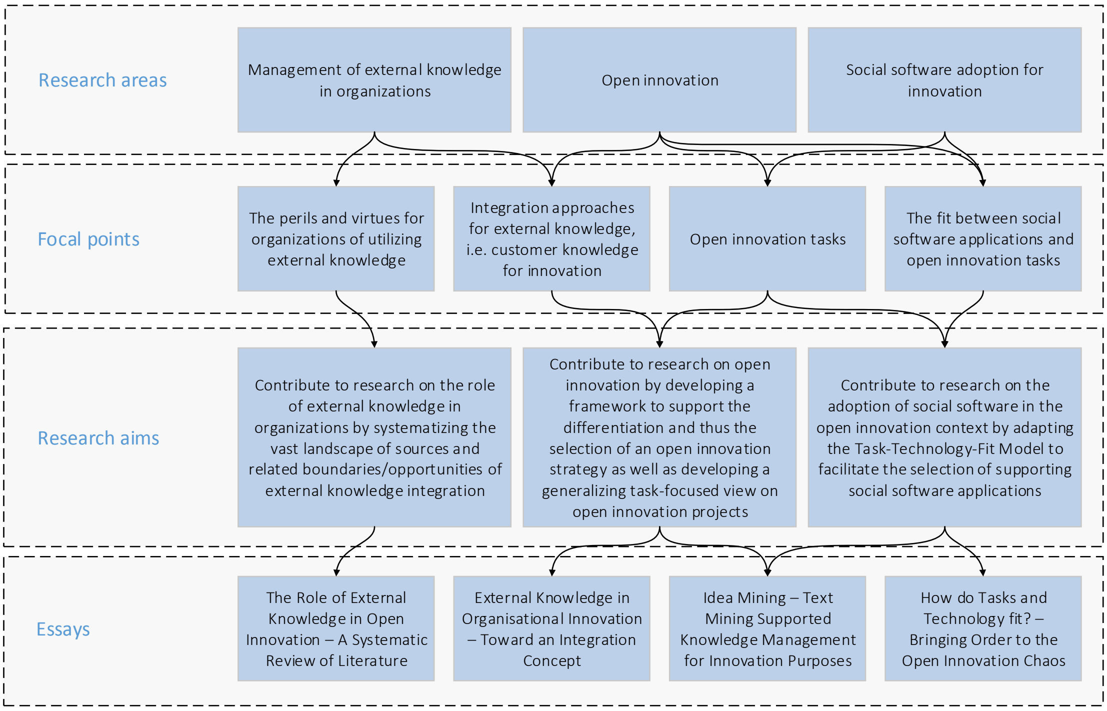

Figure 1. Connections within the doctoral thesis

Borrowing its structure from Lovász-Bukvová (2012), this synopsis outlines the overall course of research of this doctoral thesis and illustrates its underlying research aims. It also summarizes methods and findings of the four essays and points out common focal points. This thesis bases on a constructivist understanding of reality (see section 2) and is associated with three different research areas: management of external knowledge in organizations, open innovation, and social software adoption (see section 3). In correspondence with these areas, four focal points were identified: the promises and perils for organizations of utilizing external knowledge, approaches to integrate external knowledge, i.e. customer knowledge for innovation purposes, open innovation tasks, and the fit between social software applications and open innovation tasks. Following this, the research aims of this doctoral thesis are (1) to systematize the vast landscape of potentially beneficial external knowledge and its sources, (2) to investigate and systematize integration approaches with a focus on current open innovation projects and strategies, (3) to develop a task-oriented picture of these approaches, and (4) to conclude with a recommendation for selecting the best-fitting social software application to support open innovation tasks (see section 4). Each part of this doctoral thesis was covered by a unique study that addressed each aim using different scientific methods (see section 5). In the end, this synopsis summarizes the findings (see section 6) of each part of the thesis by providing a holistic view on how to leverage customer knowledge in open innovation processes by using social software and concludes with contributions and implications for research and practice (see section 7). Figure 1 illustrates how research areas, focal points, research aims, and essays are connected.

2 Theoretical foundation

Although the epistemic positioning of a researcher is often referred to as a determinant for her/his methodological orientation, the author did not interpret his orientation as a restraint during the selection and application of certain scientific methods (Scholl, 2010; Smaling, 1994). However, to make sure that the author's position remains visible to everyone and through this disclosure helps others to develop a common understanding as well as the necessary context for interpreting the results, this section points out the predominant epistemic position of the author and positions his understanding of reality and truth. Therefore, it describes the theoretical foundation of the doctoral thesis and distinguishes it from other qualitative orientations (Conboy, Fitzgerald, & Mathiassen, 2012).

The present studies were based on a constructivist understanding of reality. In contrast to positivist researchers who assume that reality is external to the knower, objective, and has a structure that can be modeled, constructivists are convinced that reality is a product of mind, determined by the knower, and heavily depends upon her/his mental activity (Jonassen, 1991). Hence, constructivists build their own image of reality relying on personal experiences and interpretations, and recognize the possibility of more than one construction of reality depending on context, method of inquiry and the individual (Orlikowski & Baroudi, 1991).

Where it is unknown what the objective reality means, an understanding of truth as "a matter of consensus among informed and sophisticated constructors, not of correspondence with an objective reality" (Guba & Lincoln, 1989, p. 44) is needed. Lincoln and Guba (1985) formulate truth as "a systematic set of beliefs, together with their accompanying methods", which assumes a "single tangible reality that an investigation is intended to unearth and display" (Lincoln & Guba, 1985, p. 294). The aforementioned consensus relies on the notion of internal and external consensus. According to consensus theory, truth results from the consensus of everyone, i.e. a statement is true (e.g., for a group), if it is acceptable to the group (Niehaves, 2010). Although, the researcher is striving for such consensus in general, there is a difference between internal and external consensus. Following Poerksen (2009), "internal consensus is the correspondence between what one offers as a statement and what one oneself (perhaps even privately) holds to be real" (Poerksen, 2009, p. 87). The external consensus instead comprises the consensus with others and their acceptance of what is said. Poerksen (2009) also states that external and internal consensus may sometimes contradict each other.

Consequently, as a constructivist, the researcher cannot provide truth, but a consensus among other researchers. To achieve such a consensus in the scientific community the researcher has to ensure the trustworthiness of his research through discourse. Since knowledge transfer is not an immediate process – one can only share her/his own construction of reality (Krippendorff, 1994) – the sole dissemination of information is not sufficient. To overcome the subjectivity of the shared information and to ensure the consensus in the community, an extensive discourse is necessary. This discourse strongly depends on the ability of the individual to communicate (Rusch, 2007). To provide others with orientation for judging and understanding, Guba and Lincoln (1982) suggest four criteria that denote trustworthiness of research: credibility, transferability, dependability, and confirmability.

This thesis makes good use of many of these criteria by critically comparing findings to existing literature, by opening the discourse with colleagues and within the scientific community, as well as by inviting peers to provide feedback and reviews on for publication submitted drafts. However, the use of these qualitative criteria did neither determine nor limit the use of methods. According to Smaling (1994), "a research method, certainly a qualitative research method, does not unequivocally imply a particular paradigm" (Smaling, 1994, p. 242). The commonly claimed linkage between paradigm (i.e., constructivism) and method is partly based on certain perceived similarities, which only implies "that a particular linkage is […] more probable than another" (Smaling, 1994, p. 242). Following this notion, this section shall emphasize that it is possible to conduct a particular scientific method beyond its typical paradigm if it is used "critically and knowledgeably, within a context that makes different assumptions" (Mingers, 2001, p. 243) and highlights the necessity to interpret the results in the light of the paradigm in use (Conboy et al., 2012).

In the end, the findings of this thesis are presented in a recommendatory way and acknowledge the subjectivity of opinions – both on the researcher's and the audience's side. They consider diversity and individuality and do not attempt to provide any absolute statements about what is 'correct' or 'incorrect' (Becker & Niehaves, 2007). Hence, the utilization of the findings depends on the individual wish to reflect on their applicability and the validity for one's personal context.

3 Research areas and focal points

The focus of this thesis lies on supporting (knowledge-intensive) open innovation processes by social software. In order to reduce the enormous breadth of this area of research, the author narrowed his visual gaze down to certain sub-areas that are represented by the aforementioned research areas (see section 1):

- management of external knowledge in organizations,
- open innovation, and
- social software adoption for innovation.

Influenced by the current state of research in these areas, four focal points were identified which influenced the selection of research aims for this doctoral thesis.

This section begins with a brief introduction of the central research areas and illustrates how they interact with each other. Afterwards it sheds light on the focal points that were derived from the research areas.

Management of external knowledge in organizations. Following the knowledge-based view, knowledge is the most valuable resource in an organization (Cohen & Levinthal, 1990). Previous research has emphasized its importance, difficulties with the acquisition or creation of knowledge as well as the need for organizations to exploit it (Almeida & Phene, 2004; von Krogh, 2012; Xu, Houssin, Caillaud, & Gardoni, 2010). Moreover, knowledge management is considered "a prerequisite for higher productivity and flexibility" (Mårtensson, 2000, p. 204) and has been observed by scholars from almost every possible discipline, including sociology, economics, management science, and computer science (Alavi & Leidner, 2001). Traditionally, the lion's share of this resource was obtained within the borders of the company. Today, only few organizations gain and maintain competiveness and innovativeness by relying only on internal sources of knowledge (Powell et al., 1996). They are increasingly depending on externally conducted research, expertise, and developed technologies, i.e. knowledge sources beyond organizational borders. Hence, research particularly highlights the value of external knowledge for organizations (Bergman, Jantunen, & Saksa, 2009). Research on user innovation (von Hippel, 1986), collective invention (Allen, 1983), or interactive value creation (Reichwald & Piller, 2006) are just a few examples to be named. Other studies focus on certain bearers of knowledge (Ahrweiler, Pyka, & Gilbert, 2011; Bogers, 2011; Kang & Kang, 2009; Tether & Tajar, 2008), branches (Hughes & Wareham, 2010; Lorentzen, 2005; Rohrbeck, 2010), organization types (Laursen & Salter, 2006; Roberts, 2010; van Gils, Vissers, & de Wit, 2009), company sizes (Fletcher & Harris, 2012; Huggins & Johnston, 2009; Lichtenthaler & Ernst, 2007), geographical regions (Cantner, Joel, & Schmidt, 2009; Gallego, Rubalcaba, & Suárez, 2013; Love, Roper, & Bryson, 2011), or a combination of two or more of these categories. Considering this broad spectrum, organizations struggle with external knowledge in various ways. Thus, the prominence of knowledge management as a discipline that handles such knowledge in an economic context (Davenport & Prusak, 1998) and research related to it have gained dramatically.

Open innovation. There is a widespread understanding among researchers and practitioners that the increasing importance of innovation to economies and companies presents a great dynamic (Damanpour, 1991). Organizations innovate in order to keep up with fluctuating customer demands. Without continuous innovation they would not be able to capitalize on opportunities that new technologies, markets and structures offer and, thus, could not capture and protect their competitive advantage(s) (Chen, Chen, & Vanhaverbeke, 2011; Cohen & Levinthal, 1990; Gassmann & Enkel, 2006). The success of such endeavors depends on the firm's effectiveness in generating, developing, and implementing innovation (Fichter, 2009). As highlighted in several studies, organizations are increasingly drawing in external knowledge to foster their innovation process. They not only focus on ideas generated by external stakeholders (e.g., customers, competitors, suppliers, research institutions), they go even further by inviting them to participate throughout the whole process of innovation (Du Plessis, 2007; Enkel, Kausch, et al., 2005). Consequentially, most recent research on innovation and current developments in practice led to a new understanding of this problem area that resulted in a paradigm shift toward the concept of open innovation (Chesbrough, 2003). From a knowledge-based point of view this observation leads to the conclusion that external knowledge can be regarded as one central benefactor for innovativeness (Xu et al., 2010), especially in an open innovation context. However, even if an organization is able to identify the most valuable knowledge, open innovation comprises numerous approaches to integrate/acquire such knowledge. Plus, each procedure has its own perils and virtues depending on the type of knowledge, company, branch, product, and technical supportability.

Social software adoption for innovation. With the emergence of social software applications (e.g., wikis, weblogs, microblogs, and social networking sites) the amount of openly accessible external knowledge (extracted from data and information) has grown significantly (Belkahla & Triki, 2011). Furthermore, the internet, its various platforms and channels encourage discussions on existing products or ideas for future ones. Despite the fact that the use of social software is well-established in the private context (Chai, Das, & Rao, 2011; Hsu & Lin, 2008;

Krasnova, Spiekermann, Koroleva, & Hildebrand, 2010), social software applications increasingly attract the attention of organizations. Their utilization promises advances in knowledge sharing, collaboration, and innovation (Bughin, Chui, & Miller, 2009; Kügler, Smolnik, & Raeth, 2012). As a part of information systems in general, social software is subject to the same theories and models that explain adoption and use. Most notably, the Technology Acceptance Model (Davis, Bagozzi, & Warshaw, 1989; Davis, 1986, 1989), the Unified Theory of Acceptance and Use of Technology (Venkatesh, Morris, Davis, & Davis, 2003), the Theory of Reasoned Action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975), the Theory of Planned Behavior (Ajzen, 1991), as well as the Task-Technology-Fit Theory (Goodhue & Thompson, 1995; Zigurs & Buckland, 1998) fall into that category. Regarding the adoption of social software in organizations, some of the established theories have been extended to explain causal relationships for the implementation and use of enterprise social software, i.e. micro-blogging (e.g., Schöndienst et al. 2011; Zhang et al. 2010), weblogs (e.g., Ip and Wagner 2008), corporate blogs (e.g., Wattal et al. 2009), wikis (e.g., Danis and Singer 2008; Stocker and Tochtermann 2011), or enterprise social network services (e.g., DiMicco et al. 2008; Kügler and Smolnik 2013).

Based on the above-mentioned research areas and reviews of the particular literature in those areas, four focal points were identified that subsequently led to research aims and questions (see section 4).

The perils and virtues for organizations of utilizing external knowledge. This aspect was identified based on a study of literature on knowledge management and external knowledge in the broader context of open innovation. Due to the fact that external knowledge manifests itself in various forms or can be provided by different sources, organizations must know how to concentrate on the most beneficial mix of sources. Considering this, external knowledge is increasingly regarded as a capital (Carneiro, 2000) with a fostering but also limiting character (Kang & Kang, 2009) for innovativeness (Enkel, Gassmann, & Chesbrough, 2009) and competiveness. Moreover, there is still some uncertainty concerning the positive and negative effects that can be attributed to certain sources or bearers of external knowledge (Chen et al., 2011) – even without focusing innovation. Although some studies already offer conclusions on selected benefits of certain types/sources of external knowledge as well as useful categorizations (Berkhout, Hartmann, & Trott, 2010; Ili, Albers, & Miller, 2010; Laursen & Salter, 2004; Love et al., 2011; Teirlinck & Spithoven, 2008; Weck & Blomqvist, 2008), research lacks a generalizing view on the role of external knowledge and its potential impact on innovation.

Integration approaches for external knowledge, i.e. customer knowledge for innovation. This aspect was identified based on a study of literature on open innovation and documentations of open innovation projects. Although the importance of external knowledge is indisputable, organizations cannot refer to a general integration approach for such knowledge (especially customer knowledge) that allows them to support innovation. Even prior to the paradigm shift toward open innovation (Chesbrough, 2003) many organizations already succeeded in using customer knowledge, e.g. through feedback systems (Hennestad, 1999) or customer knowledge management (Gibbert, Leibold, & Probst, 2002) for innovation purposes. Moreover, research has identified a multitude of strategies that cover or substitute different parts of the traditional process of innovation. Examples include, idea generation (di Gangi & Wasko, 2009; Ebner, Leimeister, & Krcmar, 2009; Piller & Vossen, 2012), design and development (Bullinger, Neyer, Rass, & Moeslein, 2010; Füller et al., 2011; Piller & Berger, 2003; Wei & Wei, 2011), prototyping (Kelleher, Céilleachair, & Peppard, 2012; Moser, Müller, & Piller, 2006), marketing (Burmann, Hemmann, Eilers, & Kleine-Kalmer, 2012; Dodgson, Gann, & Salter, 2006), as well as cross-process strategies covering the whole process of innovation (Kruse, 2012a). Nevertheless, recent studies on open innovation do illustrate many new approaches but do not offer a unified approach to customer knowledge integration.

Open innovation tasks. This aspect was identified based on a study of literature on tasks, especially group tasks, and innovation management. Open innovation projects exhibit a huge variety regarding aims, focus, and execution. Nevertheless, the tasks executed within these projects have many similarities. Although each project varies in its order of tasks, the output of each task, and the players involved during task execution, they rely on the same basic set of tasks. A starting point for understanding the peculiarities of tasks can be derived from the context of interaction and performance in groups as well as between individuals (McGrath, Arrow, Gruenfeld, Hollingshead, & O'Connor, 1993; McGrath, 1984). Since open innovation strongly depends on a collaborative culture (Standing & Kiniti, 2011) it emphasizes team work and group effort rather than individual effort and reward (Standing & Benson, 2002). Thus, the types of tasks in a group environment have similar attributes compared to those executed in an open innovation environment (Bergman et al., 2009). Nevertheless, most research still uses open innovation tasks synonymously to open innovation strategies (Helms, Booij, & Spruit, 2012) and thereby neglects the operational level of open innovation projects. A task-oriented view on open innovation would support the understanding of its feasibility.

The fit between social software applications and open innovation tasks. This aspect was identified based on a study of literature on innovation tasks, social software, and IT adoption.

Open innovation projects may involve a great variety of external actors (Kruse, 2012b) and their contribution to different phases of the process of innovation (Kruse, 2013). Due to the fact that these actors have no or only limited access to the organization's information and communication technologies – some organizations might even want to maintain this cutoff – other platforms and technologies are needed to establish a collaborative environment between external and internal workforce (Ip & Wagner, 2008; Skeels & Grudin, 2009). Moreover, social software applications have almost become pervasive in organizations (Leonardi, Huysman, & Steinfield, 2013) and allow individuals not only to ubiquitously communicate one-to-one (e.g. instant messaging, chat) or many-to-many (e.g., social network systems, weblogs) but to collaboratively generate content (e.g., wikis). Realizing the potentials of social software, its adoption for organizational purposes was just a question of time (Howaldt & Beerheide, 2010; McAfee, 2006). Similar to open innovation tasks these social software categories span a broad range from easy-to-use and -setup applications to organization-spanning solutions. Some of which may cover only one, while others may support a multitude of innovations tasks. Nevertheless, the variety of applications in both scenarios remains huge. Recent studies provide categorizations based on similarities regarding end-user functionalities of social software applications (Pirkkalainen & Pawlowski, 2013). Based on such categories, the allocation of the most beneficial application to support a particular innovation task is facilitated. Nevertheless, the reasoning for or against one alternative concerning its implementation in an organization can only build upon best practice examples so far (e.g., DiMicco et al. 2008; Dugan et al. 2007; Standing and Kiniti 2011). Such examples cannot be transferred directly to another open innovation project due to the variety of unknown variables involved. Despite these insecurities, achieving a fit between task and technology should be a principle for effective support of open innovation through social software. Hence, fit profiles, as used for identifying group support systems that support group tasks, and the underlying Task-Technology-Fit Theory (Goodhue & Thompson, 1995; Zigurs & Buckland, 1998) offer one theoretical approach to map tasks and a supporting social software applications based on their end-user functionalities. Such fit profiles will tremendously facilitate the selection of the most supportive social software application for specific tasks.

The four focal points directed the definition of research aims of the thesis, as well as the formulation of concrete research objectives and questions for each essay. The following section (section 4) summarizes these objectives and questions and illustrates how they guided the studies in each part of the doctoral thesis.

4 Research aims and questions

The central research object of this doctoral thesis is the organizational process of innovation, in particular its representation following the open innovation paradigm. Specifically, the focus lies on the investigation of tasks involved in open innovation projects and their supportability by social software applications.

In this regard, thesis contributes to three research areas: management of external knowledge in organizations, open innovation, and social software adoption for innovation. In particular, it adds to the existing knowledge of four focal points: the perils and virtues for organizations of utilizing external knowledge, approaches to integrate external knowledge, i.e. customer knowledge for innovation, open innovation tasks, and the fit between social software applications and open innovation tasks. Based on these focal points, research aims were formulated and research questions were posed to contribute to research and practice. The aims are:

1. Contribute to research on the role of external knowledge in organizations by systematizing the vast landscape of sources and related boundaries/opportunities of external knowledge integration,
2. Contribute to research on open innovation by developing a framework to support the differentiation and thus the selection of an open innovation strategy as well as developing a generalizing task-focused view on open innovation projects, and
3. Contribute to research on the adoption of social software in the open innovation context by adapting the Task-Technology-Fit Model to facilitate the selection of supporting social software applications.

The thesis consists of four studies that have been described in four research essays. Each study contributes to the overall research aims by targeting specific research objectives or questions. The following briefly introduces the research objectives or questions of each study.

Study 1: The Role of External Knowledge in Open Innovation – A Systematic Review of Literature

The first essay was concerned with sources and types of external knowledge. The study has been documented in *Essay 1: The Role of External Knowledge in Open Innovation – A Systematic Review of Literature.* The findings of the study addressed the first research aim by contributing to the following research objectives:

- Identify potential sources and types of external knowledge involved in open innovation,
- Develop meaningful categories for such knowledge, and

- Identify positive as well as negative influences that can be associated with external knowledge and its organizational use.

Study 2: External Knowledge in Organisational Innovation – Toward an Integration Concept

The second essay was concerned with integrating external knowledge, i.e. customer knowledge through open innovation projects. The study has been documented in *Essay 2: External Knowledge in Organisational Innovation – Toward an Integration Concept.* The findings of the study addressed the second research aim by contributing to its first part and providing answers to the following research questions:

- How do organizations currently integrate customer knowledge through open innovation projects?
- How can social software applications improve current integration concepts or strategies?
- How can best practices for integration concepts and strategies be systematized?

Study 3: Idea Mining – Text Mining Supported Knowledge Management for Innovation Purposes

The third essay was concerned with the collection and management of ideas provided by customers on social software platforms. The study has been documented in *Essay 3: Idea Mining – Text Mining Supported Knowledge Management for Innovation Purposes.* Its findings addressed the second part of research aim two by contributing to the following research objectives:

- Identify requirements for gathering most valuable ideas during ideation,
- Develop a process model as a generalization for ideation and related innovation tasks, and
- Prepare user-generated data for research and development by applying text mining methods.

Study 4: How do Tasks and Technology fit? – Bringing Order to the Open Innovation Chaos

The fourth and last essay was concerned with the whole breadth of open innovation tasks and the supporting role of social software. The study has been documented in *Essay 4: How do Tasks and Technology fit? – Bringing Order to the Open Innovation Chaos.* The findings of the study addressed the third research aim by contributing to the following research objectives:

- Propose generalizations for processes, which represent the tasks to be conducted during each step of the process of innovation in an open innovation environment and
- Develop profiles to support the selection of well-fitting social software applications for open innovation tasks across the whole process of (open) innovation.

5 Methods

Although each study contributes to the same set of research aims and their underlying research object – organizational innovation processes, in particular their representation in the context of open innovation – the four parts had their own research objectives and questions (section 4). To answer the questions or to contribute to the particular objectives, each study employed a different method or a set of methods rather than following a unified approach. Because of this multi-method approach each research objective and question could be addressed with adequacy and focus. The methods conducted in each study are outlined below. A more detailed description can be found in the corresponding essays (see Appendix with Essay 1, 2, 3, and 4).

Essay 1: The Role of External Knowledge in Open Innovation – A Systematic Review of Literature

This study employed a structured content analysis (SCA; Mayring, 2008) based on a structured literature review (SLR; Webster and Watson, 2002). The aim of an SCA is to identify structures in existing (textual) material and to extract them using a pre-defined system of categories. The initial concepts on which the researcher concentrates her/his identification efforts at the beginning can be changed and enhanced during extraction. Hence, one advantage of the SCA is that (a) the researcher is able to refer to her/his previous knowledge and that (b) she/he does not need a completely elaborated category system before starting the analysis.

The data for the SCA was generated from an SLR that comprised queries on a set of electronic databases. If the queries proved to be too generic, they were rendered more precisely using Boolean operators. Despite the efforts, the initial database search resulted in an unmanageable number of hits and had to be narrowed down in several steps. Intentionally, the author only examined scientific journals, as they are considered to best represent the state of research in a particular domain and in a particular period of time. Hence, in a first step, the search results were limited to articles that were peer-reviewed and published in the most relevant (e.g., European Journal of Innovation Management, Journal of Knowledge Management) and high quality academic journals (e.g., R&D Management, Journal of Management Studies, Research Policy). The sample of journals was based on their individual position in academic rankings (cf. Harzing, 2011). For a better orientation and a systematic extension of the number of quality hits, certain journals and prominent works were utilized as a point of reference (Webster & Watson, 2002). After that, duplicates were removed, which resulted in 314 unique articles. Second, every article was examined by its abstract in order to estimate its fit to the objectives of the study (i.e., research on the use of external knowledge in the context of open innovation). This led to further elimination of articles, which were part of the results of the initial queries but did not contribute to problem solving. Subsequently, the remaining articles were examined based on the full paper and once again revised according the exclusion criteria. The final list of literature included 210 individual articles.

In order to develop a categorization schema for external knowledge, a stepwise approach was conducted. First, 20 randomly picked articles were analyzed and the accuracy of the initial categories, their definition, related examples, and coding rules were tested (Mayring, 2008). This test run allowed an adjustment of the definitions based on the sample avoiding a complete re-review of the 200+ articles after pre-screening the whole material. If a phenomenon could not be assigned to a concept a new concept was included. Following an inductive approach, this procedure is based on the principles of Grounded Theory (Glaser & Strauss, 1967; Strauss & Corbin, 1998). After that, the review was started all over again, now, focusing on the entirety of the articles. Considering the plentitude of articles the author conducted only a single run through the material without re-runs. The set of categories contains all inductively and deductively defined categories and their respective relation to each other. Every node from a certain category represents a concept that is standing in for a phenomenon of the real world or an aggregation of multiple phenomena. Each phenomena identified by reviewing the material is represented by a single word, phrase or paragraph (Strauss & Corbin, 1998). Using unique labels the author worked with these concepts later on. This approach is referred to as coding (Miles & Huberman, 1994).

Essay 2: External Knowledge in Organisational Innovation – Toward an Integration Concept

This study employed a systematic literature review (Webster & Watson, 2002) in order to improve the theoretical understanding of approaches to tapping customer knowledge during open innovation. Because of the relative novelty of the topic (Ebner et al., 2009) the author focused on qualitative data to aid theory building (Glaser & Strauss, 1967). Following Glaser and Strauss (1967) data collection started with a broad research aim to collect as much data as possible. The search for respective scientific papers was limited to queries on research published between 2003 and 2012. Books, newspapers, or other unpublished articles were not considered, because the aim was not to cover every single publication, but prominent as well as most recent ones. To limit the findings to research on practical examples, best practice-related terms, such as *case* or *project* were used as additional keywords. In addition to that, only full papers accessible in English language were included. After applying and re-applying the ex- and inclusion criteria (Webster & Watson, 2002), the final list of literature was reduced to 51 unique articles describing case examples and open innovation projects. Moreover, in order to map the findings from literature with current open innovation projects, company websites, project reports, and intermediates' websites were analyzed for substantial contributions to answering the research questions. Hence, the data taken into account covers a mixture of results from scientific research as well as openly available online data. Thereby, the study follows the principles of data collection as suggested by Yin (2003): multiple sources of evidence, a case study database, and a chain of evidence.

Essay 3: Idea Mining – Text Mining Supported Knowledge Management for Innovation Purposes

This study employed design science research focusing on the development of a business process model for ideation as a part of the process of innovation using BPMN. Hevner et al. (2004) suggest seven guidelines[1] that summarize the requirements for effective design-science research and repeat some previously-mentioned aspects of relevance (section 4) and anticipate findings (section 6). (1) The result of this research "is, by definition, a purposeful artifact created to address an important organizational problem" (Hevner et al., 2004, p. 82). The artifact developed in this study is an enhanced BPMN-based process model that illustrates an integration approach for state-of-the-art methods of knowledge management and text mining for innovation purposes. (2) Its relevance derives from the huge and increasingly unmanageable amounts of UGC from social media. The analysis of such content can be facilitated by applying methods of text mining (Felden, Bock, Gräning, Molotowa, & Saat, 2006; Weiss, Indurkhya, & Zhang, 2010). Similar research discussed and demonstrated the applicability of these methods in adjacent fields (Gopal, Marsden, & Vanthienen, 2011; Porter & Newman, 2011; Shaw, Subramaniam, Tan, & Welge, 2001). Other related research areas that add to the relevance of the study, concentrate on the tie between text mining and knowledge management (Ur-Rahman & Harding, 2012) or the extraction of textual information from blogs (Thorleuchter, van den Poel, & Prinzie, 2010). (3) Research rigor comes not only with an estimation of the performance of the developed artifact, but also from the comparison to other approaches in literature (described as theory-based exploration by Bortz & Döring (2006, p. 362 ff)). Process modeling with BPMN has been used as a notation for business processes in various cases and has since proven to be suitable for such efforts (Wohed, van der Aalst, Dumas, ter Hofstede, & Russell, 2006). Formalisms such as process modelling enable the identification of potential for automation as well as the development of interfaces to applications. Research on innovation processes looks back to an even longer tradition (Ortt & van der Duin, 2008; Robertson,

[1] Hevner et al. (2004) name (1) design as an artifact, (2) problem relevance, (3) research rigor, (4) design as a research process, (5) design evaluation, (6) research contribution, and (7) research communication.

1967; Rothwell, 1994; Utterback, 1971) and has since been adopted to related emerging disciplines, such as knowledge management (Xu et al., 2010), collaboration (Philbin, 2008), or text mining (Lin, Hsieh, & Chuang, 2009) and paradigmatic changes, such as open innovation (Bergman et al., 2009; von Hippel, 1976; Wallin & Von Krogh, 2010). Based on the latter, this study provides a task-oriented perspective. Thus, this research draws from a clearly defined and tested base of modeling literature and knowledge from prior research in order to develop the artifact. On the other hand text mining and knowledge management are equally established disciplines that enable and support the generation of UGC as well as a (semi-)automated processing of such content. (4) Regarding the guideline on design as a search process (Hevner et al., 2004), the design of the enhances process model builds upon BPMN and a thorough analysis of existing ideation approaches. The study comprises several sub-models and provides details to the ideation workflow. Nevertheless, modelling only focuses on harvesting data on ideas and their preparation for R&D in order to increase their clarity. The remaining phases of the process of innovation are left for future research. (5) The evaluation of the artifact bases on observational and descriptive evaluation. While the latter uses information from the knowledge base, i.e. relevant research (di Gangi, Wasko, & Hooker, 2010; di Gangi & Wasko, 2009; Thorleuchter et al., 2010), to argument for the artifact's utility, the observational evaluation is realized by putting the artifact into a business environment and by illustrating the utilization of the process model in a complex case example (i.e., Dell's IdeaStorm). This procedure bases on argumentative-deductive as well as conceptual-deductive reasoning (Wilde & Hess, 2007, p. 282), and a scenario-based evaluation (Hevner et al., 2004, p. 84). The implementation is left for future research. (6) The central contribution of the study (see section 6) is the artifact, i.e. the process model that represents a solution of an unsolved problem (management of large amounts of UGC during ideation), extends existing knowledge and applies existing knowledge in innovative ways (use of BPMN for innovation processes; integration of methods of text mining and knowledge management). The contribution also advances the understanding of potentials of text mining for ideation. (7) The study addresses both, researchers and practitioners and motivates future research (see section 7).

Essay 4: How do Tasks and Technology fit? – Bringing Order to the Open Innovation Chaos

This study also employed design science research but this time focusing on the development of a model for the whole process of innovation. Again, the seven requirements for effective design-science research suggested by Hevner et al. (2004) are used to summarize the methodological approach – repeating some previously-mentioned aspects of relevance (section 4) and anticipating first findings (section 6): (1) This study proposes two things: First, it enhances the task-view on open innovation projects and summarizes the findings in an artifact (i.e., a framework). Second, it adopts an existing theory to a new context by translating Goodhue's and Thompson's (1995) Task-Technology-Fit model to facilitate the development of fit profiles between open innovation tasks and social software applications. (2) The relevance of this research draws from the great variety of social software applications and the lack of research on the specific benefits of each option for solving open innovation tasks. Since open innovation involves external experts and innovators, the utilization of social software could facilitate the integration and collaboration in innovation projects (Reinhardt & Amberg, 2010). Finding the most suitable application to execute a particular task is currently based on personal preferences or best practice examples (e.g., DiMicco et al. 2008; Dugan et al. 2007; Standing and Kiniti 2011) and not on theoretical research. Other research discussed and demonstrated the applicability of the Task-Technology-Fit Theory in related fields (e.g., Dwyer 2007; Kwai Fun Ip and Wagner 2008) and adds to the relevance of the study by emphasizing the need of fit between group tasks and group support systems (Zigurs & Buckland, 1998) or on social software-supported collaboration (L. Zhang, 2010). (3) Research on innovation processes looks back to a long tradition (Ortt & van der Duin, 2008; Robertson, 1967; Rothwell, 1994; Utterback, 1971). In this study, the identification of innovation-related tasks covering the whole process of innovation adds a new perspective to open innovation research. Formalisms such as process modelling enable the development of a representation for a generalized view on workflows as well as the identification of requirements regarding the use of supportive applications. Hence, this research draws from a clearly defined base of innovation literature and knowledge from prior research in order to develop the artifacts. (4) Regarding the guideline on design as a search process (Hevner et al., 2004), the overall framework builds upon a thorough analysis (described as theory-bases exploration by Bortz & Döring (2006, p. 362 ff)) of existing open innovation approaches and related tasks as well as social software categorizations (Pirkkalainen & Pawlowski, 2013). Additionally, the estimation of fit between the characteristics and requirements of both sides integrated the results from a focus group discussion conducted with three practitioners familiar with social software and innovation processes at expert-level. (5) The evaluation of the artifact is descriptive and arguments the utility by briefly discussing a case example (argumentative-deductive and conceptual-deductive reasoning (Wilde & Hess, 2007, p. 282)) and putting the artifact into a use scenario (Hevner et al., 2004, p. 84). The qualitative measurement of fit is partly discussed by providing exemplary performance indicators but mainly left for future research. (6) The main contribution of the study (see section 6) is the artifact that summarizes open innovation tasks and thereby represents a first step to facilitate the mapping to a supportive social software application. The study extends existing knowledge (task-view on open innovation projects and their allocation in a process model) and applies existing knowledge in innovative ways (adaption of Task-Technology-Fit Theory to open innovation processes). (7) Finally, the study addresses both, researchers and practitioners and motivates future research (see section 7).

6 Findings

The research objects of this thesis were customer knowledge in open innovation processes and the support of open innovation tasks by social software. It was studied from four distinct perspectives that each contributed to the understanding of such processes and added knowledge to existing research on: benefits of external knowledge integration for organizations, identifying external knowledge integration approaches, identifying open innovation tasks, and using social software to support open innovation tasks. Each of the four studies contributed to at least one of these objectives. The specific findings and thus the contribution of each study are summarized below:

Benefits of external knowledge integration for organizations

There is a considerable body of research discussing the role and types of external knowledge in organizations. Some authors have discussed the topic from the sourcing perspective (Kang & Kang, 2009), others emphasized regional peculiarities (e.g., Belussi et al. 2010; Chen et al. 2011), investigated particular organizations and the way they manage such knowledge (e.g., Bröring and Herzog 2008), a whole branch (e.g., Ili et al. 2010) or a specific source (e.g., Tether 2002), such as universities (e.g., Laursen and Salter 2004) and consultants (e.g., Tether and Tajar 2008). However, none of these studies tries to part from their narrowed path in order to provide a generalized view on the role of external knowledge for organizations. Therefore, one aim of this thesis was to *contribute to research on the role of external knowledge in organizations by systematizing the vast landscape of sources and related boundaries/opportunities of external knowledge integration*. The aim was addressed by the study of existing literature on open innovation and knowledge management (see Essay 1) and the integration of knowledge management methods for innovation (i.e., ideation) purposes (see Essay 2).

The first contribution to this research aim consists of a novel categorization schema for sources of external knowledge. Based on Freeman's (2010) stakeholder theory the study provides a comprehensive overview on potential sources of external knowledge. In addition to the initial set of categories the author developed several sub-categories that allow a more accurate allocation of the fragments extracted from literature that discussed the role of specific sources of external knowledge.

Figure 2 illustrates the sources of external knowledge identified during the review of literature. In contrast to the initial set of sources derived from Freeman's stakeholder theory, the range of potential sources of external knowledge goes far beyond the group of basic stakeholders. The author developed 7 categories and 20 sub-categories, which, e.g., include sources, such as science networks, R&D alliances, industrial alliances and other contract agreements. Although the range covers many different sources, not every knowledge bearer contributes equally, e.g., to competitiveness and innovativeness. Other research also indicates that some sources are taken into consideration more often (i.e., academic institutions, customers and suppliers) in comparison to others (i.e., standards, innovators, patents).

Figure 2. Sources of external knowledge

As a second contribution, Essay 1 summarizes potential influences of external knowledge integration for each part of the innovation process (Desouza et al., 2009) and thus categorizes the aforementioned perils and virtues of integrating such knowledge for organizations. Research frequently focuses on the quantitative output of certain initiatives involving external knowledge and does not include every facet of the process of innovation (Sparrow, 2011). Hence, if the impact of external knowledge, e.g., from a university, is to be measured, the evaluation usually employs quantitative measurements, such as the number of patent applications or licensing procedures. In order to calculate the ROI these numbers have to be set off against grants, wages, project costs, etc. To avoid such a strictly quantitative view the study does not stick to measurable effects, but includes qualitative aspects as well as influences that are hardly measurable. Without claiming to be exhaustive the influences identified in literature sum up to 32 negative and 35 positive effects and implications from external knowledge integration. A detailed overview on these effects can be found in Essay 1.

Finally, the third contribution to the first research aim is an adjacent contribution that was developed in Essay 3. Here, the authors point out how knowledge management may support the process of innovation, in particular the ideation phase (Cooper & Edgett, 2009). Following the authors' advices should help to better understand customer demands, lead to better product ideas, more innovative products, lower product costs, and a shorter time to market. The suggested knowledge management actions support customers to provide valuable knowledge, outline how to motivate them to participate and ensure that more data can be extracted for subsequent text mining.

In short, the thesis contributed to the existing research on (knowledge-intensive) open innovation processes by introducing a categorization for sources of external knowledge. Additionally, it offers a holistic overview on negative and positive effects of the integration of such knowledge and points out how knowledge management methods can be used to achieve these effects or to employ countermeasures against the perils of external knowledge integration. The findings support the strategic selection of external knowledge and facilitate the understanding of related perils and virtues of knowledge integration.

Identifying external knowledge integration approaches

Similar to the first perspective on the research object of this thesis, there is an abundance of literature that argues the benefits of involving customers in the innovation process (Weber, 2011). In order to add to existing knowledge in that area this thesis investigated approaches suggested by open innovation researchers and practitioners. This goes along with one of the aims of this thesis, which was to *contribute to research on open innovation by developing a framework to support the differentiation and thus the selection of an open innovation strategy*. The aim was addressed by the study of existing literature on open innovation as well as existing open innovation projects (see Essay 2).

Despite the previously identified range of sources of external knowledge (see Essay 1), the study (Essay 2) focused only on customer knowledge and thus followed one of the most prevalent direction of open innovation research. Customer knowledge in the form of experiences, improvement ideas, design concepts, etc. is a prerequisite to developing products that meet the customers' demand. Hence, an increasing number of organizations tries to actively involve them into their innovation processes (Belkahla & Triki, 2011). The aim of such efforts is, e.g., to generate new ideas, support product development, tap external expertise, generate new innovations or renew competencies (Dahlander & Wallin, 2006; di Gangi & Wasko, 2009). To shed light on the diverse modes and approaches of customer (knowledge) integration, i.e. innovation contests, co-production, mass customization, crowdsourcing, or participatory marketing an extensive study on existing innovation projects and literature on such efforts led to generalizing framework (see Figure 3).

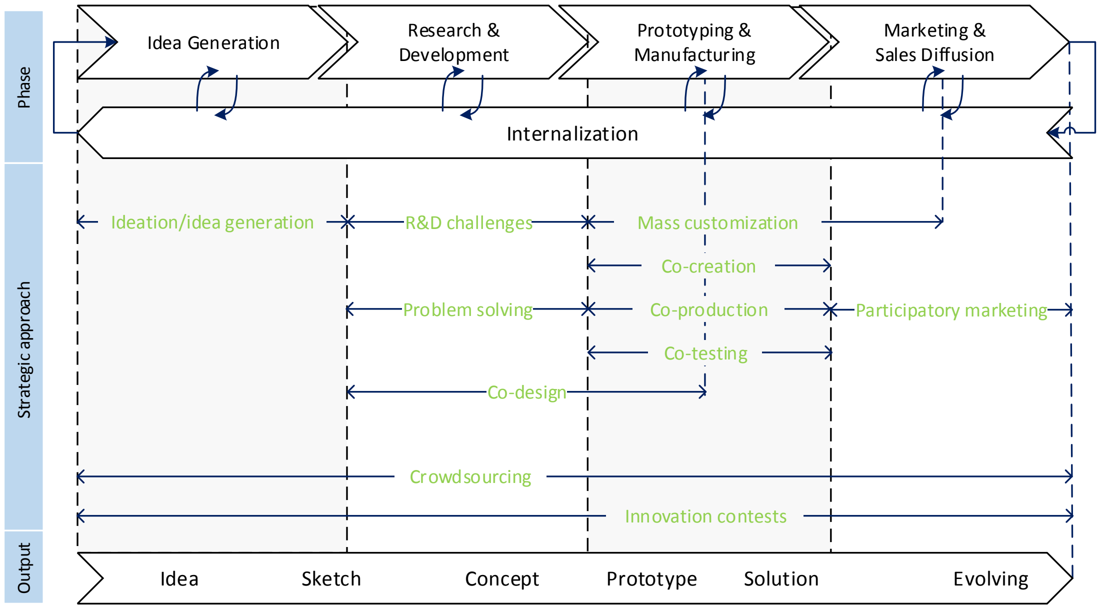

Figure 3. Customer knowledge integration across the process of innovation (cf. Bullinger et al. 2010; Xu et al. 2010)

This framework illustrates the variety of approaches and their allocation within the process of innovation (Xu et al., 2010). It contributes to the understanding of the different aims and outputs of each approach and indicates the contingency of efforts where organizations engage with customers and openly innovation with them, co-create value, and thus aim at supporting the process of innovation (or parts of it). The suggested framework should help organizations to map the most suitable open innovation approach on existing innovation demands.

In addition to the focus on the differentiation of customer knowledge integration approaches, Essay 3 illustrates differences regarding the underlying strategic claim. From an objective-centered point of view, the execution of an open innovation project may follow three strategies: First, some organizations stick to the core of the innovation task, i.e. focus on idea generation or problem solving and expect a significant contribution to their innovation efforts. These examples comprise R&D or idea/design challenges on intermediary platforms (e.g., Innocentive, NineSigma) and use the discussion on social media to support their programs' innovative output. In contrast to that, following the second strategy, other organizations try to generate a certain "buzz" around new products or during innovation contests. Other than in the first strategy, organizations engaging in the second strategy prefer participatory marketing platforms or establish own platforms to stand out against other competitors and to avoid getting lost between other projects on large intermediary innovation platforms. These endeavors solely focus on an improvement of brand recognition, e.g., through coverage in media, without actually breeding innovation. These findings are supported by research on social software adoption in corporate environments (Richter, Stocker, Müller, & Avram, 2013). Nevertheless, the fact that third-party providers, e.g., for innovation challenges provide organizations with only little control over the content end users contributions, lead to a third strategy, a hybrid approach. It allows organizations to benefit from both perspectives, but without guaranteeing them a highly innovative product or idea.

The thesis contributed to the existing research on open innovation processes by introducing a process-oriented categorization of open innovation projects and their allocation within the process of innovation. In addition to that, the study illustrates the differences between the underlying strategic claims of innovation projects. The findings support the focusing of future open innovation projects based on their respective outcome and underlying strategy.

Identification of open innovation tasks

Research on innovation and the process of innovation has a long history (Ortt & van der Duin, 2008; Robertson, 1967; Rothwell, 1994; Utterback, 1971). Research on tasks (i.e., group tasks and collaboration tasks) also led to a considerable amount of studies (Hackman & Morris, 1975; Hackman, 1987; C.-C. Huang, 2009; McGrath et al., 1993; McGrath, 1984). Joining these two streams led to the third perspective the author derived from the research object of this thesis. The challenge connected to the remainder of the second research aim was to identify common tasks in open innovation projects and generalizing them. Thus this thesis also *contributes to research on open innovation by developing a generalizing task-focused view on open innovation projects*. This aim was addressed by studying existing open innovation projects as well as literature on innovation processes and tasks (see Essay 3 & 4).

Following the process-oriented view on open innovation approaches (see Essay 2) the author wanted to add more detail to the workflow of each project. Hence, as a first step, the initial idea generation (step 1 of the innovation process) was investigated further and subsequently modelled using BPMN (see Essay 3). Although, the resulting model was mainly used as a vehicle to transport and illustrate the applicability of knowledge management and text mining methods (to extract and process data from user-generated content), this step represents a prerequisite for the development of an overall model that included the remaining phases of the innovation process (see Essay 4). The overall framework bases on a comprehensive description of tasks, an understanding how tasks can be distinguished from the process itself, and illustrates the chain of tasks leading to a certain level of elaboration (see Figure 4).

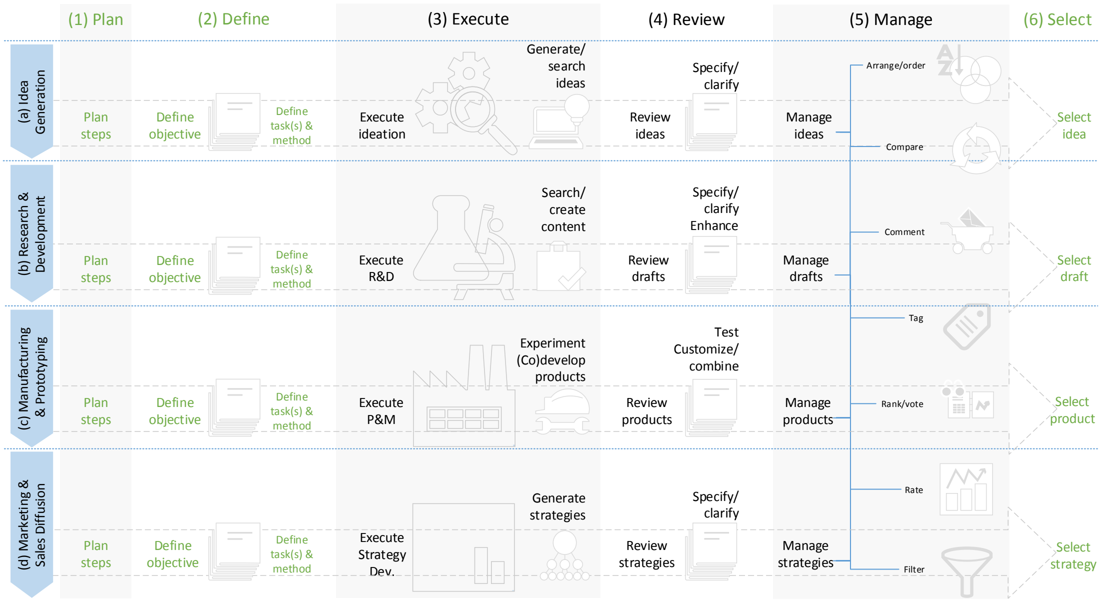

Figure 4. Open Innovation Tasks within each stage of the Process of Innovation

Figure 4 distinguishes four phases of the innovation process (a) idea generation, (b) research & development, (c) manufacturing and prototyping, and (d) marketing & sales diffusion (Xu et al., 2010). In this regard, the framework takes into account that each phase has its own work-flow. After analyzing open innovation projects from each category (see also Essay 2) the chains of tasks within steps (a) to (d) were sub-divided in six stages (1) plan, (2) define, (3) execute, (4) review, (5) manage, and (6) select. Thus, the tasks within each step of the process of innovation follow a structure that is similar to the Stage-Gate-Model developed by Cooper, Edgett, and Kleinschmidt (2002a, 2002b).

According to the description of Figure 4, the study of open innovation projects emphasizes that the influence of external sources of knowledge, i.e. customers, varies heavily from step to step. While planning and defining objectives are clearly organization-related tasks, often executed by (open) innovation managers or internal experts, the degree of involvement increases when customers take over innovation tasks, such as designing, specifying, testing, evaluating, voting, tagging, or rating. Nevertheless, in the end it is mostly the organization which makes the final decision when selecting an idea for subsequent R&D or a strategy to be executed.

As a result, this research introduces an overall process model subsuming open innovation tasks related to each stage of the process of innovation and prepares the ground for an estimation of the supportability of open innovation through social software applications. It thus fosters the understanding of open innovation tasks and their interplay, which helps to differentiate the aims of open innovation projects and provides a contribution to existing research on innovation processes.

Using social software to support innovation tasks

Another aim of this thesis was to *contribute to research on the adoption of social software in the open innovation context by adopting the Task-Technology-Fit Model to facilitate the selection of supporting social software applications.* Due to the great variety of social software applications, the specific (bene)fit of each option for solving open innovation tasks remains unclear. Based on the processes identified in Essay 3 and 4, the fourth part of the thesis comprises an analysis that indicates how social software end-user functionalities and open innovation tasks can be matched. Hence, the study implies that selecting the best and most suitable application is one way to increase innovation performance.

Research on Task-Technology-Fit originates in a study on individual performance and the role of technology, i.e. information technology, to support it (Goodhue & Thompson, 1995). The authors highlight the importance of fit between users' tasks and technologies for individual performance. They define fit in the form of ideal profiles of task-technology alignment. Related research transferred the theory to the field of group tasks and their supportability through group support systems (Zigurs & Buckland, 1998). Here, the authors argue that "achieving a fit between task and technology should be a principle for effective group support system use" (Zigurs & Buckland, 1998, p. 313). Similar to these two studies the author adopts the Task-Technology-Fit Theory for open innovation tasks and social software applications (see Figure 5).

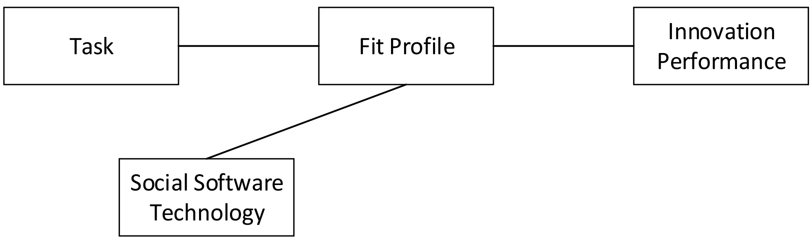

Figure 5. General model of Task-Technology Fit in open innovation

Using the adapted model serves to enhance and supplement current knowledge on social software adoption and their role in open innovation projects. The proposed fit profiles should help organizations to predict the influence of social software on task performance and therefore on innovation performance. Figure 6 illustrates which social software application was determined supportive for executing a specific open innovation task and which – following experts’ opinions – do not contribute to a facilitation of task execution.

Figure 6. Task-Technology-Fit profiles for open innovation tasks

The thesis contributed to the existing research on open innovation especially through its focus on the utilization of social software. The adoption of the Task-Technology-Fit Theory on open innovation tasks allows a more target-oriented decision between alternative social software applications that facilitate the execution of these tasks. The identified fit profiles help organizations to determine which application fits best to their task requirements, leads to a more effective task execution, and thus improves innovation performance most.

7 Conclusion

The thesis was motivated by the opportunities of open innovation projects and the adoption of social software in this context. Three research aims were proposed in order to contribute to existing knowledge and to enhance the understanding of the peculiarities of open innovation for organizations:

(1) develop a systematization of the role of external knowledge in organizations focusing on potential sources and their boundaries/opportunities,
(2) develop a framework to support the differentiation and thus the selection of an open innovation strategy and prepare a generalizing task-focused view on open innovation projects, and
(3) investigate the role of social software in the context of open innovation and adapt the Task-Technology-Fit Model to facilitate the selection of supporting social software applications.

The aims were addressed through a series of studies that have been documented in Essay 1, 2, 3, and 4. Together they form a comprehensive research project on leveraging customer knowledge in open innovation processes by using social software. Each study had its own research objectives and employed its own qualitative methods based on a constructivist understanding of research. Together they each contribute to the scientific discourse, comprise practical contributions, and outline future research areas.

The thesis contributed to the *scientific discourse* in three research areas by applying and advancing theory or methods and by developing theoretical concepts. The contribution of the thesis covers four areas:

- First, the thesis introduces a categorization for sources of external knowledge, provides an overview on negative and positive effects of the integration of such knowledge, and points out how knowledge management methods can be used to achieve these benefits or to find countermeasures against the perils of external knowledge integration. The categorization comprises 20 sources of external knowledge that heavily diverge regarding the positive (35) and negative influences (32) that can be attributed to the integration of such knowledge. The knowledge management perspective covers a discussion of 18 different sources for new product ideas (Cooper & Edgett, 2009) and illustrates two knowledge management strategies that support idea generation.

- Second, the thesis introduces a process-oriented categorization of open innovation projects and their allocation within the process of innovation. This part also illustrates the differences between the underlying strategic claims of innovations projects. The categorization distinguishes 11 types of open innovation projects. The identified strategic claims of such projects follow two main and one hybrid direction.
- Third, this research introduces an overall process model subsuming open innovation tasks (28) and their allocation within the process of innovation. The developed framework fosters the understanding of open innovation tasks and their interplay, and helps to differentiate the aims and outcomes of open innovation projects. It comprises 4 phases that were derived from research on innovation processes, which each consist of 6 stages with particular outputs.
- Fourth, the thesis contributes to existing research by adopting the Task-Technology-Fit Theory (Goodhue & Thompson, 1995; Zigurs & Buckland, 1998) on open innovation tasks. IT provides fit profiles for each task and stage of the process of innovation and thus helps to determine which application fits best to their task requirements.

Beside the theoretical contribution the thesis also adds knowledge to practice and enables organizations and open innovation managers to better understand the peculiarities of open innovation projects and the role of external knowledge for them. The *practical contribution* covers five areas:

- First, the thesis substantiates the convergence between knowledge management and open innovation by investigating how knowledge management methods support parts of the innovation process.
- Second, the studies facilitate the selection of a source of external knowledge by providing a comprehensive categorization schema that summarizes sources discussed in literature and raises the awareness concerning the underbellies of the integration of such knowledge.
- Third, the results of this research outline the options and strategic claims behind open innovation projects, increase their transparency by providing a framework, and thus will facilitate the organization of future open innovation projects.
- Fourth, by modelling the chain of tasks of each open innovation project this thesis helps organizations to better control the steps of each project, their outcome, and thus the definition of aims (internally as well as externally).

- Fifth, this thesis also provides an approach to understand the fit between social software and open innovation tasks. This will help organizations to select the most suitable social software application to support a task or a whole part of the innovation process.

Based on the above-mentioned contributions to research and practice, this doctoral thesis forms the foundation for *further research* in the respective research areas:

- Since the categorization in Essay 1 can only provide a more comprehensive overview on potential sources of external knowledge, research still needs to define how organizations can focus on the most valuable categories for their purposes. Research also needs to further investigate the suitability of means for knowledge acquisition and should provide measurements to assess if, when, and to what extent additional external knowledge inflates the complexity of the innovation process. Additionally, research lacks studies on the alignment of potential sources and types of external knowledge. Studies in this field could provide more empirical data on the impact of certain sources of external knowledge on innovativeness (Caloghirou, Kastelli, & Tsakanikas, 2004; Chen et al., 2011; Cohen & Levinthal, 1990; Laursen & Salter, 2006). Finally, the suggestions how methods of knowledge management may push the process of innovation (see Essay 3) should be further developed in order to comprise the whole process chain. Again, empirical data, e.g., from case studies would support the conclusions drawn exclusively from literature.
- As stated in Essay 2, the framework developed in this study provides an impulse for discussion and does not claim to be exhaustive. Despite the decision-supporting interpretation by the author, further research should engage in an evaluation of the framework, first and foremost through quantitative studies (e.g., draw conclusions from the identification of the most common strategies). This will provide a deeper understanding of the categorization, its strategic claims, and respective outcomes. Also, it should be evaluated if the framework can cover other sources of external knowledge or what distinctions have to be made regarding the complexity of the desired product, the degree of innovation, or the branch of the firm. Thus, the adoption of a contingency approach is likely to increase the contribution, mainly by taking into account factors that may affect the success of the integration of customer knowledge in the organizational approach.
- The process model in Essay 4 enhances the general understanding of tasks that are executed during open innovation projects. However, the variety of open innovation

tasks, their heterogeneous economic attributes and results do not allow for an unambiguous judgment and universally applicable recommendations for action. Thus, in order to enhance the usability of the framework for future open innovation projects, additional empirical data from use cases would increase the rigor of the model and could help to sharpen the order of the identified sub-tasks as well as their level of detail. In addition to that, a more detailed description of the open innovation tasks regarding owner (Hetmank, 2013) and type (Elmquist, Fredberg, & Ollila, 2009) could also be a starting point for future research. Such detailing would help to assign responsibilities of tasks as well as their assignment to individuals, groups, or the crowd.

- The Task-Technology-Fit Theory adopted in Essay 4 reduces the understanding of innovation performance by indicating that a good fit between task and technology may lead (or leads) to a higher innovation performance. Here, a more differentiated picture is required which, e.g., provides indicators for a performance measurement, such as innovation acceptance and sales performance (Hambrick & Macmillan, 1985), achievement of innovation objectives as suggested by the OECD (2005), influence on R&D investment (Frenz & Ietto-Gillies, 2009; Sofka & Grimpe, 2010), or the degree of social interaction (J.-W. Huang & Li, 2009; Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998).
- Finally, the depiction of fitting social software applications for open innovation tasks can only refer to social software categories. The lion's share of these categories covers similar functionalities, but often to a different extent. The reflection of research on this issue would help to better map the end-user functionalities and tasks. Moreover, not every application from a single category covers the same features as its competitors in the same category (e.g., compare MediaWiki, Wikia, and wikispaces). Hence, a differentiation between actual applications would be helpful for an even more considered decision (cf. CosmoCode 2014).

This doctoral thesis focused on the support of open innovation processes by social software. It employed descriptive, but also explanatory and design research and worked with different scientific methods to study the research object. As a result, this doctoral thesis presents findings covering the complete process of innovation in the context of open innovation, starting with the basic role of sources of external knowledge, its management, approaches to integrate such knowledge, the tasks involved in such approaches, and their supportability through social software application.

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Appendix

Appendix

The Role of External Knowledge in Open Innovation – A Systematic Review of Literature

Paul Kruse

Abstract: The importance of knowledge and knowledge management for organizations has been widely discussed in recent years. Historically, the lion's share of organizational knowledge was generated internally, e.g., by a company's R&D department. Today, only few firms can sustain their competitiveness and innovativeness by focusing exclusively on internal knowledge sources. In order to keep track of recent trends, they are increasingly drawing in knowledge from external sources. Managing highly specific knowledge from customers, technologies, markets, etc. is a key to innovation. Its importance is widely reflected in research on, e.g. "user innovation", "collective invention" or "interactive added value". However, integrating external knowledge to foster innovation faces companies with a number of challenges. Open innovation as paradigm shift in innovation management and strategic approach to include the outside world into internal innovation processes is widely regarded as a promising approach in current research.

The present article examines the role of external knowledge in the field of open innovation. By carrying out a systematic literature review the author develops eight categories with 19 sub-categories of potential external knowledge sources. A systematization of the identified sources investigates a variety of assets and drawbacks that can be associated with the integration of such knowledge. Thereby, the article shows that (a) the current research on open innovation is already highly concerned about the role of external knowledge, but (b) mainly focuses on just a few categories/subcategories and (c) tends to neglect many positive and/or negative influences on creativity and innovativeness.

The study illustrates that selecting external sources of knowledge is one of the main challenges of open innovation. Therefore, the author provides a set of strategic recommendations: Firms must concentrate on the most valuable sources, limit their number, provide the necessary means to acquire that knowledge and accurately measure if such additional external knowledge does not over-expand the complexity of innovation processes.

Keywords: innovation management; knowledge management; external knowledge; open innovation; literature review

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The Role of External Knowledge in Open Innovation – A Systematic Review Of Literature

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Abstract: The importance of knowledge and knowledge management for organizations has been widely discussed in recent years. Historically, the lion's share of organizational knowledge was generated internally, e.g., by a company's R&D department. Today, only few firms can sustain their competitiveness and innovativeness by focusing exclusively on internal knowledge sources. In order to keep track of recent trends, they are increasingly drawing in knowledge from external sources. Managing highly specific knowledge from customers, technologies, markets, etc. is a key to innovation. Its importance is widely reflected in research on, e.g. "user innovation", "collective invention" or "interactive added value". However, integrating external knowledge to foster innovation faces companies with a number of challenges. Open innovation as paradigm shift in innovation management and strategic approach to include the outside world into internal innovation processes is widely regarded as a promising approach in current research.
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1. Introduction

The importance of knowledge and knowledge management (KM) is widely discussed in research (e.g., Lehner, 2009; Probst, Raub, & Romhardt, 2010). Following the knowledge-based view, knowledge is the most valuable resource in an organization (Cohen & Levinthal, 1990). Traditionally, the lion's share of this resource was developed within the borders of the company. Today, few companies can maintain their competiveness and innovativeness by focusing only on internal sources (Powell, Koput, & Smith-Doerr, 1996). They are increasingly relying on externally conducted research and developed technologies.
The understanding of innovation processes has changed in recent years. Therefore, this work is based a modern conception of innovation (Reichwald & Piller, 2006). The employed concept relies on the innovation paradigm *open innovation* (OI). OI tries to untighten traditional innovation processes in order to integrate external ideas and actors (Chesbrough, 2006a, 2006b). By opening their doors and integrating external knowledge (EK) bearers (Kang & Kang, 2009) companies can cope with shorter innovation cycles, rising R&D costs, and a lack of resources (Gassmann & Enkel, 2004) turning OI into a "frequently dominant competitive factor" (Piller & Hilgers, 2008).
In a recent study on over 4.500 European companies Filippetti (2011) reveals that the most important sources of innovation are internal design activities (43%), internal R&D (54%), and the acquisition of mechanical equipment (83%). Not surprisingly, the study also illustrates that external research (35%) and external know-how (59%) play an equally important role. Such figures prove that innovative ideas can be found within the organizational limits as well as outside its borders (e.g., Chesbrough, 2006b; Laursen & Salter, 2006). Consequently, companies increasingly innovate with the aid of customers, suppliers, universities and even com-

petitors. The broader and deeper they search for innovative ideas and EK the more successful their endeavors will be (e.g., Chen et al., 2011; Laursen & Salter, 2006).
This research tries to shed a light on how EK exercises its influence on OI processes or innovativeness in general. The author develops meaningful categories of EK and maps positive as well as negative influences that can be associated with these sources. Hence, the study helps to identify potential sources of EK and facilitates the allocation of advantages and disadvantages that can be attached to the categories.

2. External knowledge

Current research already highlights the value of EK (Bergman, Jantunen, & Saksa, 2009). Research on user innovation (von Hippel, 1986), collective invention (Allen, 1983), or interactive value creation (Reichwald & Piller, 2006) are just a few examples to be named. Many of these studies focus on certain bearers of knowledge (e.g., Ahrweiler, Pyka, & Gilbert, 2011; Bogers, 2011; Kang & Kang, 2009; Tether & Tajar, 2008), branches (e.g., Hughes & Wareham, 2010; Lorentzen, 2005; Rohrbeck, 2010; Sieg, Wallin, & von Krogh, 2010), company types (e.g., Laursen & Salter, 2006; Roberts, 2010; van Gils, Vissers, & de Wit, 2009), regions (e.g., Cantner, Joel, & Schmidt, 2009; Huggins & Johnston, 2009; Love, Roper, & Bryson, 2011), company sizes (e.g., Fletcher & Harris, 2011; Huggins & Johnston, 2009; Lichtenthaler & Ernst, 2007) or a combination of two or more categories mentioned above.
Due to the fact that EK manifests itself in various types and contents or is provided by different bearers, companies must know how to concentrate on the right amount and mix of sources. Thus, the importance of KM as a discipline that organizes the handling of knowledge in an economic context has gained dramatically (e.g., Davenport, 2008; McAfee, 2006). EK is increasingly regarded as a capital (Carneiro, 2000) and thereby as a fostering but also limiting factor (Kang & Kang, 2009) regarding innovativeness (e.g., Gassmann & Enkel, 2006) and competiveness (Chen et al., 2011; Cohen & Levinthal, 1990, p 128). Nevertheless, there is still some uncertainty concerning the positive and negative effects that can be attributed to certain sources or bearers of knowledge (Chen et al., 2011). Research lacks a generalizing view on the role of EK and its potential impact on innovation processes.

3. Open innovation and external knowledge

Innovation is commonly known as "the outcome of an interactive process between the firm and its environment, as the result of the collaboration between a wide variety of actors, located both inside and outside the firm" (Mention, 2011, p 44). In order to develop an overview on the potential influences of EK and its bearers on OI, the author focuses on the interactive process described by Mention (2011) which can be divided into several steps. Figure 1 illustrates the five steps of innovation as pointed out by Desouza et al. (2009).

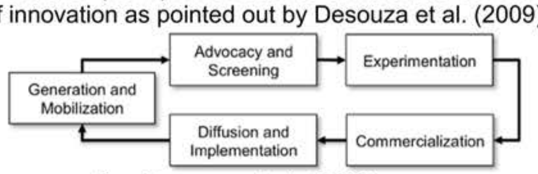

Figure 1: Innovation process after (Desouza et al., 2009)

Generation and Mobilization as the starting point of the circular process is responsible for the development of ideas, such as new concepts, process developments, etc. (Desouza et al., 2009, p 12). Due to the fact that ideas can also be generated outside the firm (in an OI context) mobilization comprises the (physical or logical) transfer of ideas within as well as outside the organization. That includes the possibility of transferring ideas to new domains, e.g., in order to cut new/additional development.
In the following *Advocacy and Screening* phase innovators estimate the potential value a certain idea can add to the company value and possible issues that may occur during the realization of that idea (Desouza et al., 2009, p 17). Not every idea is worthy to be commercialized. Some may be too risky, e.g. from a financial point of view, others could cause defensiveness and therefore need people (e.g., employees, customers) advocating them.
If an idea passes the second phase the prototypical realization can begin (Desouza et al., 2009, p 20ff.). By *Experimentation* ideas are evaluated if they fit to the organization's portfolio. Through an iterative process the prototype is examined regarding its implementability, practicability, etc. resulting in a collection of potentially realizable ideas that the firm can commercialize now or in the future.

Commercialization is all about implementing an idea for the internal or external value creation. Typically, in this phase of the innovation process the firm develops new products of services – not just by demonstrating the practicability but convincing potential customers and consumers. The subsequent *Diffusion and Implementation* phase focuses on the distribution and supply of resources that are needed for a long-term development of the innovative idea (Desouza et al., 2009, p 25) or product/service.

Research illustrates that sources of EK can contribute to every phase of the above-mentioned process – either positively of on a negative way. OI – as the central unit of analysis of this study – can be regarded as a paradigm shift in traditional innovation management and even as an own "strategy of innovation management" (Reichwald & Piller, 2006, p 96). Openness is associated with "the number of different external sources of knowledge that each firm draws upon in its innovative activities" (Laursen & Salter, 2004, p 1204). Therefore, OI is devoted to the strategic use of such sources and the inclusion of the outside world into innovation processes (Gassmann & Enkel, 2004). Hence, like any other corporate asset (Carneiro, 2000) EK can significantly contribute to innovative performance (cf. Gassmann & Enkel, 2006) and competitiveness (cf. Chen et al., 2011), as mentioned above.

4. Research method and analytical framework

Before answering the research objective (cf. chapter 1) the following paragraphs describe the analytical framework of this paper. After a brief introduction into the research method this chapter provides a description of the data collection process and the sources that where into account.

Central objective of this research paper is the analysis of data from textual sources, i.e. available literature in order to investigate the various influences of EK on OI processes. Due to the enormous amount of literature in this domain, such as scientific books and papers, magazines, conferences proceedings, etc. the author carries out a structuring content analysis (cf. Mayring, 2008) based on a literature review (cf. Webster & Watson, 2002). This approach allows a data collection that not only follows a deductive but also inductive procedure. By extracting findings that can only be found between the lines the author completes the results with explicit findings in current literature.

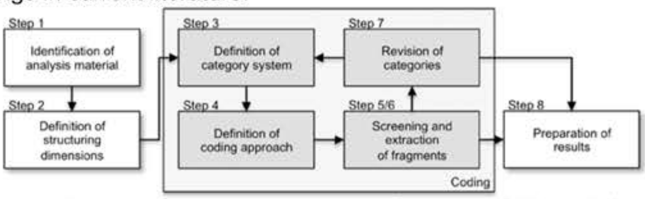

Figure 2: Procedure of a structuring content analysis (Mayring, 2008, p 84)

The aim of the SCA is to identify structures in existing (textual) material and to extract them based on a pre-defined system of categories. The initial concepts on which the researcher concentrates her/his identification at the beginning can be changed and enhanced during extraction. Hence, one of the main advantages of the SCA is that (a) the researcher is able to refer to her/his previous knowledge and that (b) she/he does not need a completely elaborated category system before starting the analysis.

Step 1: Identification of analysis material. As stated above, Mayring's procedure (cf. figure 2) mainly relies on textual sources. Therefore, step one starts with the identification and selection of the material. In this case the present study only focuses on the analysis of electronic sources (as of 10/2011) that deal with OI and KM. Intentionally, the author only examines scientific journals, because they are supposed to best represent the state of research in a particular domain and in a particular period of time. This study does not attempt to provide an overview on the available material in its entirety. Hence, the author aims to develop a list of scientific articles that does not exceed about 200 hits.

Initially, a sequence of superficial queries was conducted to generate rough hit lists and to gain an overview on the amount of existing literature (cf. table 1). The author used two public library databases: the catalogues of the 'Sächsische Landesbibliothek – Staats- und Universitätsbibliothek Dresden' (SLUB) and the 'John Rylands University Library Manchester' (JRUL). For additional in-depth queries four renowned scientific databases and search engines (ScienceDirect, Emerald, EBSCOhost, Wiley and Microsoft Academic Research (MAS)) were employed. In a stepwise process and by refining and/or expanding the search strings relevant literature was isolated and extracted.

	Search string	Hits	Purpose	Evaluation
Surface scan	innov* (all fields)	240.266	List of every work including every possible combination of the words 'innovation', innovate', 'innovative', etc.	Many hits; unspecific context; no reference to knowledge
	innov* (all fields) topic: innovation	4.548	Reduced list of the first scan in the specific field of innovation (if tagged)	Common context; still too generic
	keyword = innov*	26.781	Detailed list of every work including an innovation-related keyword (provided by author or editor)	See above
	innov* AND knowledge	56.416	Reduced list of the first scan that also contain the string 'knowledge'	Many hits; Broader context

Table 1: Results of superficial queries on the SLUB catalogue

For a better orientation and a systematic extension of the number of hits certain journals and prominent works were utilized as a point of reference (cf. Webster & Watson, 2002). After that the search strings were evaluated based on a superficial scan of the results. Logical connectors (Boolean operators) were used to link certain strings and narrow the hit list. Table 2 provides an overview on queries and results.

	Search string	Hits	Purpose	Evaluation
Extended queries	"open innovation"	563	List of works on open innovation in general	Strongly OI-related; without reference to knowledge
	"open innovation" AND knowledge	287	Foundation of works with strong relation to the unit of analysis	Unspecific context of knowledge
	"open innovation" AND "knowledge management"	51	Restricted list of works that explicitly name 'open innovation' and 'knowledge management'	Narrow context; no direct reference to EK

Table 2: Results of enhanced queries on the SLUB catalogue

The basic inquiry illustrates that a sufficient specification of initial general queries delivered manageable results. However, the results – if the same queries would be carried out on all the selected databases – still proved to be too generic. Hence, the query had to be rendered more precisely. In the end the author chose a combination of the strings 'open innovation' and 'external knowledge'. The number of hits among the above-mentioned databases is divided as follows: EBSCOhost (19 hits), Emerald (61), JRUL (32), ScienceDirect (123), SLUB (39) und Wiley (102). After eliminating duplicates 314 articles remained.

In the next step to reduce the number of results to roughly 200 hits, the review was limited to most relevant (e.g., European Journal of Innovation Management, Journal of Knowledge Management) and high quality journals. The present sample of journals was based on their individual position in academic rankings (cf. Harzing, 2012). Finally, the selected studies were examined regarding their fit to the objectives of the present research. This lead to a further elimination of articles, which were identified by queries but did not provide a significant contribution to problem solving. The final list of literature included 210 individual articles. Therefore, the initial goal of about 200 papers was reached.

Step 2: Definition of structuring dimensions. During the second step of Mayring's SCA basic structuring dimensions must be defined. Focusing on two unit of analysis (sources of EK and influences of EK on OI processes) the author developed two different structures:

- The basic dimensions for sources of EK are based on differentiations that can be found in research. Freeman (2010, p 25), one of the leading researchers on stakeholder theory, names governments, customers, competitors, media, suppliers, employees, environmental and other interest groups, communal organizations and owners as the basic stakeholders of an organization. The present study solely concentrates on external sources of knowledge and therefor on external stakeholders eliminating the last four groups proposed by Freeman (2010). Those groups are either internal stakeholders or cannot contribute to OI processes.

- In addition to the source perspective, this research sheds a light on the potential influences of EK in an OIcontext. The initial structure for this facet starts with the differentiation between positive and negative influences.

Step 3: Definition of category system. The set of categories contains all inductively and deductively defined categories and their respective relation to each other. In this study the relationship type is reduced to "is a" relations. Subordinated nodes can only be related to a concept of a higher level. Every node from a certain category represents a concept that is standing in for a phenomenon of the real world (in this case extracted from literature) or an aggregation of multiple phenomena. Each phenomena identified by reviewing the material is represented by a single word, phrase or paragraph (Strauss & Corbin, 1998). Using unique labels, the author can work with these concepts later on. This approach is often referred to as coding (Miles & Huberman, 1994, p 55).

Each concept that was identified was assigned to exactly one structuring dimension. Starting with the basic set of dimensions the author enhanced the initial categorization by adding more detailed dimensions resulting in a more detailed assignment.

Step 4: Definition of coding approach. As illustrated above, the coding process relies on the definition of abstract concepts. In order to facilitate the assignment of certain concepts to extracted phenomena a dictionary of codes (or coding manual) was developed that defines the rules had to be followed. Mayring also points out that this approach supports the researcher during the extraction process and adds the required comprehensibility for readers. He suggests three elements that each concept should include:

- an accurate *definition* that provides a comprehensible description for each concept and a short form, which is used to highlight the phenomenon in the text,
- a set of *examples* that illustrate the assignment of certain concepts to a category and can be used to compare an extracted fragment with the already assigned ones and
- additional *coding rules* which allow an exact assignment if definition and examples cannot support the differentiation between potential categories.

Step 5/6: Screening of material and extraction of fragments. In the following step the material previously selected must be read through. Parallel to this, the author used the pre-defined categories and the coding manual to annotate findings in the texts. First, the author mainly focused abstracts and conclusions, because these parts usually contain the new findings, their interpretation and the value added. Nevertheless, the author thoroughly read through the other parts as well in order to grasp the whole picture of the particular paper.

In detail, a stepwise approach was conducted. First, 20 randomly picked articles were analyzed and the accuracy of the categories, definitions, examples, and coding rules were tested (Mayring, 2008, p 83). This test run allowed an adjustment of the definitions based on the sample avoiding a re-review of the 200+ articles after pre-screening the whole material. If a phenomenon could not be assigned to a concept a new concept could be included. Following an inductive approach, this step is partly based on Grounded Theory (Glaser & Strauss, 1967; Strauss & Corbin, 1998). Mayring (2008, p 84) refers to this procedure as "open coding". After that, the review was started all over again, now, focusing on the entirety of the articles. Considering the plentitude of articles the author conducted only a single run through the material without re-runs.

Step 7: Revision of categories. Before presenting the result of the SCA in step 8 some adjustments of the initial categories had to be made. If a textual fragment could not be assigned to one of the developed categories but was considered valuable for answering the question a new category was introduced. In any other case the fragments were assigned to existing categories.

5. External Knowledge in open innovation processes

Based upon Freeman's stakeholder theory this research provides a comprehensive overview on possible bearers of external knowledge. In addition to the initial set of categories the author developed several sub-categories that allow a more accurate allocation of the extracted fragments. Figure 3 illustrates the potential sources of external knowledge identified during the review.

Figure 3: Sources of external knowledge

Due to the limited capacity of this paper the full list of examples and references that were extracted from literature had to be left out. Nevertheless, figure 3 still shows that the range of potential sources of EK goes far beyond the group of basic stakeholders as they are referred to in current research. The author developed 7 categories and 20 sub-categories. In addition to institutional sources, such as academic (universities, laboratories, research facilities, etc.), non-academic (commercial/private research institutes, etc.) and governmental institutions (chambers of commerce, governments, etc.), customers, such as users/consumers (lead users, user communities, etc.) or clients (potential customers, focus groups, etc.), competitors, business partners, such as suppliers (of material, IT, Software, etc.), innovators (intermediaries, etc.) and companies within (specialized SMEs, service providers, etc.) or outside the value chain (consultancies, start-ups, venture capitalist, etc.), employees, such as scientific (researchers, alumni, PhDs, etc.) or business-related staff (external specialists, knowledge brokers, etc.) and media, such as documentations in the form of patents and licenses, standards/regulations (concerning security, health standards, etc.), mass media (sources form the internet, magazines, TV, search engines, etc.) and events (fairs, tradeshows, conferences, workshops, etc.), the results include forms of collaboration, such as science networks (science parks, university alliances, etc.), R&D alliances (research projects/consortia, etc.), industrial alliances (cooperation agreements, technology parks, industrial clusters, etc.) and other contract agreements (communities, joint ventures, general strategic alliances, etc.).
Though the range covers a great deal of sources, not every knowledge bearer can contribute equally to competitiveness and innovativeness. Still, current research highlights that some sources are taken into consideration more often (i.e. academic institutions, customers and suppliers) in comparison to others (i.e. standards, innovators, patents, etc.).
In a second step the author analyzed potential influences of EK on OI processes. The results concentrate on the impact of EK regarding its transfer into the organization and initially differentiate between positive and negative influences. Research frequently focuses the (quantitative) output of certain initiatives involving EK and lack a process-oriented view (Sparrow, 2011). If the impact of EK, e.g., from a university, is to be measured, the evaluation usually takes quantitative measurements, such as the number of patent applications or licensing procedures into consideration. In order to calculate the ROI these numbers have to be set off against grants, wages, project costs, etc. To avoid such a strictly quantitative view this study includes changes in innovation process and hardly measurable influences. Due to the complexity, the author waives assumptions concerning comparative values or quantifiable impacts. The categorization is based on the five steps of innovation processes as illustrated in figure 1 and additional cross-process influences. From a general point of view, EK strongly influences the generalization and mobilization as it allows the introduction of external ideas and new perspectives. Advocacy and screening can be influenced as well, but regarding the fact that this step commonly relies on personal experiences and internal knowledge the potential impact is comparatively low. A similar observation can be made in the following phase. Nevertheless, experimentation and designing – as long as it directly involves customers, external employees, etc. – can be influenced in various ways. In the subsequent steps of the innovation process, literature indicates that the potential influence increases. In addition to EK impacts that can be related to a certain phase of the innovation process there are influences that can occur across the whole process. The following table (Table 3) sums up the potential positive as well as negative effects that were extracted from literature without in any way claiming to be exhaustive.

Phase	Positive Influence	Negative Influence
Generation and Mobilization	Compensate low R&D resources Skimming Spillover from EK bearers Increase innovativeness Increase number of ideas and degree of novelty Generate new knowledge	Cannot guarantee uniqueness of EK Increases dependency on EK bearers Cannot automatically increase innovativeness
Advocacy & Screening	Facilitate radical innovation Support technological innovation Allow selection of complex innovation	Cause nonobservance of opportunities Leads to miss of chances
Experi-mentation	Shorten time to develop Increase/Improve innovation quality Enable new combinations (e.g., of EK and technology)	
Commercia-lization	Decrease risk and insecurity Increase mutual benefit in collaborative agreements Increase probability of successful realization Increase Return on R&D Investment Shorten time to market	Increase risk and insecurity Cannot automatically increase business value Cause IPR problems Increase cost f. search, acquisition, integration of EK Cannot exclusively belong to organization
Diffusion & Implemen-tation	Deregulate loss/outlet of knowledge Increase number of new products Increase number of new processes Increase number of patents Avoid redundancies Enhance organizational knowledge base Incorporate new abilities/capabilities Enhance existing skills	Cause conflict between sharing and protection Impede exchange by over-protection Pollute internal body of knowledge
Cross-process	Depend on previous knowledge/R&D Complement internal knowledge/R&D Integration develops into core competency Increase competitiveness Increase flexibility and visibility Increase financial savings Shorten innovation process Facilitate acquisition/transfer of EK Decentralize innovation processes Reduce complexity of internal R&D Improve internal R&D	Cannot replace internal R&D Cannot secure correctness of EK Cause internal knowledge to seep out Require cultural changes Require organizational changes Lead to immoderate openness Cannot complement internal R&D Cause lock-in effect Reduces internal R&D Cause "over-search" by exorbitant number of sources Increase complexity if sources are widespread Equals internal body of knowledge Differs from internal body of knowledge Increase complexity of relationships Slowed down by low number of sources Cause Inertia Not-invented-here syndrome / buy-in Relate-out / all-stored-here Only-used here / sell-out

Table 3: Positive and negative influences of external knowledge in open innovation processes

6. Challenges for organizations

The present study illustrates that selecting EK sources in an OI context involves several challenges. First, there are many sources from which an organization can acquire EK (cf. figure 3). This leads to the conclusion that firms must know how to chose the right sources, which are most suitable to generate innovation and what potential influences can be associated with the sources. In general, there is no system of rules that supports such decisions. Depending on, e.g., the length of a project or its focus (e.g., product vs. service, technological vs. process, etc.) the set of suitable sources of EK to support a project may differ.
One aim of OI is experimentation with new ideas and the managing such approaches in order to generate a business value. Hence, firms have to concentrate on those sources that have the biggest positive impact on innovativeness and competitiveness. Nevertheless, potential risks and disadvantages must not be neglected (e.g., Barge-Gil, 2010; Grimpe & Sofka, 2009; Hurmelinna-Laukkanen, 2011). The study showed that although research frequently highlights the benefit of EK (e.g., Ahrweiler et al., 2011; Allee & Taug, 2006; Cantner et al., 2009), the consideration of consequences and negative influences tends to fall short and not uncommonly causes damage (e.g., Frickel, 2011).
Another challenge can be associated with the time and amount of external knowledge. Organizations must define the critical mass of EK and have to decide when a satisfactory level that can lead to a satisfactory decision is reached (Laursen & Salter, 2006).

An issue that is often related to knowledge in general is the fact that it quickly becomes obsolete (Hurmelinna-Laukkanen, 2011). In addition to that, by using social media platforms such knowledge is available to more than just a selected circle of players and organizations (Grimpe & Kaiser, 2010). Opening the innovation process forces firms to actively search for highly potential developments to make sure that competitors cannot draw any advantage from an earlier discovery. Anyhow, there are cases where openness is neither necessary nor reasonable (Ahrweiler et al., 2011). Processes requiring in-depth knowledge are a regular basis for competitive advantages. Therefore, opening up to EK bearers could jeopardize benefits from exclusivity. If openness causes leaks of critical knowledge, firms must calculate such risks (Bergman et al., 2009).

While internal knowledge is a part of the organizational body of knowledge by nature, EK needs special effort to integrate it and to decide about its compatibility to existing knowledge. If an external source of knowledge requires, e.g., internal changes, such as cultural or structural changes (Chen et al., 2011; Chiaroni, Chiesa, & Frattini, 2009), or an investment in transformation (Laursen & Salter, 2006; Sofka & Grimpe, 2010), firms must evaluate whether the potential benefit compensates the additional effort or not.

Organizations that are willing to launch an OI project or to open their innovation process, must define a concise role of internal R&D. They must decide if OI shall act as substitute or complement to existing innovation approaches. If an organization fails to communicate a comprehensible understanding of the role, issues such as the not-invented-here syndrome (Lichtenthaler & Ernst, 2006), an unintended reduction of internal R&D (Teirlinck, Dumont, & Spithoven, 2010) or inertia (Enkel, Perez-Freije, & Gassmann, 2005) can occur.

All in all, organizations must not consider EK as a magic bullet. There are still plenty of risks (Blomqvist, Hara, Koivuniemi, & Aijo, 2004), such as an increasing dependence on external sources (Huggins & Johnston, 2009) or the questionable correctness of EK (Grimpe & Sofka, 2009; Sofka & Grimpe, 2010). Research lacks an analysis of distinct correlations between potential sources/types of EK and their impact on innovativeness. Hence, a forecast of consequences of a knowledge transfer activity is still impossible.

7. Conclusion

This study presented the results of a literature review in the area of tension between OI and management of EK. The aim was to develop an overview on potential sources of EK and their impact on the innovation process. For this purpose, an SCA was conducted.

The study revealed that because of the fact that companies are increasingly forced to tap EK and to openly innovate by collaborating with external actors (Kang & Kang, 2009). By sticking to internal sources of knowledge only few organizations can remain competitive or foster innovation (Powell, Koput, & Smith-Doerr, 1996). Therefore, the present research points out that (a) EK in OI is widely discussed in research and considered as critical to success. The literature review illustrates that (b) external sources of knowledge are by no means restricted only to customers, suppliers and academic research institutes. Literature reveals comprehensive scenarios in which, e.g., events such as innovation contests or non-customers/non-suppliers contribute to innovative performance (cf. Sofka & Grimpe, 2010). The sources identified were divided into 7 categories and 20 sub-categories. Each source significantly differs from another regarding the type of knowledge, its contribution to innovation performance and accessibility for companies (Sofka & Grimpe, 2010). Notwithstanding, research lacks a holistic view. Therefore, (c) many positive and negative influences are neglected. Table 3 illustrates positive and negative effects of external sources of knowledge on the innovation process. The future challenge is to focus on the most valuable categories, to provide the necessary means for knowledge acquisition and to accurately measure if additional EK inflates the complexity of the innovation process. Nevertheless, research lacks a distinct alignment of potential sources/types of EK and their impact on innovativeness, which impedes the process of decision-making in organizations. In order to solve this problem, feasible measuring instruments are required.

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Appendix

External Knowledge in Organisational Innovation – Toward an Integration Concept

Paul Kruse

Abstract: The integration of customer knowledge into innovation processes not only faces companies with many challenges but also opens up opportunities for new product development and fostering innovativeness. Past research describes a multitude of approaches and practical examples, which companies can refer to if they are willing to tap customer knowledge. With the emergence of social software and open innovation there are even more potential paths to follow. In this regard, this research aims to propose a concept that categorises such strategies. Based on a structured literature review in the domain of open innovation the author analysed the body of related literature and best practices in order allocate the identified options within the process of innovation. Thus, the study emphasises strategic perspectives that distinguish between objective-centred, marketing-focused and hybrid approaches.

The results can be utilised as guidance for knowledge integration and help companies to navigate through the selection process of strategies for customer knowledge integration in organisational innovation processes.

Keywords: open innovation, knowledge management, customer knowledge, product innovation, customer integration.

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EXTERNAL KNOWLEDGE IN ORGANISATIONAL INNOVATION – TOWARD AN INTEGRATION CONCEPT

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Abstract

The integration of customer knowledge into innovation processes not only faces companies with many challenges but also opens up opportunities for new product development and fostering innovativeness. Past research describes a multitude of approaches and practical examples, which companies can refer to if they are willing to tap customer knowledge. With the emergence of social software and open innovation there are even more potential paths to follow. In this regard, this research aims to propose a concept that categorises such strategies. Based on a structured literature review in the domain of open innovation the author analysed the body of related literature and best practices in order allocate the identified options within the process of innovation. Thus, the study emphasises strategic perspectives that distinguish between objective-centred, marketing-focused and hybrid approaches.

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1 Introduction

There is a widespread understanding among researchers and practitioners that the increasing importance of innovation to economies and companies presents a great dynamic. Companies must innovate to manage fluctuating customer demands. Without innovation they would not be able capitalise on opportunities that new technologies, markets and structures offer and, thus, could not sustain their competitiveness (Kruse, 2012). The success of such endeavours depends on the firm's effectiveness in generating, developing, and implementing innovation (Fichter, 2009).

As highlighted in several studies, companies are increasingly drawing in external knowledge (EK) to foster their innovation process. They not only focus on ideas generated by external stakeholders, they even invite them to participate along the whole process of innovation (Du Plessis, 2007; Enkel, Kausch, & Gassmann, 2005). From a knowledge-based perspective this observation leads to the conclusion that EK (e.g., from customers, competitors, suppliers, research institutions, etc.) can be regarded as central the benefactor for innovativeness (Xu, Houssin, Caillaud, & Gardoni, 2010).

Due to the fact that EK exists in numerous forms and is held by a wide range of knowledge bearers (Kang & Kang, 2009) companies must focus on the most valuable knowledge or base its acquisition, e.g., on strict financial considerations. This led to an increasing importance of a purposeful knowledge management. Nevertheless, even if a company is able to identify the most valuable knowledge, there are numerous approaches to integrate/acquire such knowledge. Plus, each procedure has its own perils and virtues depending on the type of knowledge, company, branch, product, etc.

To provide a first glimpse on the complexity of the above-mentioned situation this study investigates approaches suggested by Open Innovation (OI) researchers and practitioners. The author focuses on customer knowledge (CK) as one of the most important sources of ideas, experiences with products, etc. in the context of OI (Kruse & Geißler, 2012). Following Gebert, Geib, Kolbe, and Brenner (2003, p. 109) CK can be classified into three categories: In addition to *knowledge for* and *knowledge about customers* there is *knowledge from customers*. While the first type comprises knowledge, which is required to satisfy customer needs and which is allocated in products, services, markets, etc., the second type accumulates knowledge, which helps companies to understand their customers, beliefs, needs, etc. Beside these two highly valuable types of CK the focus of this research lies on type number three: knowledge from customers. Such knowledge derives from customers' experiences with products, services, markets, etc. and can be used for innovation purposes. A comprehensive overview on potential knowledge assets associated with this type can be found in Kruse and Geißler (2012).

With the emergence of Web 2.0 technologies the amount of CK as well as its accessibility has grown significantly (Belkahla & Triki, 2011). Furthermore, the Internet and its various platforms, channels, etc. encourage discussions on existing products or ideas for future ones. An organisation, that manages to identify and fulfil such demands and ideas, may gain a competitive advantage.

Even though the importance of such knowledge is indisputable, companies cannot refer to a general approach that allows them to foster innovativeness through EK, i.e. CK. Following the paradigm shift towards OI (Chesbrough, 2003) many companies already succeed in tapping CK. However, OI with its multitude of strategies lacks an ideal approach as well. In this regard, the author suggests a systematisation based on the analysis of existing OI projects or platforms while emphasizing the benefits of the application of Web 2.0 technologies (i.e., social software). It shall provide a frame for the CK integration approaches and illustrate how they can be allocated within the stages of the process of innovation.

The suggested concept will help companies to map the most suitable OI approach on their innovation demands and may allow them to gain more than just brand awareness by inviting customers.

To reach the research aim the following questions will be answered:

- How do companies currently integrate customer knowledge through OI projects?
- How can Social Software tools improve current integration concepts or strategies?
- How can best practices for integration concepts and strategies be systematised?

To set up the necessary foundations the following section summarises the body of related literature on innovation, esp. innovation processes. After that, section 3 sheds a light on the methodological approach of the study. Subsequently – keeping in mind the wide range of types of EK and its bearers –, the author conducts an analysis of existing OI projects and best practices, which aim at integrating CK (section 4). Answering question 1 should provide a comprehensive overview on existing strategic approaches to customer knowledge integration (section 4.1). Following the description of examples (section 4.2), the answer to question 2 will clarify how Social Software tools (section 5) may support the strategies. Finally, solving question number 3, the author develops a systematisation, which helps to summarise and differentiate the identified CK integration approaches (section 6).

2 Extant studies on innovation process

It is commonly known that organisations need to innovate in order to be able to respond to changing customer demands as well as to capitalise on opportunities offered by new technology and changes in markets (Rowley, Baregheh, & Sambrook, 2011). Innovation plays a central role in value creation and to sustain competitive advantage.

Although this idea is not new – neither in practice nor research – innovation and the process of innovation lack a general definition. Many authors highlight several perspectives, which relate to innovation as a process, as an item (e.g., product, service or program) or innovation as an attribute of organisations. From an output-oriented point of view innovation can simply be defined as "the generation, acceptance and implementation of new ideas, processes products or services" (Thompson, 1965). From a more business-related perspective innovation comprises "the creation of new knowledge and ideas to facilitate new business outcomes, aimed at improving internal business processes and structures and to create market driven products and services" (Du Plessis, 2007, p. 21). Although the author does not waive the possibility that the concept can be applied on services as well, the present research is primarily limited to product innovation.

Throughout literature the process of innovation encompasses different numbers and definitions of stages that business organisations pursuit to innovate. Godin (2006), e.g., refers to a linear model of innovation as a one-way flow from fundamental over applied research to product development that comprises invention, innovation, and diffusion. In a similar way Ruttan (1959) differentiates between invention, innovation and technological change. Although these models have been very influential, widely disseminated decades ago, today's understanding provides a more complex view on the process of innovation and tends to add several intermediate steps. Utterback (1974), e.g., widens the conception of the three stages and divides the process into "generation of an idea, problem-solving or development, and implementation and diffusion" (Utterback, 1974, p. 621). Generation involves a synthesis of diverse information, e.g., about a market or needs and technologies to meet the needs and results in a proposal. Problem solving is concerned with "setting specific technical goals and designing alternative solutions to meet them" and leads to an original solution or invention. After that implementation, i.e. "manufacturing-engineering, tooling, and plant and market start-up required to bring an original solution or invention to its first use or market introduction" is followed by diffusion, which "takes place in the environment and begins after the innovation is introduced" (Utterback, 1974, p. 621).

Due to fluctuating customer needs, increasing technological changes and soaring competition, innovation is extremely dependent on the availability of internal and external knowledge (Du Plessis, 2007). Hence, current definitions of the process of innovation strongly emphasise the knowledge perspective, e.g., with "knowledge creation" (Miles, Snow, & Miles, 2000) or "knowledge commercialization" (Desouza et al., 2009).

In order to keep the focus on knowledge the present study draws upon an innovation process that was developed to highlight the increasing importance of the knowledge perspective. Figure 1 illustrates a simple process model derived from Xu et al. (2010, p. 580), which concentrates on four stages.

Idea generation and research/development can be compared to what (Utterback, 1974, p. 621) described with the first and second phase of his innovation process. These stages result in elaborated ideas/sketches or further concepts (Bullinger, Neyer, Rass, & Moeslein, 2010). The following ones (prototyping/manufacturing and marketing/sales diffusion) separate the stage of implementation and diffusion as suggested by Utterback (1974) and thereby differentiate between early development, e.g., of a new product and its final commercialisation. Hence, the degree of elaboration ranges from early prototypes to final solutions (Bullinger et al., 2010).

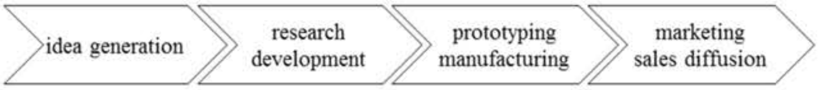

Figure 1. Process of innovation (cf. Xu et al., 2010, p. 581)

Most recent research on innovation and, moreover, developments in practice led to a new understanding that resulted in a paradigm shift towards the concept of OI (Chesbrough, 2003). As mentioned earlier, this idea also focuses on tapping knowledge of the customers. In addition to that, the integration of social media, whose principles OI adopts, may facilitate knowledge transfer and, thus, innovation.

Studies already revealed that involving external stakeholders into organisational innovation processes positively influences the success of new product development (NPD) (Kirchmann & Warschburger, 2003). The most common sources of EK include, e.g., academic institution, companies within and outside the value chain, competitors and customers. Despite the rich discussion about the perils and virtues of EK integration current research is restricted to proving general applicability and usefulness, but lacks an integration concept that describes possible approaches from start to end of the process of innovation. Xu et al. (2010) already try to integrate models of innovation and knowledge transfer but rather focus on the knowledge perspective and remain on an abstract level.

3 Methodology

Because of the relative novelty of the topic of OI (section 1 & 2) the author focused on qualitative data to aid theory building (Ebner, Leimeister, & Krcmar, 2009; Glaser & Strauss, 1967). First, to improve the theoretical understanding of approaches to tapping customer knowledge through OI a systematic literature review (SLR) was conducted. The methodology provides a repeatable and structured procedure to identify, evaluate, and interpret existing literature (Webster & Watson, 2002). Second, in order to map the findings from literature with current OI projects, company websites, project reports, and intermediates' websites were analysed for substantial contributions to answering the above-mentioned research questions (section 1). Hence, in order to offer a first glimpse on the data taken into account a mixture of literature review and online data analysis was conducted. Thereby, the present study covers the principles of data collection as suggested by Yin (2003): multiple sources of evidence, a case study database, and a chain of evidence.

The planning stage of the data collection included several steps. First, the research interest of the paper was stated in the form of three research questions (section 1). Second, an appropriate search strategy was derived. The search strategy comprises the identification of the population, the selection of suitable resources, the definition of search strings, and the determination of inclusion and exclusion criteria (Webster & Watson, 2002, p. xv).

During SLR the search for respective scientific papers was limited to research published between the year 2003, when the term OI was first coined by Henry Chesbrough, and 2012. Books, newspapers, or other unpublished articles were not considered, because the aim of this search was not to cover every single publication, but prominent as well as most recent ones. Therefore, the databases used were restricted to those supplying scientific journals and conference proceedings. In addition to that, only full papers accessible in English language could be included.

In reference to the search strategy ACM Digital Library, Emerald Group, ScienceDirect, and Wiley Online Library were used as databases to start with. The search terms were derived from the RQs (section 1). Following Glaser and Strauss (1967) the author began with a broad research aim to collect as much data as possible. Thus, starting with the main term *open innovation,* the first search query resulted in 2389 publications. To limit the findings to papers, which refer to practical examples in their studies *best practice* related terms, such as *case* or *project* were used as additional keywords. Table 1 illustrates exemplary findings from the conducted search queries.

Database / String	*"open innovation"*	*"open innovation" AND "best practice"*	*"open innovation" AND title:case*	*"open innovation project"*
ACM Digital Library	212	7	0	4
Emeral Group	476	59	0	3
ScienceDirect	941	6	52	13
Wiley Online Library	757	154	18	11
Sum	**2386**	**226**	**70**	**31**

Table 1. Results from search various search queries

After scanning through the abstracts to eliminate irrelevant publications (e.g., those which include the search terms but do not offer examples) and duplicates the number of papers could be reduced to 52. This sample only comprises papers from the management and related disciplines, have a strong OI focus, and thus do not represent the whole body of literature.

Following the second step of data collection the findings from literature were triangulated with publicly available information, which could be identified following the case descriptions in literature and through observation by the author (e.g., company web-sites, project reports, and intermediates' websites)[1]. In theory, the collection of data can be stopped once a point, at which learning becomes minimal, is reached (Glaser & Strauss, 1967). In this case, theoretical saturation was reached when additional studies or best practices could not add to what was already known.

4 Analysis

With their knowledge in the form of experiences, improvement ideas, etc. customers possess one prerequisite to innovative products that meet their demands. Hence, companies should try to actively involve them into their innovation processes. The aim of such efforts is, e.g., to generate new ideas, support innovation development, tap external expertise, generate new innovations, and renew competencies (Dahlander & Wallin, 2006; Di Gangi & Wasko, 2009). In this concern the integration of customer knowledge is regarded as a mode of value creation (Reichwald & Piller, 2006) in which customers take part in "operational as well as innovation value-creating activities" (Ebner et al., 2009).

4.1 Basic strategies

Across the process of innovation (Figure 1) the degree of customer involvement and amount of customer knowledge varies. They may go so far and co-develop products supervised by the firm (Von Hippel, 1986) or just participate in the generation of product ideas without covering further stages of the innovation process (Graham & Bachman, 2004). Each degree of involvement can be achieved by different integration approaches. Literature offers a great variety of solutions that can be derived from OI project descriptions. In order to categorise the approaches found during SLR and best practice search this study distinguishes different strategies that aim at innovation. Each strategy is related to one or more stages of the innovation process and therefore supports the sequence differently. Also, each approach comprehends different aspects of CK, such as ideas in general, design input, product improvements, feedback, experience, etc. and entails a different way to integrate it. The following overview introduces the most common approaches but does not claim to be necessarily exhaustive as it does not provide any quantitative significance.

The first step towards innovation starts with the generation of an idea (Figure 1). Customers, who are willing to provide ideas, can be found, e.g., in online communities, social networks, etc. On this level

[1] The bias towards examples from German-speaking countries is caused by the nationality of the author and shall not lead to the misunderstanding that other countries do not have suitable examples ready.

companies should try to motivate their customers to share their thoughts and experiences. The degree of involvement remains low because customers tend to communicate with each other rather than with the company directly. If a firm is aiming at a more controlled discussion and higher participation idea competitions (Terwiesch & Xu, 2008) provide the necessary environments. Such competitions focus on a limited group of customers who are invited to generate ideas in a limited time on a pre-defined platform. Through incentives and direct feedback companies can achieve a higher level of customer involvement (Ebner et al., 2009).

On the next level the best ideas are handed over to R&D. Here, customers can be invited as well. As participatory designers customers can bring in knowledge beyond problem definition and idea generation. This enables firms to "refine and validate the marketing positioning of a product through posting and receiving comments on the forum about the beta-test of its products" (Ramaswamy, 2010, p. 23). Using, e.g., "configurators, choice boards, design systems, toolkits, or co-design-platforms" (Reichwald & Piller, 2006, p. 7) companies can even guide their customers, through the configuration of products or variants of them. This approach leads customers over to traditional mass customisation and may involve activities within the final stage of innovation, where they can individualise a product by choosing from a set of options. Here, customers and their specific knowledge are also integrated to act as marketers.

Beside the above-mentioned approaches, the analysis illustrates the existence of strategies, which do not focus on a single or two stages of the innovation process. Some strategies can be applied throughout the whole process of innovation and thereby allow a deeper integration. Innovation competitions (Terwiesch & Ulrich, 2009), e.g., do not solely focus on the generation of ideas (Terwiesch & Xu, 2008). They also allow customers to accompany firms from the initial idea over an iterative review to the point of where the final product is sold. Crowdsourcing and interactive value creation have a similar focus. In both cases companies communicate tasks or problem descriptions to a group of customers and openly invite them to contribute to a solution (Ebner et al., 2009). While the former can be compared to outsourcing, the latter comprises a stronger focus on value creation. Nevertheless, the definition of both terms is blurry and not disjunctive (Helms, Booij, & Spruit, 2012). In contrast to idea generation and idea competition companies do not take sole responsibility for realisation of the ideas. In this broader view participants are also invited to support development, manufacturing and marketing (Figure 1).

4.2 Best practices

The subsequent sections each represent a category of actual projects, which were identified in current literature or practice. Their categorisation follows the differentiation made in section 4.1 and references the steps of innovation as suggested by Xu et al. (2010). Hence, the examples may be associated to more than one step of the innovation process. Plus, the overview also illustrates examples of service providers, which allow companies to use their platform to get in touch with a community, e.g. of researchers or design experts.

Due to the limited space in this paper, the following tables can only provide a limited number of examples, which each represent a larger group of OI projects identified during data collection. For each example the related company, starting year, name, and a short description of its focus are listed below.

Idea generation.

The collection of ideas from customers in addition to traditional idea generation (Sowrey, 1990) proves to be one of the most common approaches in current practice (Enkel et al., 2005; Von Hippel, 1978). Cooper and Edgett (2008) alone identified 18 sources of new product ideas in business and highlight the importance of voice-of-customer approaches and other OI strategies.

The timeline of projects identified in this study ranges from 2001 to 2012. This indicates that idea generation with customers involved within an OI context can look back to a longer history of successful projects. The examples all follow a similar routine, where the company provides a platform and lets its customers discuss ideas brought in by users. This allows them to guide the process of ideation and to harvest the most valuable ideas. Table 2 illustrates a selection of projects:

Company	Begin	Name	Focus	Source(s)
Westwood	2003	Westwood Online	Idea community for computer game	Jeppesen & Molin (2003)
Propellerhead	2004	Propellerhead Forums	Forum for feature suggestions for an existing music software	Jeppesen & Frederiksen (2006)
SAP	2007	SAPiens	Platform and community where new products and services can be submitted	Ebner et al. (2009)
Dell	2007	Dell IdeaStorm	Ideation community with sharing, discussion and voting functionality	Di Gangi & Wasko (2009)
Starbucks	2008	MyStarbucksIdea	Ideation community with sharing, discussion and voting functionality	Piller & Vossen (2012)

Table 2. Idea generation projects

Research and development.

During this stage companies may initiate, e.g., co-design projects (Piller, Schubert, Koch, & Möslein, 2006), allowing customers to bring in their knowledge for design development or during the creation of new products. Hence, this stage focuses on concepts (e.g., designs) rather than developing new goods and services. Table 3 illustrates some examples:

Company	Begin	Name	Description	Source(s)
Peugeot	2000	Peugeot Concours Design	Design competition for cars	Wei & Wei (2011)
Swarovski	2002	Crystal Tattoo Design	Design competition for jewellery	Fuller (2006)
Audi	2006	Virtual Lab	Design community for an infotainment system	Füller, Bartl, Ernst, & Mühlbacher (2006)
Swarovski	2008	Enlightened	Design competition for jewellery	Füller, Hutter, & Faullant (2011)
SPAR	2009	SPAR Bag-Designcontest	Design contest for a new shopping bag	Bullinger et al. (2010)

Table 3. Research and development projects

Prototyping and manufacturing.

After the conceptual development of new products companies select the best drafts and hand them over to production. The aim of this step is to develop prototypes for further testing as well as manufacturing of marketable products. In this regard, this stage comprises marketable products created by customers or in collaborative environments.

On the one hand customers may be involved in product individualisation and mass customisation (Piller et al., 2006) where they contribute knowledge about needs and benefits in respect of potential product combinations. On the other hand customers may also contribute to co-creation (Piller & Vossen, 2012), co-production (Bendapudi & Leone, 2003) and testing of pre-configured products. Table 4 provides some examples:

Company	Begin	Name	Description	Source(s)
Adidas	2006	miADIDAS	Individualisation platform for existing product	Moser, Müller, & Piller (2006)
Volkswagen	2009	App my Ride Contest	Co-creation of mobile apps	Kelleher, Céilleachair, & Peppard (2012)
McDonald's	2011	Baue Deinen Burger	Co-creation contest of a new product based using a configuration tool	www.mcdonalds.de/mein_burger/index.cfm

Table 4. Prototyping and manufacturing projects

Marketing and sales diffusion.

The final stage towards a commercialised idea is covered by marketing and sales purposes. In this phase companies also tap CK, e.g., by involving them in co-marketing or social commerce strategies (Koch & Richter, 2009; Piller & Vossen, 2012). Here, customers provide valuable knowledge about the target group and its preferences, e.g., regarding sales approaches, packaging, distribution channels, etc.

Due to the fact that most of the above-mentioned examples (Table 2, Table 3, and Table 4) target marketable products and their commercialisation these projects already cover aspects of CK powered marketing. Nevertheless, there are projects, which focus on marketing and promotion and do not primarily intend to develop new products. Table 5 contains a selection of suitable examples:

Company	Begin	Name	Description	Source(s)
Procter & Gamble	2002	Connect + Develop	Initiative to turn more technologies into products	Dodgson, Gann, & Salter (2006)
Google	2007	Gmail M-Velope Video Competition	Viral video-competition	mail.google.com/mvideo
Pepsi	2009	Ultimate Refresh	Competition about a song and video to promote product	www.ultimaterefresh.com
Henkel	2011	Mein Pril – Mein Stil	Design competition for labels of a washing-up liquid	Christoph Burmann, Hemmann, Eilers, & Kleine-Kalmer (2012)
20th Century Fox Germany	2012	Dein Filmplakat	Design competition about a movie poster	unseraller.de/Schlussmacher/Filmplakat

Table 5. Marketing and sales diffusion projects

Integrated/cross-process.

In addition to numerous examples, which illustrate the adoption of projects focusing on single steps of the innovation process, other approaches do not stick to one stage (section 4.1). These include, e.g., innovation competitions, which cover the process of innovation from idea generation to commercialisation or innovation communities, "distributed groups of individuals focused on solving a general problem and/or developing a new solution supported by computer mediated communication" (Dahlander & Wallin, 2006, p. 1246). As Table 6 illustrates, the examples may overlap with projects mentioned in one of the previous stages:

Company	Begin	Name	Description	Source(s)
Volkswagen	2009	App my Ride Contest	Competition about of mobile apps including ideas and customer-developed apps	Kelleher, Céilleachair, & Peppard (2012)
Mari-Senf	2010	Senf-Dip	Competition on mustard-bases products from flavour and ingredients to packaging	unseraller.de/mari_senf/senf_dip
Swarovski	2011	Lifestyle Electronics Design Competition	Design platform for consumer electronics	lifestyle-electronics-competition.swarovski-gems.com
Hibiscarin	2012	Hibiscarin Kosmetik	Competition including product tests, idea generation, and marketing by customers	unseraller.de/Hibiscarin/HibiscarinKosmetik

Table 6. Integrated and cross-process projects

The tabular overview gives examples the options companies can refer to if they are willing to utilise CK, but is not intended to be exhaustive.

Other possible strategies also include offerings by companies, which specialised on providing platforms for firms on which they can get in touch with a community or experts who solve tasks for them. This approach is often referred to as crowdsourcing. In exchange members of the platform receive rewards, prize money, or other gratifications. Typically, such ventures bring together companies with a large number of creators, inventors, designers, agencies or freelancers, depending on the focus of the platform. Additionally, many service providers concentrate on certain areas, such as product related safety, health, educational and environmental issues or designs and thereby set themselves apart from full-service providers. Other platforms give companies the opportunity to reach a community of potential customers, who test new products and spread word-of-mouth and influence the degree of popularity of a brand, e.g., among the circle of friends or beyond.

Another perspective arises from so called Idea Contests as a Service (Piller, 2007). Similar to current software delivery models for, e.g., Cloud Computing, MIS, HRM, or ERP solutions, idea contests can be sourced out to social media specialists instead of launching OI initiatives on one of the above-mentioned platforms or an own solution. Software service providers include, e.g., imaginatik, Brightidea, spigit, Pitchburner, yet2.com, or Skild.

5 Social software supported knowledge integration

While user innovation or customer innovation communities are not entirely new phenomena (Bullinger et al., 2010; Ebner et al., 2009; Fichter, 2009), improving information and communication technology (ICT) allow customers to extensively participate in innovation, e.g., through online communities (Di Gangi & Wasko, 2009) or innovation challenges. OI and crowdsourcing strategies strongly depend on a Web 2.0 infrastructure as well. To reach a community and potential customers beyond, firms do not need to rely on personal meetings anymore. Organisations can nowadays reach many of their customers through social media channels. Hence, their "innovations are reflected through the creation and exchange of user-generated content" (Helms et al., 2012, p. 3). In addition to that, virtual communities grant them access to a broad community with experts all over the world without higher expenses.

From an objective-centred perspective the implementation of innovation challenges and social software for CK integration offers three main approaches. First, some companies stick to the challenge, focus on idea generation or problem solving and expect a significant contribution to their enterprise. These examples prefer R&D or idea/design challenges on platforms, such as Innocentive, OpenIDEO, wiLOGO, or NineSigma. Although many providers also fuel the discussion, e.g., via twitter or Facebook, the focus of their programs clearly remains on the innovative output. Second, other companies try to generate 'buzz' or brand awareness around new products or competitions. In comparison to the above-mentioned examples, such companies stick to participatory marketing platforms, such as BzzAgent and trnd or use own platforms to stand out against other competitions and to avoid getting lost in a large number of projects on big-size innovation platforms (Table 2 to Table 6).

Both strategies have their own perils and virtues. While the latter may improve the recognition value of a brand, e.g., through coverage in media, without breeding an innovation, the former may, in case the challenge cannot be solved, deliver no results. Also, using third-party providers, e.g., for innovation challenges gives companies little control over the content end users post. Therefore, a third strategy, a hybrid approach, was discovered. It allows companies to benefit from both perspectives, but without guaranteeing them a highly innovative product or idea.

If we take a final look at the examples identified in this research, we see many examples that pursuit one of the three strategies. When, e.g., Henkel initiated its "Mein Pril – Mein Stil" competition in 2011, they did not invite customers to innovate their washing-up liquid or provide any other product idea. Instead they asked them to re-design labels, thus, concentrating on the viral effects caused by over 50.000 creative workers (Christoph Burmann et al., 2012). McDonald's also followed that path when they asked customers to design new burgers. By allowing participants to register via Facebook McDonald's consciously targeted the social network's wisdom of the crowd. Nevertheless, considering the fact that the winning creations were available for only a short period of time, this challenge could be also regarded as a marketing stunt rather than a serious attempt to innovate.

Volkswagen on the other hand pursued a rather hybrid strategy. Though the company's core competences do not lie in software development, they launched a contest about smartphone apps for a future infotainment system. By inviting customers as well as coders and developers they showed interest in innovative applications not only in marketable ideas. Parallel to this, VW engaged in discussions on Facebook and established a twitter account. Therefore, this approach exemplifies how such a strategy can generate marketable products, i.e. apps, and also cause a 'buzz' in social media.

Other companies, which are primarily interested in ideas, solutions, or actual products, tend to engage on platforms like Innocentive, where they post a task, a due date and offer prize money. Most of these endeavors do not include participation in community action or feedback. Some companies even trigger challenges without being named as sponsor.

6 Toward an integration concept

Although the projects analysed above indicate that many companies deliberately chose a certain strategy projecting its outcome, they often waive the possibility that a well-executed OI project can result in more than grown brand awareness. One the one hand, the wisdom of the crowd can become the curse of the crowd. As occurred, when, e.g., when Henkel decided to change the rating system for entrants shortly before their contest ended, causing a 'shitstorm' and negative reviews in the community and by media coverage. On the other hand, integrating CK may provide valuable input for innovation from numerous ideas to actual innovative products.

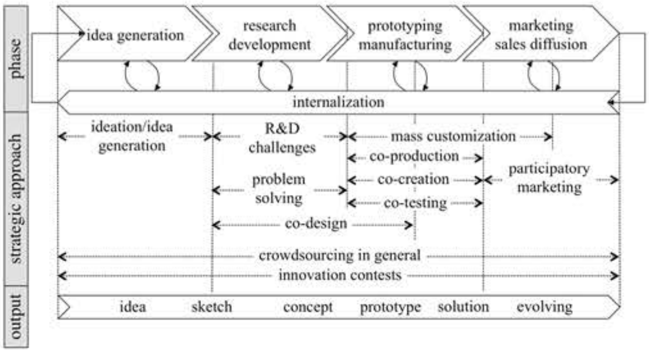

Figure 2. Customer knowledge integration across the process of innovation (cf. Bullinger et al., 2010; Xu et al., 2010)

As mentioned in section 4.1, potential strategies can range from projects that cover just one part of the innovation process to those that cover the whole bandwidth. Figure 2 demonstrates the allocation of each approach to its respective stage(s) in innovation (not claiming to be necessarily exhaustive). It also illustrates the degree of elaboration (Bullinger et al., 2010) and, thus, the output of each strategy.

7 Conclusion

In this research the author analyses and categorises current approaches that support the integration of CK across the process of innovation. Based on a study of projects and platforms throughout literature and web sources the author derives a framework, which helps companies to distinguish between OI approaches with regard to their outcome or strategic claim. Hence, the central contribution of this research is the development of a framework that helps companies determining which strategies can be followed and how social media may support them. In this regard, the study emphasises the importance of social media in current user-centred innovation activities but only grazes conditions, success factor, potential pitfalls, and the particular suitability of certain social software applications for the different strategies. Beside this practical contribution the study also provides a more theoretical one by suggesting a categorisation for CK integration approaches across the process of innovation. In addition to that, the author identifies and explicates three strategic perspectives that differentiate objective-centred, marketing-focused and hybrid approaches.

Although the research questions could be solved, there are some limitations to be pointed out. The proposed framework should be regarded as an impulse for discussion and does not claim to be exhaustive. Nevertheless, the concept should provide a better description of advantages and disadvantages of the depicted strategies regarding output, barriers, etc. Therefore, one of the goals for further research is an evaluation, which should comprise a quantitative study (e.g. identifying the most common strategies), which will allow a deeper understanding of the categorisation. Also it should be evaluated if the framework can cover other sources of external knowledge or what distinctions have to be made regarding the complexity of the desired product, the degree of innovation, or the branch of the company (cf. section 1). A prospect that could not be covered in this research, but will be studied subsequently, is the evaluation of the given alternatives regarding their particular impact on innovativeness and competitiveness. Hence, suitable criteria are needed to develop a conclusive measurement (section 7).

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Appendix

Idea Mining – Text Mining Supported Knowledge Management for Innovation Purposes

Paul Kruse, Andreas Schieber, Andreas Hilbert, Eric Schoop

Abstract: Following the emergence of Social Media and the increasing willingness of customers to share thoughts, ideas, and experiences companies are trying to capitalize on such activities. Due to the vast amount of user-generated content, manual analysis and interpretation will not meet the demands of companies in highly competitive environments. Based on an integrative process model, which describes the process of idea generation, we outline a BPMN-based path that allows companies to steer user participation and the application of Text Mining methods to gain valuable ideas for innovative products. Our approach also illustrates the Knowledge Management perspective supporting the customers during idea generation. In order to demonstrate the applicability of our model we finally depict the whole process utilizing Dell's IdeaStorm.

Keywords: Innovation, Knowledge Management, Text Mining, BPMN.

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Idea Mining – Text Mining Supported Knowledge Management for Innovation Purposes

Completed Research Paper

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ABSTRACT

Following the emergence of Social Media and the increasing willingness of customers to share thoughts, ideas, and experiences companies are trying to capitalize on such activities. Due to the vast amount of user-generated content, manual analysis and interpretation will not meet the demands of companies in highly competitive environments. Based on an integrative process model, which describes the process of idea generation, we outline a BPMN-based path that allows companies to steer user participation and the application of Text Mining methods to gain valuable ideas for innovative products. Our approach also illustrates the Knowledge Management perspective supporting the customers during idea generation. In order to demonstrate the applicability of our model we finally depict the whole process utilizing Dell's IdeaStorm.

Keywords

Innovation, Knowledge Management, Text Mining, BPMN.

INTRODUCTION

Innovation is commonly defined as "the outcome of an interactive process between the firm and its environment, as the result of the collaboration between (…) actors, located both inside and outside the firm" (Mention, 2011, p. 44). Spanning from idea generation (ideation) to their commercialization (Xu et al. 2010, p. 581) innovation requires social interaction from which knowledge is created, distributed, and adopted. Traditionally driven by internal researchers, innovation nowadays focuses more on customers' ideas driven by an open innovation approach (Chesbrough, 2003). For companies customers' communication and knowledge exchange (user-generated content, UGC) – discussing trends, product developments, and individual needs – are highly valuable. Therefore, companies should listen to their customers and integrate them into their innovation process. Beside the discussion about products companies are strongly interested in customer ideas. Ideas can be regarded as images formed in the mind written down as textual information. These images are often the base for technological breakthrough (Thorleuchter et al. 2010, p. 7182), but are mostly hidden in large amounts of data.

Following the emergence of Web 2.0 technologies, the WWW provides many opportunities to share ideas. Such diversity confronts companies with some disadvantages: As potential customers can use several technologies the amount of data from which valuable knowledge (i.e. ideas) can be extracted is vast. And beside potential ideas there is a lot of "noisy" data from these sources.

Fostering the process of ideation (Graham & Bachman, 2004) we suggest that companies should apply methods of Text Mining (TM) on the collected content. TM focuses on large amounts of textual data and its transformation into valuable knowledge. We therefore use TM methods on social media analyzing the provided content. To supply TM with data and to support customers during ideation the methods of Knowledge Management (KM) provide the prerequisites in our approach.

We develop a BPMN-based process model integrating state-of-the-art-methods of KM and TM for efficiently discovering knowledge from web sources to support the innovation process. First, the process model is aimed at motivating people to share their ideas to fuel new product development resulting in a huge text corpus. Second, our model supports the selection of eligible TM methods for an automated extraction of knowledge in the collected data. Hence, the present study helps companies to foster a steady generation of innovative ideas and thereby to sustain competitiveness.

RELATED WORK

The paper is located in three different research areas: Innovation Management, KM and TM. The importance of innovation has a very long history (Rowley et al. 2011). Although there are many efforts in innovation research, a general definition and detailed description of the innovation process itself is still missing. Utterback (1974) describes a simple process to which Desouza et al. (2009), Miles et al. (2000), and Xu et al. (2010) add aspects of KM considering the important role of knowledge in innovation.

Our second research area covers the field of KM: Gibbert et al. (2002) point out that KM enables companies to provide and maintain the requirements and resources for customers to participate in innovation and allows them to contribute ideas and feedback, discuss trends, etc. This includes technology, motivational aspects as well as the involvement of the firm's employees guaranteeing that enough UGC is available for analysis.

The analysis of that UGC content leads to TM (Felden et al. 2006; Hippner & Rentzmann, 2006; Weiss et al., 2010). TM methods are able to automatically analyze textual content and, e.g., to cluster ideas of similar topics. Many researchers demonstrated the applicability of these methods in several fields. Related to our work are applications in product development and KM (Ur-Rahman and Harding (2012)), patent technology mining (Feng & Fuhai (2012)), and even the extraction of textual information from blogs (Thorleuchter et al. (2010)). Nevertheless, their work does not provide a model to an integrated approach.

These findings illustrate that many scientists are working in this research area. Hence, a complete and integrated description of the whole process from ideation over knowledge and its management to concrete TM methods is still missing.

BACKGROUND

To fill this research gap we identified we propose a process model, which covers the peculiarities of an integrated approach between Innovation Management and KM-supported TM. Figure 1 illustrates the different perspectives and highlights the relations between each sub-step of the model.

Starting from a general process of innovation our approach strongly focuses on the ideation or idea generation phase. This phase integrates two main paths of user participation and results in product ideas and the discussion about them, which we, first, want to foster by applying supportive KM methods and which subsequently shall be analyzed through TM methods. A more detailed description of the single steps and the relation between the identified sub-processes can be found in the following chapters.

INNOVATION MANAGEMENT

It is commonly known that organizations need to innovate responding to changing customer demands as well as capitalizing on opportunities offered, e.g. changes in markets (Rowley et al., 2011). However, the process of innovation lacks a general definition. Many authors highlight several perspectives, which relate to innovation as a process, as an item (e.g., product, service, or program) or innovation as an attribute of organizations. Although we do not waive the possibility that our process model can be applied on services or processes, the present research is limited to product innovation.

Process of Innovation

Merging state-of-the-art-methods of KM and TM for efficiently discovering knowledge from UGC, we first focus on the process of innovation. It can be defined as "the generation, acceptance and implementation of new ideas, processes products or services" (Thompson, 1965). In a more specific manner, Du Plessis (2007, p. 21) describes innovation "as the creation of new knowledge and ideas to facilitate new business outcomes, aimed at improving internal business processes and structures and to create market driven products and services".

Following Utterback (1974, p. 621) the process of innovation can be divided into three stages: "generation of an idea, problem-solving or development, and implementation and diffusion." Generation involves a synthesis of diverse information, e.g., about a market or needs and technologies to meet the needs. Problem solving is concerned with "setting specific technical goals and designing alternative solutions to meet them" and leads to an original solution or invention. After that implementation, i.e. "manufacturing-engineering, tooling, and plant and market start-up required to bring an original solution or invention to its first use or market introduction" is followed by diffusion "after the innovation is introduced" (Utterback, 1974, p. 621).

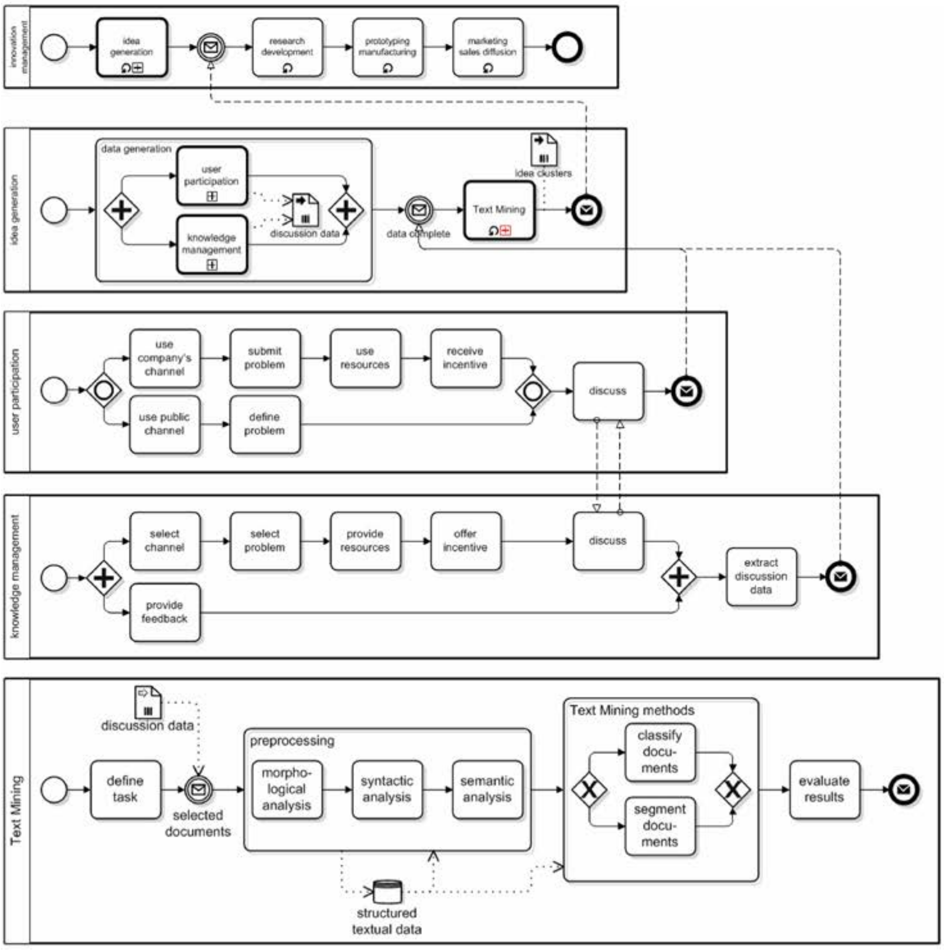

Figure 1. Overall process model

Innovation is extremely dependent on the availability of internal and external knowledge (Du Plessis, 2007). Current definitions of the process of innovation increasingly focus on the knowledge perspective, e.g., on "knowledge creation" (Miles et al., 2000, p. 304) or "knowledge commercialization" (Desouza et al., 2009, p. 23). Hence, the present study draws upon an innovation process which was developed to support the increasing importance of the knowledge perspective (Xu et al., 2010, p. 581).

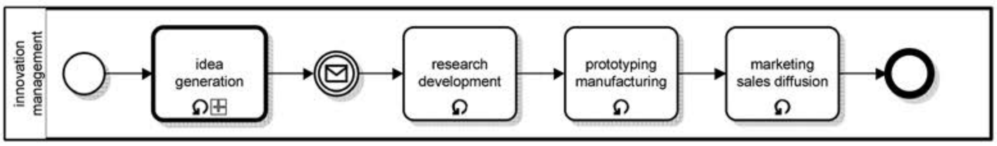

Figure 2. Process of innovation

Idea generation and research/development can be compared to what Utterback (1974) described with "generation of an idea, problem-solving or development" (p. 621). The subsequent stages separate the single stage of implementation and diffusion and thereby differentiate between early development of, e.g., a new product and its final commercialization.

APPROACH

The present paper primarily focuses on the idea generation step of the innovation process (Figure 2). We believe that this stage in particular can be supported by KM and TM methods. In order to apply these methods we divide the ideation process.

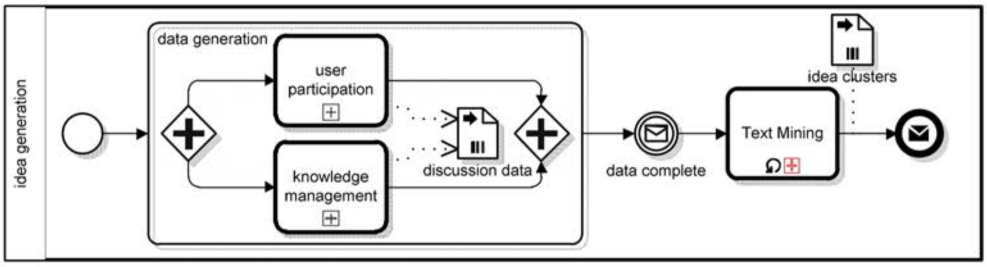

Figure 3. Process of idea generation

From a general customer-centric perspective our approach begins with user participation on suitable social media channels (Figure 3). After that data must be extracted from the channel(s), followed by the extraction of valuable data with TM methods. Subsequently, the aggregated and structured data can be handed over to R&D where the ideas are checked for suitability, reliability, etc. and the process leaves our observation focus.

Challenges of User Participation in Idea Generation

Chau & Tam (2000, p. 230) illustrate "two motivations and driving forces" behind ideation: It can be driven by technology push or by market/need pull. While the former suggests that innovation is driven by science, and thus drives technology and diffusion, the latter indicates that ideas are derived from user needs as key drivers of adoption: Figure 4 illustrates this differentiation by representing two possible ways.

On the one hand, we observed that some companies set up own ideation platforms and provide one (or more) social media channels for submitting ideas. On the other hand, companies also extract data from already established channels (e.g., Twitter).

In the first case, companies can exercise more influence on the customer. They not only control the technology and the problem (product) that needs to be innovated, they can also support ideation by offering incentives directly to the customers. The other case gives companies less power. They can only narrow down the unit of analysis in order to limit the amount of data. Nevertheless, they have to browse through vast amounts of blog posts, tweets, etc.

Like Langrish et al. (1972) other researchers have concluded, ideas from a market pull show a higher probability to gain commercial success than technology-push innovation. Plus, recent research on innovation leads to a paradigm shift towards the concept of Open Innovation (Chesbrough, 2003) focusing on tapping the knowledge of the customer. Therefore, our process model allows companies to benefit from customers' ideas.

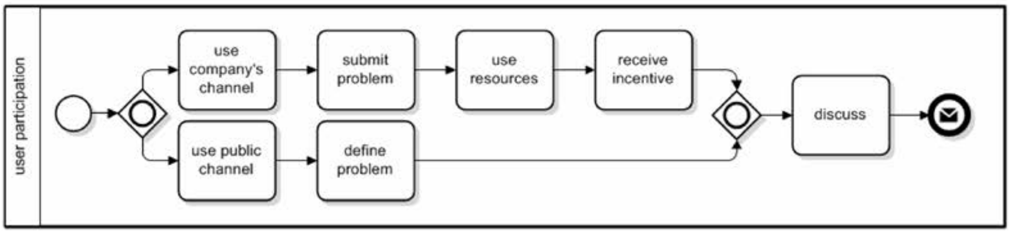

Figure 4. Process of user participation

After covering innovation and its process we now examine suitable KM methods. As mentioned above, we investigate methods that facilitate the exchange of customer knowledge. Due to the fact that customers know best what they need, they can provide most valuable ideas for innovative products. If companies collaborate with such bearers of external knowledge (Kang & Kang, 2009) they will be able to cope with shortened innovation cycles, rising R&D costs, etc. (Gassmann & Enkel, 2004).

Hence, the key questions remain, how companies can tap such knowledge/ideas, where do good ideas come from and what can companies do to push external ideation?

Knowledge Management in a Web 2.0 Environment

With the emergence of Web 2.0 customers participate in communities, networks, and other social media activities. After purchasing a product customers review the product providing recommendations for others, name positive and negative characteristics and discuss possible improvements or entirely new ideas.

When companies are willing to harvest such valuable input, they must overcome several obstacles:

- Customers tend to criticize and discuss a product only if it failed to match their expectations. Providing valuable ideas and suggestions to improve a product depends on the individual motivation of the customer.
- Many customers do not address companies directly. Unless the company has its own feedback system through which customers exclusively provide their feedback, innovators have to retrieve such data all by themselves.
- Web 2.0 offers a wide range of communication channels that can hardly all be monitored or controlled. Some of these may even be private and not accessible for non-invited users. Therefore, companies must focus on the most important channels in order to gather the best input from them.
- The variety of UGC is equally huge. It spans from limited-character messages (e.g., on micro-blogs or social networks) to detailed and more elaborated essays (e.g., on blogs).
- As a result, the relevant data is mostly unstructured and available in vast amounts.

Depending on the particular situation, we identified two general approaches and KM supported paths that can push the extraction of textual data (Figure 4): From a KM perspective, a company can, on the one hand, establish an own platform or channel to gain full control over product discussions. On the other hand, the focus can remain on selected public channels, such as blogs, micro-blogs or social networks. Thus, bias caused by the presence of the company during discussion or the need to invest and administrate an own platform can be avoided. In both cases companies rely on methods and techniques, which provide them with the required knowledge. They always must collect data from web sources in form of unstructured textual data.

KM offers a wide range of practices to identify, extract, create, distribute, and adopt external customer knowledge fostering innovation. For example: Companies, such as SAP (SAPiens), Lufthansa (Air Cargo Innovation Challenge), or Dell (IdeaStorm) are increasingly drawing in external ideas from customers by providing a central platform. Other companies, such as Subway's (Subway Fresh Buzz) or McDonald's (McCafe Your Day) limit their activities to certain social media channels (e.g., own Twitter channels) and thereby allow and encourage customers to provide innovative ideas. Thus, the latter do not limit the customers' creativity to a specific task (innovation/idea contests) or a certain product (co-design, co-creation, etc.) but are less visible than companies with own platforms. In addition, they cannot offer incentives directly or benefit from community effects. Following a third approach, companies can also refuse to set up an own channel and focus just on existing channels (Kruse, 2012). Thereby, they attract even less direct feedback and lose any control over the communication of customers, but can access a much bigger data pool. Recent studies illustrate that, e.g., the amount of tweets has increased by nearly 700% over the last two years (Blog.twitter.com, 2012). Hence, companies can access large amounts of data even without establishing own channels.

Knowledge Management supported Idea Generation

From a KM perspective companies should engage in certain activities supporting the ideation. Cooper & Edgett (2009, p. 94ff.) identify 18 different sources of new product ideas. We consider most of them suitable to feed the phase of ideation with valuable data. Nevertheless, some methods such as patent mapping, open innovation with vendors, and ethnography depend on physical contact with the source, are rather inward-looking or do not involve any Social Media channel. Due to our research limitation we rather focus on those sources and methods that comprise customer knowledge, such as customer brainstorming, communities of enthusiasts, external idea contests, etc. Finished designs from customers or open innovation projects with partners and vendors may also be interesting for our research, but only if they cover at least one of the above-mentioned idea generation and KM paths.

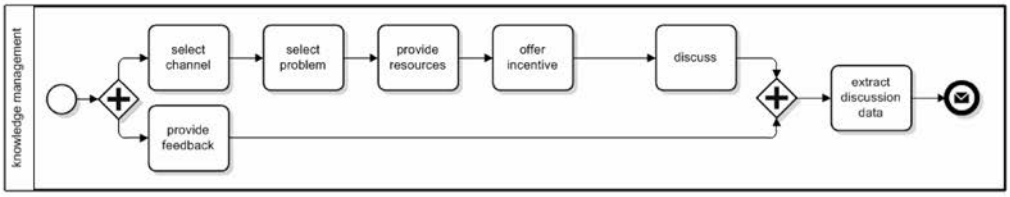

Figure 5. KM supported idea generation

In general, Web 2.0 with its new application classes not only allows companies to tap more channels through KM, it also facilitates the collection of customer knowledge (i.e. ideas). Effective KM may also lead to a better understanding of demands, better product ideas, more innovative products, a shorter time to market and lower product costs. Hence, in order to overcome the above-mentioned obstacles and to provide data for TM a company's KM must ensure the following points:

Support the process of ideation. To allow a direct collection of ideas, companies can run, e.g., innovation contests (Bullinger, Neyer, Rass, & Moeslein, 2010). Here, as customers are invited to provide solutions to a well-defined problem, no extensive data analysis is necessary. For an indirect extraction of valuable data, e.g., tweets or blog posts prove to be a suitable base for TM.	Select the right Social Media channels and, if necessary, limit their number.	Provide the necessary resources (Di Gangi & Wasko, 2009, p. 304) actively listen or comment.
Invite customers, offer incentives and guarantee openness, to motivate them (Fu, 2012).	Secure the sourcing of knowledge through social media channels. Therefore, employ the right methods to deliver such knowledge (Ribière & Tuggle, 2010).	Extract content from different websites (e.g., blogs, Twitter, Facebook, etc.).

Hence, our KM perspective supports customers to provide valuable knowledge, motivates them to participate and ensures data extraction for subsequent TM (Figure 5).

Analyzing Unstructured Data with Text Mining

After data extraction we collected a huge textual corpus. In order to reduce labor costs which would incur by reading and classifying the collected texts, it is necessary to analyze this data using appropriate algorithms.

Description and Process of TM

Related to the methods of data mining discovering patterns in structured data TM methods reveal information in unstructured textual data (Weiss et al., 2010, p. 1). TM describes the partially automated discovery of new and valuable knowledge from text documents (Feldman & Sanger, 2006, p. 1; Hippner & Rentzmann, 2006, p. 287). Because of the mentioned relationship to data mining the process also shows several pre-processing tasks preparing the data (Figure 6).

Task Definition and Document Selection

The first step in any TM project is to define the objectives. In our case the task is to understand customer ideas. Therefore, we group the collected data in homogeneous segments containing similar content. Afterwards, we select the relevant documents, in our case represented by UGC extracted from Web-2.0-channels (Figure 4).

Pre-processing

Before we can apply TM methods and identify idea clusters, several pre-processing tasks have to be performed. This step is very important and comprises necessary tasks structuring the otherwise unstructured text data. Therefore, terms (or tokens, i.e. a single word or a group of words) representing the documents are extracted and set into relation with each document (Weiss et al., 2010, p. 16). For term extraction are used methods of the research area of natural language processing which are separated in three groups: morphological analysis, syntactic analysis, and semantic analysis (Hippner & Rentzmann, 2006, p. 288).

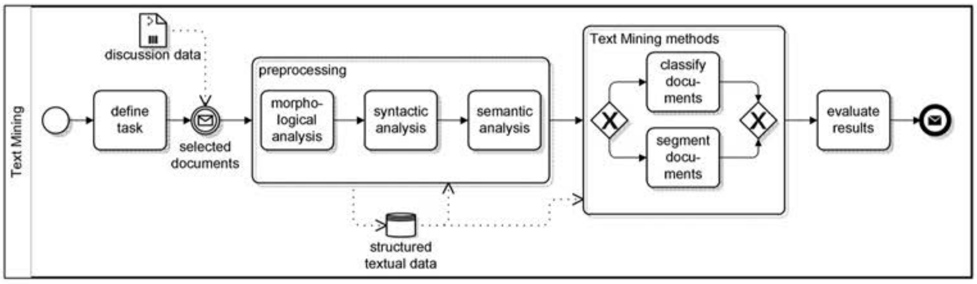

Figure 6. TM process

The aim of the morphological analysis is to reduce the complexity for analysis methods (Weiss et al., 2010). Complexity in text analysis correlates with the word count: irrelevant words or terms have to be removed. Therefore, we convert terms into a unified expression. This procedure is called stemming or lemmatization (Hippner & Rentzmann, 2006, p. 288; Weiss et al., 2010, p. 18). For example, the words "complexity" and "complexities" are different terms but are forms of the same word. With stemming such terms are identified and normalized. Another possibility for complexity reduction is to remove stop words (Heyer et al., 2006, p. 80). Stop words are words or terms, which appear very often (e.g., articles or pronouns) and have no special meaning within the text.

The aim of the subsequent syntactic analysis is the annotation of the terms with part of speech (POS) tags structuring the raw text data and extracting information selectively, e.g., concentrating on proper nouns or adjectives (Heyer et al., 2006, p. 112; Ur-Rahman & Harding, 2012, p. 238; Weiss et al., 2010, p. 31). For POS-tagging a dictionary showing word-POS correspondence can be useful (Hippner & Rentzmann, 2006, p. 288). Afterwards the terms are analyzed regarding their function in a sentence, e.g., subject, predicate, object, allowing us to select information from specific syntactic units.

The aim of the final semantic analysis is the detection of the context the document deals with (Hippner & Rentzmann, 2006, p. 289). Since specific words have different meanings, this procedure tries to discover the right intent. This task can also be supported by a dictionary or a product database containing terms in the relevant context (Schieber et al., 2012).

After pre-processing the raw text data obtained a kind of a structure: sentences are separated in relevant terms, POS- and sentence-functions are determined, and the context within the idea texts is revealed. Thus, we prepared the data for applying the TM methods.

Text Mining Methods and Evaluation

As mentioned before, our task is to divide the corpus in groups with similar content (i.e. ideas). Since our aim is not to provide new methods for TM, we use two established methods: first, we classify the documents into existing groups, and second, we segment the documents regarding their content.

Methods of text (or document) classification are related to traditional data mining methods coping with classification tasks. These methods require an existing catalogue of possible classes by which the documents can be merged (Felden et al., 2006, p. 2; Weiss et al., 2010, p. 6). In context of innovation processes we should elaborate this catalogue with regard to knowledge and innovation management. Suitable approaches are, e.g., decision trees, Naive Bayes, or Support Vector Machines (Felden et al., 2006).

In contrast to text classification as described above, we can segment the documents using text cluster algorithms (Heyer et al., 2006, p. 195; Weiss et al., 2010, p. 91). Therefore, we do not require a predefined catalogue: the method finds the clusters by itself scoring the document similarity. The similarity is evaluated by comparing terms: documents containing similar terms are merged in a cluster. An advantage of this procedure is that we are able to detect classes, which we did not bear in mind previously. As traditional clustering methods we suggest, e.g., k-Means (Weiss et al., 2010, p. 96) or co-occurrence-based approaches like topic models (Blei & Lafferty, 2009; Sommer et al. 2011).

After performing the TM methods we can evaluate the document clusters by browsing in a specific segment for further analysis. In particular, when segmenting the documents without a predefined catalogue, we can gain important insights by evaluating the keywords of the found segments. So, we get a feeling about the problems or ideas our customers have. This clean set of ideas is handed over to R&D, the subsequent step in the innovation process (Figure 2) where the ideas are checked for suitability, etc.

APPLYING OUR MODEL ON DELL'S IDEASTORM

To illustrate the applicability of the proposed process we apply the different steps on Dell's ideation platform IdeaStorm. Since its introduction in 2007 customers submitted 18,500+ ideas, voted 740,000+ times, and thereby contributed to the implementation of 520+ ideas (IdeaStorm.com, 2013). On IdeaStorm, users write articles containing their ideas, vote for them and add comments. With this platform Dell's main interests are ideas to new products/services. Therefore, we use this platform as an example which can be allocated to our process of innovation (Figure 2) and which illustrates the applicability of our overall process model very well.

The first step of the process of innovation is the idea generation dealing with user participation and KM (Figure 3). Referring to a specific idea[1] and the discussion about it, we explain the applicability of our process model. The idea – dealing with color variations for PCs – was posted on August 1st, 2012. Following the upper path of the process of user participation (Figure 4), the user published his idea ('submit problem') on Dell's platform ('use resources'), Dell motivates contributors by highlighting their reputation ('receive incentives'). The idea received 25 votes, one extension (fostering the evolution of the idea through user collaboration) and 29 comments ('discuss') by other users and a Dell Partner representing the Dell's KM (Figure 5). On IdeaStorm ('select channel') the Partner looks for new ideas ('select problem') and discusses them with the community providing feedback. The last step of the company's KM is the extraction of discussion data. Regarding this example, we extract the description of the idea itself, the extension, and the comments. In turn, the comments to this idea can be separated in those containing commendations, useful hints, opinions, or off-topic statements.

In this simple case we can easily group and aggregate the information regarding this idea. As this platform contains 18,500+ ideas, some of them can be similar or refer to similar concerns. Besides, there are 97,000+ comments, which have to be analyzed to get an idea about the users' commitment. Dell also interacts with customers through several other Social Media channels, which have to be considered in an integrated innovation process. Facing this situation, we support the last step of idea generation with TM methods analyzing the discussion data automatically. Following Figure 6 after defining our task – i.e. group ideas/comments – we have to pre-process the textual data (e.g. separating terms, identifying adjectives/nouns/synonyms/misspellings) before we segment the extracted documents obtaining a list of similar ideas. Afterwards, we can evaluate the results and start another analysis looking into the comments of the corresponding ideas. After the successful detection of a valuable idea the subsequent step is to submit this idea to the step of R&D in the process of innovation. For the mentioned idea the Dell Partner set its status to 'under review' showing the community Dell's interest on their concern.

Overall, the example above illustrates how much data can incur and how important useful automatic procedures can be in order to gain advantage from listening to customers. Nevertheless, our proposed model still requires further evaluation.

CONCLUSION

With the emergence of Social Media the amount of UGC that covers valuable ideas is too high to be handled. Therefore, if companies aim to capitalize on customer knowledge by identifying such ideas manual analysis and interpretation will not meet their requirements in today's competitive environment.

In order to facilitate the analysis of UGC and ideas we suggested an integrated process model. As a prerequisite of analysis we illustrated how KM and selected methods allow companies to source data from Social Media and highlighted the importance and implementation of customer support during ideation. After that we showed the potentials of TM methods to identify structures in the extracted data and how to embed them into the process of innovation.

Following our process, we believe that companies can start the subsequent steps of innovation on a more sophisticated level, as they gathered valuable ideas from a range of sources they were not able to handle or even access before. In addition, we

[1] Color variations for PCs, http://dell.to/VlyGa4

illustrated the dependencies between each step and developed a methodology that covers the process of ideation from user participation through supporting KM methods to TM and its results.

The depicted process model makes no claims of being exhaustive. It should be regarded as a road map, which covers the main paths but is open to side roads. Hence, we believe that other TM (e.g., Opinion Mining for prioritization of ideas or Document Warehousing for long-term analyses) or KM methods (e.g., Social Media supported brainstorming or focus groups) can be included into the process. This would also require a proof of concept.

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Appendix

How do Tasks and Technology fit? – Bringing Order to the Open Innovation Chaos

Paul Kruse

Abstract: Open innovation (OI) projects comprise various steps from the generation of ideas and their development to the market launch of a product (or service). Each step of the innovation process consists of tasks whose execution results in particular outputs. Following the paradigm shift towards OI, organizations increasingly allow external stakeholders to contribute during these steps by taking over certain tasks. Although the general benefit of OI is considered to be positively influential on innovativeness and competitiveness of a new product, the individual output of each task and, thus, the OI project varies tremendously. Research illustrates a broad range from projects with a focus on just initial idea generation to ones that result in complex strategies and marketable solutions. The question remains, which tasks or sub-tasks are involved in OI projects that lead to one particular output? To answer this question, the present study analyzes existing research on open innovation projects and summarizes the tasks that are performed.

In addition to this process-oriented perspective, the technical side, i.e. the support of innovation tasks by ICT, lacks research. Recent developments, especially regarding social software, present new approaches to support these tasks. Hence, this paper uses its initial findings to develop profiles of fit between tasks and technology. By adapting the Task-Technology-Fit theory by Goodhue and Thompson (1995) this research helps organizations to select the most suitable application for a specific task.

Keywords: Open Innovation, Task-Technology-Fit, Social Software, Task.

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HOW DO TASKS AND TECHNOLOGY FIT? – BRINGING ORDER TO THE OPEN INNOVATION CHAOS

Complete Research

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Abstract

Open innovation (OI) projects comprise various steps from the generation of ideas and their development to the market launch of a product (or service). Each step of the innovation process consists of tasks whose execution results in particular outputs. Following the paradigm shift towards OI, organizations increasingly allow external stakeholders to contribute during these steps by taking over certain tasks. Although the general benefit of OI is considered to be positively influential on innovativeness and competitiveness of a new product, the individual output of each task and, thus, the OI project varies tremendously. Research illustrates a broad range from projects with a focus on just initial idea generation to ones that result in complex strategies and marketable solutions. The question remains, which tasks or sub-tasks are involved in OI projects that lead to one particular output? To answer this question, the present study analyzes existing research on open innovation projects and summarizes the tasks that are performed.

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1 Introduction

Open innovation (OI) is a powerful phenomenon that has turned into a rich concept over the past years. It aims at improving the innovation process of organizations (Carbone, Contreras, Herández, Gomez-Perez, & Hernández, 2012) and puts the collaborative creation and development of ideas and products to the fore. In practice OI projects comprise various steps beginning with the generation of ideas and ending with the launch of a new innovative product (Kruse & Geißler, 2012). The majority of these steps include several sub-steps and a chain of tasks, which are executed in order to develop and market innovative products. This study adds knowledge to this field of research from two overlapping perspectives: open innovation tasks and their supportability through social software applications.

Although the general benefit of OI is considered to be positively influential on the innovativeness and competitiveness of new products (Chesbrough, 2006; Gassmann, Enkel, and Chesbrough, 2010), the individual output of each OI project varies tremendously. Bullinger and Moeslein (2010) relate this observation to the *degree of elaboration* of an idea. Following their research we can distinguish between *ideas, sketches, concepts, prototypes, solutions* and *evolving* (Bullinger and Moeslein, 2010, p. 4). Although their model bases these levels on different design elements focusing on innovation contests, it remains unclear, which stage of an OI project leads to one (or more) of the above-mentioned degrees of elaboration, i.e. outputs. A first step towards filling this gap was outlined by Kruse (2013) who aligned OI approaches identified during a literature review on the process of innovation. His study illustrates that different OI projects and their underlying methodological approaches lead to different degrees of elaboration. Nevertheless, a concise description of a chain of tasks towards such levels of elaboration is still missing.

In addition to that process-oriented perspective, the technical side, i.e. the support of each task and sub-task by ICT, lacks research. Recent developments, especially regarding social software, present new approaches to execute and support tasks on the path towards the launch of a new innovative product. Due to the great variety of social software applications, the specific benefit of each option for solving OI tasks remains unclear.

Against this background, this study fills two gaps in research:

(1) by proposing generalizations for processes, which represent the tasks and sub-tasks to be executed during each step of the process of innovation in an OI environment, and

(2) by developing fit profiles in reference to the Task-Technology-Fit theory by Goodhue and Thompson (1995) and Zigurs and Buckland (1998), which represent well-fitting OI task and social software application combinations.

As a result, this research introduces an overall process model subsuming OI tasks related to each stage of the process of innovation (Section 3). Based on these processes, a subsequent analysis indicates which OI stakeholders qualify for each task/process and thereby illustrates deviating paths within each step of the overall process, that ask for different stakeholders. Finally, following the aggregation of basic social software end-user functionalities (Section 4), another analysis points out how each task can be supported by the implementation of social software and which application appears to be more suitable to increase innovation performance (Section 5). This also sheds light on blind spots and gaps of current solutions, which should be investigated in future research (Section 6).

2 Related Work

Guided by the purpose of this research, this paper applies the theory of Task-Technology-Fit to open innovation environments and serves to enhance and supplement current knowledge. The theory fills a current gap by first separately defining *task*, *social software*, i.e. social software technologies, as well as *fit.* Due to the limitation of space, a broader focus on dimensions of *innovation performance* has to be neglected in favor of the previously mentioned basics.

Originally, Task-Technology-Fit is a theory developed for guiding the selection of suitable group support systems for group tasks (Zigurs and Buckland, 1998) or similar technologies for individual tasks (Goodhue & Thompson, 1995). In this paper I explore the adoption of the Task-Technology-Fit Theory for open innovation tasks and social software applications. To do so, we first need to understand how the process of innovation in an OI environment can be divided into tasks. This requires an understanding of what a task is and how it can be distinguished from the process itself. Therefore, the following section introduces the basics on tasks as well as a work definition for the subsequent investigation of the Task-Technology-Fit. This study is not intended to investigate all tasks, which can be related to OI, but those which are crucial for a single or more stages of the process of innovation (cf. Xu, Houssin, Caillaud, & Gardoni, 2010) in the given context.

Task-Technology-Fit is defined in the form of ideal profiles of task/technology alignment along the process of innovation. In addition to that, propositions are presented for predicting the influence of social software on (open) innovation performance and therefore enhanced innovativeness in an OI environment, i.e. success.

2.1 Open innovation tasks

The definition of task relies on McGrath's understanding of what a group or an individual in a group does (McGrath, 1984). He differentiates between 4 quadrants and 8 types of tasks, which categorizes the steps of a group process and their notions (McGrath, 1984, p. 61f.): (1) generate alternatives (planning and creativity), (2) choose alternatives (intellective tasks and decision making), (3) negotiate (cognitive conflicts and mixed-motive tasks), and (4) execute (contests/battles and performance tasks).

Since open innovation strongly depends on a collaborative culture (Standing and Kiniti, 2011, p. 293) it also emphasizes team work and group effort rather than just individual effort and reward (Standing and Benson, 2002). Thus, the types of tasks performed in a group environment are similar to those executed an OI environment (Bergman, Jantunen, and Saksa, 2009) and involve every quadrant of the *Group Task Circumplex* from generating ideas (quadrant 1) to executing tasks (quadrant 4).

Nevertheless, in contrast to traditional or closed innovation (Chesbrough, 2003) the interpretation of tasks in the subsequent sections assumes some specific characteristic of open innovation tasks and thus refines McGrath's (1984) understanding. Herzog (2011) summarizes the underlying understanding with 5 principles: First, organizations do not need to become the employer of "all the smart people anymore" (Herzog, 2011, p. 22). In an open innovation environment they should rather try to work with them inside and outside the firm. For solving OI tasks this means that organizations are increasingly involving external experts and customers. Second, innovative efforts do not necessarily require a "firm to discover, develop, and market everything" (Herzog, 2011, p. 19). Open innovation follows the idea that such activities can also be solved outside the firm – internal innovation efforts should be aware of these activities and try to generate a value for the organization out of them. This is closely related to, third, the need to find a better business model instead of being the first one to market an innovative idea. This includes, fourth, not being the firm with the "best and most ideas, but [the one making] the best use of internal and external ideas" (Herzog, 2011, p. 22). Thus, open innovation comprises not only gathering and developing ideas to a quantitatively larger extent and handing tasks to numerous external (co)innovators, but also a strategically more customer-led and market-oriented idea development (Di Stefano, Gambardella, and Verona, 2012). The fifth principle states that intellectual property (IP) management should be handled more loosely in comparison to traditional closed innovation. Although this allows competitors to benefit from the firm's IP, it also helps them to benefit from their competitors' IP, if they have opened their innovation process in a similar manner. Hence, OI does not ignore that every single task executed by someone who is not part of the organization could be executed for a competitor as well.

Open innovation tasks in general span a broad range. In contrast to traditional or closed innovation firms do not only search for customer needs or problems to be solved, but also for external stakeholders to be involved in innovation tasks (Kruse, 2013). These external players include, e.g., "inventors, start-ups, small entrepreneurial firms, partners, and other sources of available technologies that can be used as a basis for internal or joint development" (Cooper, 2008, p. 231). Focusing on the phases of the process of innovation and the involved tasks, firms are also seeking external developers, scientists or even "external innovations that have already been productized" (Cooper, 2008, p. 231) in order to integrate them. On the other side, they may provide licenses for IP which they do not utilize and thus skip/avoid tasks which would lead to the commercialization of the IP.

2.2 Towards an open innovation process

To improve the comprehensibility of OI tasks and their interdependencies this section examines possible tasks and sub-tasks and summarizes previous research in that field.

Starting with the **generation of ideas** as the first phase of the process of innovation (Xu, Houssin, Caillaud, and Gardoni, 2010) Bergman et al. (2009) introduced a structure for tasks that lead to a set of evaluated and prioritized ideas (Bergman et al., 2009, p. 147). Although they focus on Group Decision Support Systems (GDSS), they identified seven sequential phases beginning with a (1) *planning* stage, where objectives, an agenda of tasks and the ideation method are defined. After that the (2) *ideation* takes place. Bergman et al. (2009) suggest a brainstorming session, which in their case comprises a group session of 6 to 10 participants. In a more open context, the size of such a group would not be limited. Other ideation options are, e.g., lead user analyses (von Hippel, 1986), ideation contests (Poetz & Schreier, 2012), focus groups (Cooper & Edgett, 2009), or active search (Herring, Jones, & Bailey, 2009). Subsequently, the participants have to (3) *review* their ideas, i.e. *specify* any peculiarities/characteristics and *clarify* ambiguities/uncertainties, to make sure that the ideas can be prepared for R&D. (4) *Managing* ideas comprises not only *categorizing* and *commenting/discussing* them, but also an *evaluation* and *prioritization*. The final (5) *selection* of the best idea (depending on the specific context) bases on customer *voting/rating* of the generated ideas and who may also put them in reference to each other. This *evaluation* allows companies to *filter* the most suitable idea(s) and hand them over to the subsequent step of the process of innovation (Xu et al., 2010).

Plan/define, idea generation (brainstorm, search, etc.), review (specify, clarify), manage (categorize, comment, evaluate/rate, vote/prioritize/filter), select

The central output of this phase are sets of ideas and further descriptions of them. Bergman et al. (2009) close the idea generation process with an (6) *evaluation of the innovation process,* which, from the author's point of view, should be a recurring part – not only of the first phase of the process of innovation. Most notably, the execution of a method (i.e., ideation technique) might ask for a review of the method itself if it did not lead to the expected number or quality of ideas (based on a review of the results). Hence, a feedback loop should be integrated between every stage of the process of innovation.

The second phase of the process of innovation (**research & development**) also consists of sub-steps with distinct tasks. Current literature offers a variety of systematizations or models, which help to distinguish these tasks. One of the most prominent ones is the *New Concept Development Model* introduced by Koen et al. in 2001, which generalizes this 'fuzzy front end' of innovation processes. The authors suggest that after selecting an idea a concept and technology development stage is necessary before starting new product development (here: manufacturing & prototyping). During this part the firm not only develops the business case for an idea, but also considers its market chances, required investments, and potential competition (Koen et al., 2001, p. 51). Based on this estimation, the firm defines the next steps towards the ideas' transformation into concepts. Following Cooper's (2008) *Stage Gate* model, this may also involve the development of initial designs and first prototypes. Nevertheless, the main tasks of this part of the process of innovation are the further development of previously generated ideas. From the organization's perspective, this may involve (1) (re)adjusting the objectives and deriving R&D tasks during the *planning* stage, literature (2) *research*, patent *search*, resource gap identification as well as material acquisition (Cooper, Edgett, and Kleinschmidt, 2002a, p. 27). From an OI perspective and the external point of view this stage comprises tasks leading to concepts, design sketches, etc. (Bullinger and Moeslein, 2010). Therefore, the range of sub-tasks is very broad and spans the spectrum between *creating designs,* e.g., for a label of a washing-up liquid (Burmann, Hemmann, Eilers, and Kleine-Kalmer, 2012) over *developing concepts* for complex infotainment systems in the automotive industry (Kelleher, Céilleachair, and Peppard, 2012) to *solving* specific innovation challenges/contests (Bullinger, Neyer, Rass, and Moeslein, 2010). Hence, the generalizability of such tasks is challenging. Nevertheless, all projects analyzed have tasks in common, similar to steps (3) to (5) from the previous phase of the process of innovation, which are also part of a general group decision process (Laaksonen, Edelmann, and Suikki, 2001):

Plan/define, search/create/develop/design/solve, review (specify, clarify, enhance), manage (categorize, comment, evaluate/rate, vote/prioritize/filter), select

The central output of this phase are sets of drafts, concepts, or designs (in different stages of development) as well as solutions for product developments and further descriptions of the aforementioned.

After the conceptual, content-oriented steps of the process of innovation **prototyping and manufacturing** involve project-oriented tasks that lead to a marketable product (Boeddrich, 2004). As in the stages before, this comprises (1) *planning, selecting,* and (2) *executing a method*, i.e. a method supporting manufacturing and production. Cooper et al. (2002a) associate this step with tasks, such as *experimental work*, preliminary market *assessments*, and feasibility *tests* (Cooper et al., 2002a, p. 27). So before a product enters a market, the open innovation project manager has to make sure that the idea (turned into a concept) is presented to the public opinion. Until then, this involves not only *manufacturing* prototypes or variants of a product but also (3) *customizing* and *improving* existing ones, or *combining* (pre)products. After that, similar routines as those mentioned in the two previous phases take place, when customers or other stakeholders are invited to (4) *categorize* the collected product samples, *comment* them, *evaluate* them and participate in the (5) *selection* of the most promising one.

Plan/define, experiment/produce/manufacture/(co)develop, review (assess/test/combine/customize, improve), manage (categorize, comment, evaluate/rate, vote/prioritize/filter), select

The central output of this phase are products in early as well as final stages of development.

In the final phase of the process of innovation (**marketing & sales diffusion**) the open innovation perspective returns to the strategic view when marketing strategies come to the fore. This again involves (1) *planning* and *defining* the objectives of this phase. Regarding the recent emphasis, e.g., on viral marketing and consumer-generated advertising (Schultze and Prandelli, 2007) customers become co-marketers when they are involved in (2) *generating* customer-oriented *strategies*. Beside the involvement in strategy development, customers integrated into previous innovation tasks may also become first buyers or act as *promoters* of their own ideas, and turn into *sales persons*. If presented to a set of alternative strategies, customers again (4) *categorize*, may *comment* or *evaluate*, and *vote* for strategic alternatives. Subsequently, they also may be involved in (5) *selecting* the best alternative and (6) be part of the above-mentioned *marketing* activities.

Plan/define, (co)develop strategy, review (specify, clarify), manage (categorize, comment, evaluate/rate, vote/prioritize/filter), select, (co)execute strategy (promote, sell, (co)market, etc.)

The central output of this phase are marketing strategies and in-depth descriptions of how to market the previously developed products. In addition to the already mentioned outputs of each stage, OI projects generate a lot data from evaluating, rating, prioritizing, and categorizing the results of each stage.

Summarizing this section, it shows that there is a multitude of tasks to be solved within each stage of the process of innovation. Despite the lists derived from literature for each stage there is still no particular order in these tasks and sub-tasks. Therefore, the subsequent section (Section 3) sheds light on categorization and structuring approaches for the aforementioned findings.

3 Bringing Order to the OI Chaos

As mentioned before, this section offers a first glimpse on potential categorization and structuring approaches for the tasks identified in section 2. After providing and discussing different category systems this section leads to an overall process model which brings the tasks from section 2.2 into an order. Additionally, different characteristics are introduced which help to structure OI tasks.

3.1 Structuring open innovation tasks

Coming back to the *Group Task Circumplex* (cf. Section 2.1) the tasks identified can now be realigned to the above-mentioned quadrants. Table 1 illustrates the categories comprising the described tasks.

Quadrant	Task/Sub-Task
I – Generate	Plan, idea generation, (co)develop strategy
II – Choose	Search, categorize, enhance concept/design…, combine (pre)products, customize (pre)product, select
III – Negotiate	clarify idea, specify idea, clarify concept/design..., specify concept/design…, clarify strategy, specify strategy comment, evaluate, rate, vote, prioritize, filter
IV – Execute	Create, develop, design, solve, experiment, produce, manufacture product, (co)develop product, assess (pre)product, test (pre)product, improve (pre)product, (co)execute strategy

Table 1 Open innovation task categories I (cf. McGrath, 1984)

Although such a categorization helps to identify similarities with regard to the technological supportability of each individual task (in preparation for filling research gap 2), the four categories each still subsume groups of tasks with particularly differing requirements. Therefore, a more detailed categorization is needed.

In reference to Nissen, Kamel, and Sengupta (2000) Pirkkalainen and Pawlowski (2013) developed a life cycle that comprises basic knowledge management tasks and maps them to social software functionalities. Since the acquisition, transfer, integration, and absorption of knowledge plays a significant role in open innovation or innovation processes in general (Cohen and Levinthal, 1990; Gassmann et al., 2010; von Hippel, 1986) the aforementioned research can be adapted to the present context and reused for the categorization of OI tasks. The steps of the life cycle include *create*, *organize*, *formalize*, *distribute*, *identify*, *apply*, and *evolve* and thus allow a differentiated more task-oriented categorization compared to McGrath (1984) and Table 1.

Life Cycle Step	Task/Sub-Task			
	Idea Generation	**Research & Development**	**Prototyping & Manufacturing**	**Marketing & Sales Diffusion**
Create	generate ideas (brainstorm, etc.)	create, develop, design	produce, manufacture, (co)develop	(co)develop strategy
Organize	plan, define, categorize	plan, define, categorize,	plan, define, categorize, combine	plan, define, categorize
Formalize	specify, clarify	specify, clarify	assess, test	specify, clarify
Distribute	comment	comment	comment	comment, (co)execute strategy (promote, market, sell, etc.)
Identify	evaluate, prioritize, select	search, evaluate, prioritize, select	evaluate, prioritize, select	evaluate, prioritize, select
Apply	filter	solve, filter	filter, experiment	filter
Evolve	rate, vote	enhance, rate, vote	rate, vote, customize, improve	rate, vote

Table 2 Open innovation task categories II (cf. Pirkkalainen and Pawlowski, 2013)

Table 2 illustrates how the identified tasks can be aligned to the suggested categories. Step 1 *create* involves creativity during the generation of new ideas, concepts, and strategies as well as capturing and acquisition of existing ones. The following step *organize* includes tasks that aim at developing structures (e.g., taxonomies, ontologies) and plans out of the results from creative tasks. Thus, these tasks aim at (re)using or combining ideas, concepts, or strategies. *Formalize*, as step 3, involves tasks focusing on standardization or harmonization. These efforts aim at explaining and amplifying first results on their way to an innovative, marketable product. Step 4 d*istribute* concentrates on providing access to the results for customers, e.g., as external reviewers, users or future customers who then comment on the ideas and concepts or finally distribute them by themselves as part of the marketing and sales diffusion phase. Apart from the generation of ideas internally, OI also involves the identification of external IP that could be marketed or the identification of experts and expert opinions on ideas or concepts which is part of the fifth step *identify*. The subsequent tasks of the step *apply* aim at turning concepts, ideas, strategies into decisions and utilizing them to solve problems (Nissen, 1999). These tasks are the basis for the identification of room for improvement. The latter is already part of step *evolve*, where the developed ideas, concepts, strategies are subject to an evaluation. Here, external experts, users, and customers are invited do grade, rate and vote on the results, which is the fundament for further development or a customization, recombination of solution(s).

For the remainder of this research this categorization shall serve as a link between OI tasks and social software application that support them. To further structure the tasks in preparation for a task/technology alignment, the following paragraphs describe a framework that reflects the *Group Task Circumplex* and aims at bringing the tasks into a comprehensible order.

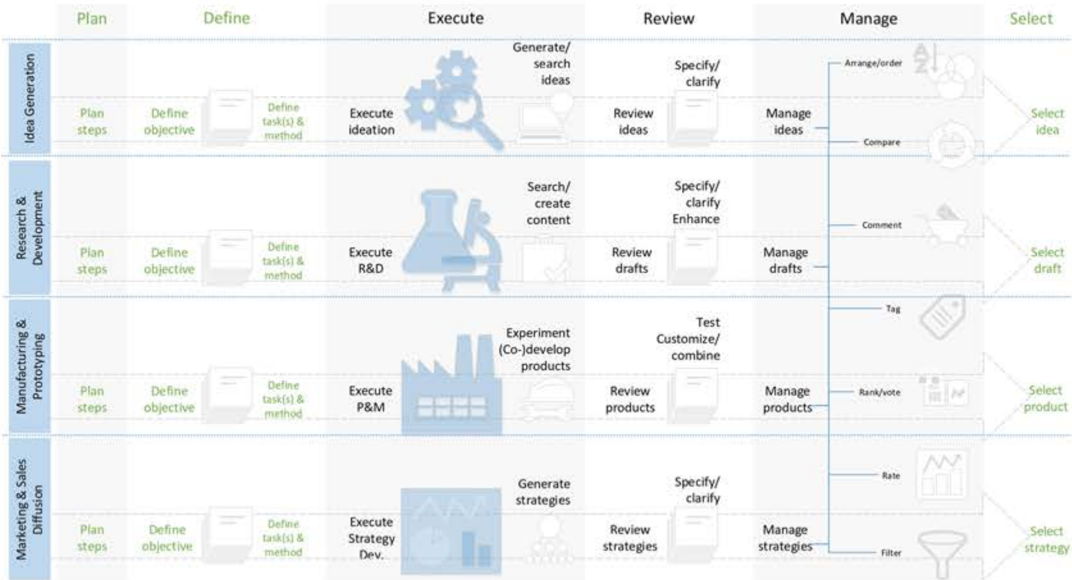

Figure 1 *Open innovation tasks aligned to the innovation process*

In reference to the steps of the process of innovation (Xu et al., 2010) in an OI environment Figure 1 illustrates how OI tasks and sub-tasks are brought into an order and thus fills the first research gap. These steps and their sequence were derived in alignment with current and historical OI projects and cover different OI approaches as well as strategies (cf. Kruse, 2013). As it turns out, the identified tasks within each step of the process of innovation follow a structure that is similar to the *Stage-Gate-Model* developed by Cooper, Edgett, and Kleinschmidt (2002a, 2002b):

First, a goal or an *objective* has to be defined. This step is usually managed by the organization's (OI) project manager(s). Following the definition of objectives, the project manager *derives tasks* (e.g., generate ideas, test products, develop strategies) and *directions* on how to solve these tasks, which are then to be solved by participants of the OI project (i.e., customers, suppliers, competitors, etc.). After *handing* each *task* to the crowd or external innovator(s), the solution mainly relies on their creativity. The project manager is responsible for *collecting* the results and *presenting* them to the participants again. The latter is prerequisite for a second collaborative step, the *evaluation of the results*, which involves rating (i.e., giving grades), voting (up- or down) and discussing them. After that, a pre-defined algorithm or again the project manager *filters* the results based on the ratings and *selects* those, which are to be handed over the subsequent step of the process of innovation.

The description of tasks indicates that OI tasks may have a variety of owners. Following Hetmank (2013), there is the *requester*, who establishes the OI project, is responsible for controlling it and has to make sure that there are enough participants, that the ideas/concepts/strategies are collected, and property or other legal issues are covered. This field of responsibility mainly covers tasks from the 2nd and 4th quadrant (cf. McGrath, 1984) – highlighted by the color green in Figure 1. The remaining tasks are solved by so-called *recipients,* who may act as individuals (e.g., experts, developers) or can be part of a group (e.g., crowd, team). In addition to these two stakeholders, some tasks of the process of innovation may also be covered and solved automatically. This includes tasks, such as rating or filtering ideas/concepts/strategies, which follow a pre-defined *algorithm* or procedure. Both remaining owner categories are written in black in Figure 1.

4 Bringing Order to the Application Chaos

As Figure 1 points out, OI tasks may comprise simple tasks, such as the collection of concepts generated, e.g., by customers, as well as highly complex tasks, such as the generation of ideas or the discussion of concepts and strategies. Following this notion, supporting applications from a social software perspective span a broad range from easy-to-use and -setup applications to firm-spanning solutions which may cover more than one task.

This finding corresponds with Zigurs and Buckland (1998) who stated that some Group Support Software (GSS) was found to be more appropriate for complex rather than simple tasks (Dennis and Gallupe, 1993), while in others, GSS was more appropriate for less complex tasks and single-solution tasks (Benbasat and Lim, 1993). The same applies to social software.

Nevertheless, the variety of applications in both scenarios remains huge. In order to facilitate the selection of the most suitable tool or system, the subsequent section summarizes social software categories which should all be taken into consideration to support OI tasks.

4.1 Social software categories

Following Pirkkalainen and Pawlowski (2013) social software tools can be divided into several categories. These categories each comprise a variety of applications and software solutions, but are equal in their purpose as well as their end-user functionality. Therefore, Table 3 comprises only categories and does not differentiate between representatives of each category.

Tool category	Purpose	End-user functionality	Example software
Blogging Tools	Communication	Writing, comment, evaluate writings, alerts	Wordpress, Blogger
Microblogging Tools	Connection/awareness	Writing, comment, share, evaluate writings, inform, manage profile, follow others, direct messages	Twitter
Social Networking Tools	Awareness, communication, sharing, (collaboration), (identification)	Manage friends/events/ groups, writing, share material, manage profile, notification, direct/instant messages, integrate in other systems	Facebook, LinkedIn
Social bookmarking tools	Identification, collaboration, sharing	Save/share links, comment on links, follow users, notification	delicious
Wiki	Collaboration, sharing, identification, communication	Collaborative editing, cross-linking, page versioning, commenting, notification	Media Wiki, Wikia, Wikispaces
Collaborative Writing	Collaboration	Writing, collaborative editing, page versioning, instant messaging, commenting	Google Docs, PiratePad
Instant Messaging/Chat	Communication	Manage contacts, send private messages, raise awareness, video call	Skype, Facebook Messenger, Whatsapp
Time management	Collaboration, awareness	Create calendars, shared calendars, organize meetings, make to-do lists,	Google calendar, Asana, Microsoft Outlook

		poll, vote, survey	
Shares information spaces	Identification, collaboration, communication, sharing	Share information, comment on information, follow users, notification	Microsoft SharePoint, IBM Connections
Conferencing	Communication	Organize group calls, webinar/webcasts, white boarding, document sharing, record sessions	FlashMeeting Adobe Connect WebEx
Brainstorming tools	Collaboration	Idea structuring, white boarding, mind mapping, voting/ranking	Mindmeister, Pollevery-where
Discussion Boards/Forums	Communication	Create discussions, create profiles, comment, notification	phpBB

Table 3 Social software categories (cf. Pirkkalainen and Pawlowski, 2013)

In addition to Web 2.0-oriented tools, open innovation tasks may also be supported by group support systems and applications not depending on the Internet. However, the focus of this research lies on the adoption of social software. A categorization for these alternatives can be found, e.g., in Nissen, Kamel and Sengupta (2000).

4.2 Summary

The findings in sections 2, 3, and 4.1 suggest that open innovation tasks can be characterized similar to the peculiarities of group tasks as introduced by McGrath et al. (1993, p. 407). Table 4 summarizes these characteristics, which help to understand how the Task-Technology-Fit theory can be adapted for OI tasks.

Characteristic	Description	Focus
Task production	A set of tasks and the outcomes that are generated by those tasks of a particular set of members using a set of tools for a set of purposes in a specific context.	innovation tasks (Section 3)
Task structure	A set of collective or shared purposes transformed into a set of projects, strategies for accomplishing those projects, and tasks by which those strategies can be done.	Tasks along the process of innovation in which each phase follows a specific strategy (Figure 1)
Group composition & structure	A set of members and relationships between them.	OI actors and owners (Section 3)
Technology	A set of tools, rules, procedures, and resources to carry out their purposes – hardware and software	social software (Section 4)

Table 4 Open innovation task characteristics

The developed open innovation process (Figure 1) and the identified end-user functionalities (Table 3) are now the basis for assessing the fit between technology and OI task. Hence, the subsequent section (Section 5) presents the core of this study and provides an example which illustrates how such a fit could be achieved and how it affects innovation performance.

5 Adapting the Task-Technology-Fit Theory on OI

Achieving a fit between task and technology should be a principle for an effective support of OI through social software applications. The question that remains is: can we specify particular combinations of tasks and applications that will improve innovation performance?

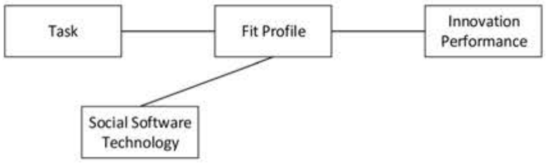

Figure 2 General model of Task-Technology-Fit in OI

By adapting Zigurs' and Buckland's (1998) Task-Technology-Fit model, this research aims to identify fit profiles between OI tasks and social software technologies (Figure 2).

The assessment of fit bases on the estimations of 3 social software experts (former researchers, now practitioners) who were interviewed during a single focus group session. The participants were asked to discuss every aspect of support by the given social software applications (i.e., end-user functionalities, Table 3) with regard to the identified open innovation tasks (Figure 1). Each participant wrote down his/her estimation of fit in an Excel-sheet. The rating of fit was divided into a 4-point scale, from 1 (no fit) over 2 (low fit) and 3 (medium fit) to 4 (high fit). Additionally, the participants were asked to provide a statement on the direction of the supportive capability. Since there are examples, where a particular social software application may support the execution of the task directly (e.g., using brainstorming tools to collect ideas) and examples, where the influence has a rather indirect effect (e.g., using wikis for product evaluation supports the collection of evaluations not the evaluation itself), the participants had to state, which alternative was predominant.

5.1 Results

Due to the limitation of space, this section only provides one example that illustrates how the Task-Technology-Fit was assessed during the focus group session and how it helps to select the most suitable social software application to solve the OI task. Following the illustrated approach (Section 5), the description of a fit profile focuses on a very condensed exemplary task: *assessing a (pre)product* during prototyping and manufacturing. The following paragraphs summarize the results of the group discussion:

Providing an assessment of a product may lead to very different results. It could produce a short statement, e.g., on the quality of a product or result in an in-depth description of the product's peculiarities, strengths, and weaknesses. Such an assessment may be conducted by an individual or a group of experts. Hence, writing plays an important role but also the collaboration and communication with other contributors. Therefore, a suitable social software application should support the task by allowing (collaborative) text editing, commenting, notifications of changes, and sharing of additional material. Much less important are, e.g., scheduling the assessment, since it is mostly a unique, non-recurring event and exchanging short information chucks, which could only indirectly support the assessment (e.g., if a customer shares her/his thoughts via posting a link on Twitter).

Based on the above-mentioned analysis of the task requirements during the focus group session and the comparison to end-user functionalities of social software, the interviewees rated blogging tools, social networking tools, wikis, collaborative writing tools, shared information spaces, and discussion board as highly supportive (high fit) for the development of an assessment of a (pre)product. Conferencing and messaging tools have an average capability to support the task (medium fit). Microblogging and brainstorming tools possess only a low supportive capability (low fit) while social bookmarking and time management tools exhibit no influence on the execution of the task (no fit). Thus, the experts' evaluation recognizes the demand for a platform to which customers and other external stakeholders can be invited and where they find the necessary functionalities to write, edit, and discuss.

By applying the same procedure on the remainder of tasks, the discussion during the focus group session resulted in a holistic overview on the fit between open innovation tasks and social software applications (Figure 3).

Figure 3 Task-Technology-Fit between open innovation tasks and social software

As Figure 3 illustrates, not every social software application may support open innovation tasks equally. Some applications possess a greater capability and support almost every task of the process of innovation (wikis, shared information spaces). Other applications only offer a very limited support for open innovation (time management tools, social bookmarking tools). Hence, Figure 3 helps to understand the suitability of certain application categories and thus facilitates the selection of the best-fitting application. Moreover, the discussion also revealed that in some cases social software – regardless the breadth of the available application categories – cannot substitute non-social applications or the simple physical meeting. Especially during prototyping and manufacturing, which involves design and construction tasks, social software cannot replace the work bench, CAD tools or the physical contact with the product. Therefore, the adoption of social software can only indirectly support the particular task. The most promising use cases for social software during open innovation projects are idea generation, where it facilitates the collaboration between external and internal stakeholders, and managing the results of the four parts of the innovation process (i.e., categorizing, commenting, etc.).

Nevertheless, although Figure 3 fills research gap number 2 it only provides an approximation to quantifiable fit profiles, which are also subject to contingency.

6 Conclusion

The range of OI tasks between initial idea generation up to evolving strategies and complete solutions is still very broad. In this regard, the present research offers a first step towards a systematization of the chaos caused by the multitude of approaches, strategies, and successful and not successful projects

(Kruse, 2013). By proposing generalizations for processes, which represent the tasks and sub-tasks to be executed during each step of the process of innovation in an OI environment, this paper helps to understand the interdependencies between them.

In addition to that, the developed fit profiles illustrate – in reference to the Task-Technology-Fit approach (Goodhue & Thompson, 1995; Zigurs & Buckland, 1998) – well-fitting OI task and social software application combinations that may have a positive influence on innovation performance. They allow organizations or individuals to purposefully differentiate between available social software applications and help to identify the best-fitting application for a certain open innovation task. Thus, utilizing the fit profiles will help to fulfil open innovation tasks in a more effective way, enabling organizations to increase the overall innovation performance.

Although, the research gaps could be filled, there are some limitations to be pointed out that also illustrate directions for future research: First, due to the limitation of space, this study only provides a small glimpse on the alignment of open innovation tasks and social software application. In this regard, the depiction of fitting social software applications and open innovation tasks (Figure 3) can only refer to social software categories. The lion's share of these categories cover similar functionalities, but to a different extent. The reflection of research on this issue would help to increase the fit between end-user functionalities and tasks. Moreover, not every application from a single category covers the same features as its competitors (e.g., compare MediaWiki, Wikia, and wikispaces). Hence, a differentiation between actual applications would be helpful for an even more considered decision (cf. CosmoCode 2014). Third, the process model (Figure 1) enhances the general understanding of tasks that are executed during open innovation projects. However, the variety of open innovation tasks, their heterogeneous economic attributes and results do not allow for an unambiguous judgment and universally applicable recommendations for action. Thus, in order to enhance the usability of the framework for future open innovation projects, additional empirical data from use cases would increase the rigor of the model and help to sharpen the order of the identified sub-tasks as well as their level of detail. Fourth, a more detailed description of the open innovation tasks regarding owner (Hetmank, 2013) and type (Elmquist, Fredberg, & Ollila, 2009) could also be a starting point for future research. Such detailing would help to allocate responsibilities for tasks as well as their assignment to individuals, groups, or the crowd. Fifth, the adapted Task-Technology-Fit theory reduces the understanding of innovation performance by indicating that a good fit between task and technology may lead (or leads) to a higher innovation performance. Here, a more differentiated picture is required, which, e.g., provides indicators for a performance measurement. Similar research can already be found in studies on innovation acceptance and sales performance (Hambrick and Macmillan, 1985), achievement of innovation objectives as suggested by OECD (2005), influence on R&D investment (Frenz and Ietto-Gillies, 2009; Sofka and Grimpe, 2010), or on the degree of social interaction (Huang and Li, 2009; Nahapiet and Ghoshal, 1998; Tsai and Ghoshal, 1998). Finally, the adapted Task-Technology-Fit model and the example should be regarded as an impulse for discussions and do not claim to be exhaustive. They provide a fundament for reasoning the selection of supportive applications in an open innovation environment but still lack detail that future research could provide.

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