# How to Conduct Knowledge Management with Enterprise 2.0 Software

## A Small and Medium Sized Enterprises Case Study

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*Keywords*

*Knowledge Management, Enterprise 2.0, Social Media, Social Networks, Communication*

Web 2.0 software proves to be very successful in knowledge sharing on the Web. Wikis are very effective in collaborative knowledge generation, while social networks and micro-blogging platforms successfully use communication to generate knowledge. The reasons for that are low-threshold contribution possibilities and a clear overview provided by news aggregators, which both make contribution cheaper and more beneficial. Such software can also efficiently be applied in firms as Enterprise 2.0 software by adapting Web 2.0 concepts for enterprise needs. Communication-based knowledge sharing can be effectively applied for the codification of tacit knowledge by leveraging communication processes. In the case study, communication-based software is successfully conducted by a knowledge management system in software development.

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## *1. Introduction*

Knowledge has always been an important requirement for economic production and services, for example, in craftsmanship or navigation. The idea that knowledge can be controlled, managed and measured as a resource of the firm, however, has only existed for a few decades. While the world's economy keeps growing, companies increasingly specialise themselves, while creating and collecting more and more knowledge about their products and services, technologies, markets and clients. Since most of this knowledge is stored as tacit knowledge in the heads of employees, it has to be made accessible to the organisation to allow optimal utilisation of the resource "knowledge" within a firm.

Although implicated by its name, knowledge management cannot directly control the creation and storage of knowledge, but must instead provide incentives for the employees to share their knowledge. Making tacit knowledge accessible to others usually requires its formalisation into spoken or written language. Since knowledge transfer and sharing is costly and there are few individual benefits on a short term basis, many companies fail to establish a culture of knowledge sharing. Information technology allows the collection, management, distribution and storage of enterprise knowledge in databases. These tools can be used to support and increase knowledge sharing in the firm; however, knowledge management software often proves to be less effective in knowledge sharing than expected, because little respect is paid to provide the right incentives for sharing. Web 2.0 software proves to be very effective in knowledge sharing in the Internet. Its concepts to improve knowledge sharing have been increasingly applied in firms and are called Enterprise 2.0 software. In this paper, we analyse how knowledge sharing is achieved using Web 2.0 software and try to apply these principles to knowledge management in the firm. In a case study, we test our hypotheses about knowledge sharing with Enterprise 2.0 software in a small team in a software development company.

The research question of this paper is: How can Enterprise 2.0 software effectively conduct knowledge sharing in the firm? We will respond to this question by rephrasing it into three working hypothesis. Each hypothesis will be discussed in a separate section. While section 2 and 3 are based on literature research, section 4 contains the discussion and formulates hypotheses how Enterprise 2.0 software can improve knowledge sharing. In section 4, these hypotheses are tested based on the results of a survey among project participants. We will summarise our findings in a conclusion.

In Section 2 Foundation of Knowledge Management, we will investigate the hypothesis "Knowledge Management Software can improve knowledge sharing by increasing the individual's motivation to share." The section provides a basic model of knowledge in the firm, how it is created and shared and how knowledge sharing can be influenced by corporate culture and knowledge management instruments. We will describe knowledge sharing as a prisoner dilemma situation and formulate requirements how software instruments can influence the individual motivation to share knowledge and increase knowledge sharing by reducing costs of sharing, searching costs and increasing the value of the shared knowledge. Section 3 Knowledge Sharing on Web 2.0 platforms investigates the hypothesis "Web 2.0 software is successful in motivating individuals to share knowledge on the Web". The section gives an introduction into Web 2.0 software and shows how knowledge is effectively shared with Web 2.0 software. In Section 4 From Web 2.0 to Enterprise 2.0, we start with the following working hypothesis: "Enterprise 2.0 is effective in conducting knowledge sharing in the firm". We try to transfer the Web 2.0 knowledge sharing models to Enterprise 2.0 knowledge management instruments. In this section, we will concertise this working hypothesis to five more detailed hypotheses, on how the two different types of knowledge sharing found in Web 2.0, namely collaboration-based knowledge sharing in Wikis and communication-based knowledge sharing, can be used as efficient tools for knowledge sharing in the firm. In 5 SME Case Study, we analyse if Enterprise 2.0 software can be efficiently applied as a knowledge management instrument in praxis. The hypotheses which were formulated in the former section are tested in a survey among team members.

## *2. Foundation of Knowledge Management*

This section tries to corroborate the following hypothesis: Knowledge Management Software can improve knowledge sharing by increasing the individual's motivation to share. Before talking about knowledge management, we will describe the characteristics of knowledge as a resource of the firm and how this knowledge can be "managed", thus how it is shared and stored in organisations. A consistent knowledge-based theory of the firm has not yet emerged. However, we will describe a basic model of knowledge conversion and sharing in organisations, which will allow us to understand how knowledge management (KM) can be influenced and improved by information technology

when using knowledge management systems (KMS). At the end of the section, we will specify the hypothesis by formulating requirements for KMS to improve the individual motivation to share.

### *2.1 Characteristics of Knowledge*

In 2.1 Characteristics of Knowledge, we define two types of knowledge which differ in terms of articulation and aggregation. In 2.2 Knowledge in the organisation, we describe how knowledge is converted and shared in the firm and how knowledge sharing can be interpreted and solved as a public good dilemma. In 2.3 Knowledge-based view of the firm, the firm is described from a new institutional economics perspective as an organisation, whose competitive advantage is determined by the management of the resource "knowledge". This view describes the efficiency knowledge management as the most important variable for economic success. In 2.4 Dimensions of knowledge management, we describe the role of corporate culture and which instruments management can use to affect the efficiency of knowledge sharing in the firm. The last sub-section, 2.5 The role of information technology, focuses on the potentials of information technology in knowledge management. We will summarise our findings by formulating requirements for knowledge management software to conduct effective knowledge sharing.

When talking about "knowledge", we have different things in mind. Therefore we need definitions of the different kinds of knowledge which exists in a firm. After describing a knowledge hierarchy, we will explain how knowledge in the firm can be characterised in terms of articulation and aggregation.

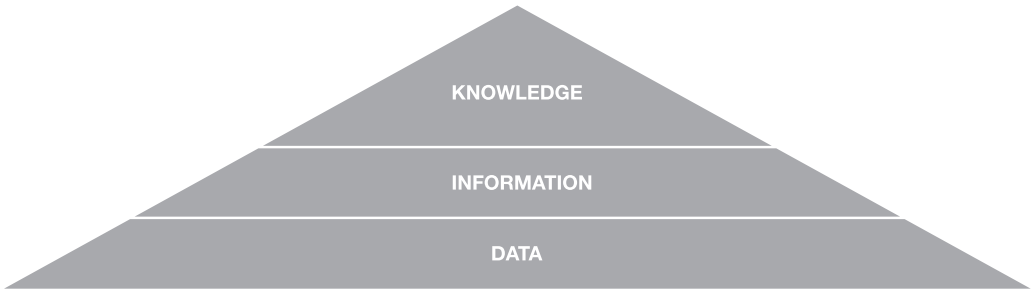


FIGURE 1 KNOWLEDGE HIERARCHY (OWN SOURCE)

The distinction between the concepts data, information and knowledge, which together form a hierarchy of knowledge, had first been made by Nicholas Henry (1974). While knowledge is individual and resides in human heads, information and data exist independently as texts, graphs, etc. for example on paper, hard drives or other media. Data is the most basic of these three concepts.

> "Data is a set of discrete, objective facts about events. In an organisational context, data is most usefully described as structured records of transactions. When a customer goes to a gas station and fills the tank of his car, that transaction can be partly described by data: when he made the purchase; how many gallons he bought; how much he paid" (Davenport/Prusak 2000: 2).

In an enterprise today, data is usually stored in some IT system like a database, an Excel-sheet or still in some cases still in traditional physical files and folders. Information consists of data, but adds context to it. It is often defined as "a flow of messages or meanings which might add to, restructure or change knowledge" (Nonaka 1994 in: Machlup 1983: 15). Information can be a letter or an e-mail, but also any other text, audio or video document. The context is created by the fact that messages usually have an author, recipient, or date which allow users to interpret the message more easily.

Knowledge had already been defined by Plato as a "justified true belief" (Gettier 1963: 121). This does not necessary mean that all knowledge must be true, but knowledge represents what humans considers to be true (cf. Kuhn 1962). The relation between data, information and knowledge can be summarised as follows: While information consists of interpretable data which has been enriched with context, it shapes individual knowledge or what one considers to be true.

Although that definition suggests that knowledge resides within the individual, it is still possible to transfer individual knowledge to information, which can be converted back into knowledge by other individuals (cf. Buckland 1991). In this paper, information which represents knowledge will also be called (explicit) knowledge, even though it does not longer reside within an individual.

*Knowledge Articulation*

When trying to understand how knowledge is articulated in the firm and how this affects the ability to transfer and aggregate it, it is important to understand the distinction between tacit and explicit

knowledge, terms which were coined by Polanyi. He stated that "we can know more than we can tell" (1966: 4) and called knowledge which is hard or impossible to articulate "tacit knowledge". As an example for tacit knowledge, he mentions the human ability to recognise faces and persons without being able to describe how this is achieved. According to Nonaka, tacit knowledge is "deeply rooted in action, commitment, and involvement in a specific context" (1994: 16). Tacit knowledge is also referred to as know-how.

Nonaka describes explicit knowledge as "formal and systematic. For this reason, it can be easily communicated and shared, in product specifications or a scientific formula or a computer program" (1991: 98). Explicit knowledge requires a deep understanding of an issue in order to articulate it (cf. Snow 1989: 9). If a person has explicit knowledge, he or she knows about something. According to our understanding of knowledge, explicit knowledge can be stored in both human heads or in some kind of document as information. The distinction between tacit and explicit knowledge is relevant for knowledge management because of its effect on transferability (cf. Grant 1996: 111). Explicit knowledge is formalised or can be formalised at low costs, which makes it easy to share, because it can be stored in information systems, accessed and copied at sero marginal cost (Stiglitz 1999: 308). Tacit knowledge, on the other hand, can hardly be codified, which makes sharing difficult and expensive.

*Knowledge Aggregation*

Knowledge in the firm can also be characterised by the degree of aggregation. The distinction between knowledge which is only known by single individuals and knowledge which most or all individuals in an organisation know about, which is called organisational knowledge, can also be made.

| | INDIVIDUAL | ORGANISATIONAL |
|---|---|---|
| TACIT | CONSCIOUS | OBJECTIFIED |
| EXPLICT | AUTOMATIC | COLLECTIVE |

FIGURE 2: DIFFERENT TYPES OF ORGANISATIONAL KNOWLEDGE (CF. SPENDER 1996: 52)

While conscious and automatic knowledge are identical to the description of explicit respectively tacit knowledge on individual level, the social dimension of organisational knowledge brings in new concepts. "Social types of knowledge are either publicly available or collective and embedded in the firm's routines, norms and culture" (Spender 1996: 52). Objectified knowledge is formalised knowledge which is – within the firm – publicly available, for example, when stored in some kind of knowledge repository. Collective knowledge, on the other hand, is organisational knowledge closely linked to action, such as routines and norms, which are not formalised. Such knowledge, including common language, norms about reliability and commitment of the workers or best practices, is essential for communication and collaboration organisations.

### *2.2 Knowledge in the Organisation*

In an organisation or firm, a lot of individual knowledge exists which needs to be shared within communication and collaboration processes to increase its value by creating organisational knowledge. In this sub-section, we first describe the SECI-Model, also known as the spiral of knowledge, which provides us with a basic model for knowledge sharing in the firm. Furthermore, we will characterise knowledge as a public good and describe how the motivation to share is influenced by the emerging public good dilemma.

#### *Models of Sharing Knowledge: The SECI-Model*

The SECI-Model was developed by Nonaka and Takeuchi at the beginning of the 1990s. It is based on "[t]he assumption that knowledge is created through conversion between tacit and explicit knowledge" (Nonaka 1994: 18.) and explains how existing knowledge isconverted to new knowledge within the firm. Four different modes of knowledge conversion are described which create a spiral of knowledge in the firm: Socialisation, externalisation, combination and internalisation. The SECI-Model is described as a spiral and not a circle because it does not recreate the same knowledge over and over again, but increases its value by the continuous conversion between theoretical and practical knowledge.


FIGURE 3: MODES OF KNOWLEDGE CREATION
IN THE SECI-MODEL (CF. NONAKA 1994: 19)

Socialisation of knowledge describes the creation of new tacit knowledge from existing tacit knowledge. This happens through observations of experienced colleagues, for instance, when a journeyman learns about the tacit knowledge of the master craftsman by watching him as he performs a certain skill. The knowledge is gained through observation, which means that tacit knowledge is socialised without the use of language. Externalisation of knowledge describes the conversion of tacit knowledge to explicit knowledge. Knowledge gets externalised if somebody uses his experiences to create a metaphor, analogy or model (cf. Ibid: 20) which can formalised as spoken and written language. This allows him to share it with others.

Combination of knowledge describes the conversion of existing explicit knowledge to new explicit knowledge. This mode represents the types of knowledge creation most people would identify with knowledge management. Explicit knowledge is exchanged by individuals in meetings, telephone conferences, databases or other information systems. Within the process of knowledge combination, existing information gets sorted, re-categorised and re-contextualised, which creates new explicit knowledge. Combination of knowledge can also be performed by computer systems which process and combine existing data to new knowledge. An example for that is the visualisation of data as a graphical chart, which can be acquired by individuals more easily than the original data used to create the graph. Internalisation of knowledge is the conversion of explicit knowledge to tacit knowledge. Knowledge is internalised if an individual transfers explicit knowledge, which can be acquired by reading documentation or listening to the explanations of a co-worker (theory), to the ability of applying this knowledge (practice). The mode of knowledge internalisation is what many people would describe with the traditional notion of learning.

In this organisational knowledge creation theory, new knowledge is created by constantly converting existent tacit and explicit knowledge to new knowledge, while increasing individual

and organisational knowledge. Before promoting the SECI-Model, most existent knowledge in a firm is tacit. Externalisation of tacit knowledge creates new explicit knowledge. This knowledge can be shared more easily in the firm and can lead to the creation of new knowledge. By constantly repeating this process, both new individual and new organisational knowledge is created in the firm. Nonaka conceptualised the firm as a "knowledge creation function" which has to be optimised (2000: 10). However, knowledge sharing cannot be enforced by management, since employees can be encouraged but not forced to share their knowledge. Instead, efficiency depends on the motivation of the individuals to share their knowledge (cf. Osterloh et al. 2000).

*Knowledge as a Public Good*

Knowledge is often characterised as a public good. A public good has the following properties: Its consumption is non-rivalrous – that means that an additional individual can enjoy its benefits at sero marginal costs – and it is not possible to exclude anybody from consuming it (cf. Stiglitz 1999: 308). While nobody can get excluded from knowledge which is publicly accessible, firms try to protect their knowledge and exclude others from consuming it, which is why knowledge in the firm must be considered a club good from an external perspective (cf. Kaul et al. 1999: 5). Therefore, knowledge in the firm cannot be characterised as a global public good; however, there is the notion of a local public good (cf. Tiebout 1956).

> "This perspective views knowledge as a public good that is socially generated, maintained, and exchanged within emergent communities of practice. […] Knowledge is a intangible resource that can be shared and spread throughout the community without losing its value, nor being consumed (used up) in the process of transfer" (Wasko / Faraj 2000: 156).

Not all, but only such knowledge which can be accessed by anybody in the firm can be considered public, thus objectified knowledge. To create public knowledge, individuals have to share their knowledge with others. Wasko and Faraj criticise that both organisation and individual often treat their organisational knowledge (e.g. documents or information in knowledge databases), respectively individual knowledge (tacit and explicit knowledge), like a private good instead of sharing it as a public good, thus not excluding anybody from accessing their knowledge. The reason for this is that

employees are opportunistic players who try to avoid costs, such as losing their reputation if their unique knowledge is known to everybody or – on organisation level – managers who overprotect organisational knowledge because of security reasons or to protect their own position in the firm.

*Knowledge Sharing Dilemma*

From an economic perspective, this problem can be described as a social dilemma or public good dilemma. It would be optimal for the organisation as a whole if individuals made their knowledge publicly accessible by sharing it. Individuals can profit from that, because commercial success of a firm usually also contributes to expected salaries and job safety. However, there are incentives on the individual level not to share individual knowledge. This causes a prisoner's dilemma situation (cf. Kaul et al. 1999: 7). In the following example, knowledge sharing equals cooperation and not sharing knowledge equals defection:

T (PLAYER DOESN'T SHARE WHILE OTHER PLAYER DOES SHARE): - 1 P (BOTH PLAYERS DON'T SHARE): -4

R (BOTH PLAYERS SHARE): - 2 S (PLAYER DOES SHARE WHILE OTHER PLAYER DOESN'T): -6

| | P2: SHARING | P2: NOT SHARING |
|---|---|---|
| P1: SHARING | - 2 / - 2 | - 6 / - 1 |
| P1: NOT SHARING | - 1 / - 6 | - 4 / - 4 |

FIGURE 4: PRISONER'S DILEMMA SITUATION FOR KNOWLEDGE SHARING (OWN SOURCE)

The pareto-optimal solution would be the case where both players share their knowledge. Because each player is afraid that the other player won't share, which would lead to the worst payoff possible for the sharing player, the player doesn't share. So the dominant strategy is, like in any other prisoner's dilemma, to defect, thus not to share knowledge (cf. Cabrera/Cabrera 2002). Later in the paper, we try to solve this dilemma situation by increasing benefits and decreasing the costs of sharing to make cooperation the dominant strategy.

## *2.3 Knowledge-Based View of the Firm*

The neoclassical economic theory of the firm ignores the important role of knowledge, since it is based on the assumption that there are sero transaction costs, perfect information and perfect factor mobility. We have already seen that knowledge conversion causes high transaction costs and is not mobile, as long it is not stored as information. The assumption of perfect information is also not compatible with knowledge as a resource since the lack of information and knowledge is fundamental for knowledge sharing.

The theoretical foundation to define a theory of the firm which is able to explain the importance of knowledge in the firm was laid by Coase's (1937) Transaction-Cost Theory and Simon's (1955) concept of Bounded Rationality in economic decision making. Coase argues that there are a number of transaction costs when using a market, such as search costs, information costs, bargaining costs, etc. The fact that these costs are lower within a firm compared to markets explains the existence of firms (cf. Coase 1937: 393). Simon stated that decisions are not made by rational individuals who have access to perfect information. His concept of bounded rationality "takes into account the cognitive limitations of [...] both knowledge and cognitive capacity" (Simon 1987: 266).

These and other findings in the field of new institutional economics lead to the resource-based view of the firm. This model understands the firm as a bundle of valuable resources, which "include all assets, capabilities, organisational processes, firm attributes, information, knowledge, etc." (Barney 1991: 102). Firms create their competitive advantage through the optimal application of these resources (cf. Barney 1991: 102). Since the focus of the model lies on understanding the successful application and does not constitute a micro-based theory, it is common to use the phrase "resource-based view" rather than "resource-based theory". The knowledge-based view of the firm understands knowledge as the most relevant resource of the firm and explains how the successful application and integration of knowledge leads to competitive advantage.

> "[F]irms have [...] institutional capabilities that allow [them] to generate and protect the unique resources and capabilities that are central to the strategic theory of the firm" (Liebeskind 199: 93).

The view can be understood as a special case of the transaction cost theory of Coase and Williamson:

> "Firms exist because they are able to avoid the costs associated with market transactions; the knowledge-based view simply focuses upon the costs associated with a specific type of transaction – those involving knowledge" (Grant 1996: 113).

Firms can avoid the high transaction costs of knowledge acquisition on the market by acquiring knowledge internally. Doing that – from a new institutional economics perspective – derives advantage from the fact that information, search, bargaining and enforcement costs are much cheaper within an organisation. Grant even argues that "knowledge is generally inappropriable by means of market transactions" (1996: 111), because intellectual property rights are – except for patents – hard to enforce. Another reason which makes knowledge transactions in an organisation more attractive lies in the nature of knowledge: If knowledge is transacted on a market, explicit knowledge can easily be "stolen", thus illegally copied and distributed by an opportunistic agent. Since knowledge is the most important resource of the firm, it must be protected and only be shared within the firm to protect the competitive advantage of the firm.

However, the knowledge-based view of the firm "is less a theory of firm structure and behavior as an attempt to explain and predict why some firms are able to establish positions of sustainable competitive advantage and, in so doing, earn superior returns" (Grant 1996: 110).

### *2.4 Strategy, Culture and Instruments for Knowledge Management*

This sub-section will give a brief overview about the objective, problems and instruments of practical knowledge management. After defining knowledge management, two generic knowledge management strategies are described. Cooperative culture is identified as a critical factor for knowledge management (cf. Alavi et al. 2006), while its constituting rules and conventions have a strong impact on the individual's motivation to share knowledge. Therefore we show how this motivation to share can be increased through the use of knowledge management instruments. Knowledge management is an interdisciplinary subject which combines findings of human resource management, new institutional economics, industrial and organisational psychology, epistemology and information engineering and others (cf. Grant 1996: 110).

One single definition for knowledge management does not exist, but most definitions are similar in listing different synonyms for "knowledge" and "to manage". Thus the objective of knowledge management is to analyse, develop, control and store knowledge entities like patterns, rules, best practices, ideas, scripts, etc., in order to optimise the "knowledge function" of the firm to improve competitive advantage of the firm (cf. Demarest 1997: 374). Since knowledge creation is an individual activity, firms must find ways and instruments to learn about the knowledge of their members (cf. Grant 1996). In 2001, already "80% of the world's largest companies […] [conducted knowledge management] projects" (Rus / Lindvall 2002: 26).

*Knowledge Management Strategies*

Hansen et al. mention two generic knowledge management strategies: A strategy of knowledge codification and a strategy of knowledge personalisation (cf. 1999). While the strategy of codification seeks to converse individual knowledge to objectified knowledge, which is stored in knowledge management systems, the personalisation strategy identifies knowledge as something which is tied to individuals and should therefore be shared from person to person and not by using databases. Companies proclaiming a codification approach are for example Ernst & Young, Accenture and other consultancies which are specialised in IT consulting, like IBM. Companies known for using a personalisation strategy in their knowledge management are e.g. McKinsey, Boston Consulting Group and Bain. The implications of the two strategies, namely to promote knowledge sharing by using information technology respectively by encouraging individual knowledge exchange, are certainly not mutually exclusive, but can be combined.

*Knowledge Management Requires a Culture of Knowledge Sharing*

The biggest challenge in knowledge management is not the analysis of existent knowledge or knowledge sharing processes in the firm or the application of suitable instruments, but the establishment of a culture of communication and trust within the firm, which makes it attractive for individuals to share their knowledge. Schein defines the expression of an organisational or corporate culture "as a pattern of shared basic assumptions learned by a group as it solved its problems of external adaption and internal integration, which has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think and feel in

relation to those problems" (2010: 18). Johnson describes a cultural web in organisations, which is determined by routines, control systems, rituals and myths, power and organisational structures and symbols (cf. 1988: 85).

A culture of communication is based on the awareness of each individual that the creation and conversion of knowledge is fundamental for the success of their firm and therefore also contributes to their personal advantage. Bock et al. summarise aspects of such a culture: "a climate in which individuals are highly trusting of others and of the organisation, an open climate of free-flowing information, a climate that is tolerant of well-reasoned failure and a climate infused with pro-social norms" (2005: 90). If a corporate culture already exists in a firm carried by individuals who are willing to share their knowledge and document their work on their own initiative, there might even be no need for knowledge management initiatives. In reality, however, most firms have failed to establish such a culture, and knowledge sharing behavior is dominated by opportunistic interests as described in the knowledge sharing dilemma.

There is no universally valid strategy to change organisational culture, but there are certain guidelines to follow if an organisation tries to change its culture. Cummings and Worley suggest first to formulate a clear strategic vision which provides purpose and direction of the cultural change. To successfully implement a culture of communication and sharing, first the top management has to adapt its behavior to show the strengths of the new strategy (cf. Cummings/Worley 2009: 526). Without such exemplary behavior, cultural changes are likely to fail, because individuals will most likely not adapt a behavior which increases individual costs on a short-term basis, without seeing a long-term benefit.

*Solving the Knowledge Sharing Dilemma*

When motivating individuals to participate in such a cultural change, the knowledge sharing dilemma has to be solved in a way that cooperation becomes the dominant strategy. This can be achieved by changing the expected payoffs for knowledge sharing. More precisely, costs of sharing have to been decreased, the expected benefits from knowledge sharing must be increased and the unwillingness to share must become more expensive. Cabrera and Cabrera propose two ways to do so:

- A cooperation-contingent transformation, which can be achieved by some kind of reward, which can also be non-monetary, most notably social recognition for individuals who share

their knowledge. This would increase the payoff for sharing. In addition to their suggestions, the author of this paper also proposes decreasing the costs of sharing if possible, which could be achieved by the use of comfortable information systems, as will be described later.

- A transformation of the public good, which means that the "perceived value of the collective gain is increased. If the collective gain is greater for the individual than the cost, then the incentive to cooperate will be increased" (2002: 696).

The payoff structure is determined by corporate culture and applied knowledge management instruments. The next section will give a short overview of knowledge management instruments, before we analyse how information technology can achieve the transformations necessary to solve the knowledge sharing dilemma.

*Knowledge Management Instruments*

Knowledge management instruments are patterns of behavior, communication and cooperation which implement best practices of knowledge management (cf. Padmore et al. 1998: 605). Such instruments can be methods, processes, trainings, software systems, etc which have an influence on knowledge sharing. These instruments can be roughly categorised in three groups (cf. v. Loh 2008: 120):

- Individual and intellectual methods, which can be applied to knowledge conversion on an individual level. Examples are creativity techniques like mind mapping or brainstorming, but also the balanced scorecard, which can be used to identify and evaluate knowledge. These methods contribute to the conversion of tacit into explicit knowledge.
- Organisational methods, which improve knowledge conversion in groups. Such methods are mostly concerned with the creation of tacit knowledge (socialisation and externalisation) and aim to improve the corporate culture. A wide range of methods exist, such as job rotation, informal meeting places, manuals, training and mentoring programs. Since such methods promote the individual reflection about the knowledge conversion in the firm, they offer a contrast to the daily routine and always include several individuals; these methods are most suitable for improving the creation of a culture of communication and sharing of knowledge.

- Technological tools and software systems, which support especially the combination of knowledge.

Since this paper focuses on the role of knowledge management software, the role of information technology will be discussed separately.

### *2.5 The Role of Information Technology*

In this sub-section, we give an introduction into information technology as a knowledge management instrument and formulate requirements for software instruments to improve knowledge sharing by increasing individual motivation to share knowledge.

Within the last two decades, an innumerable number of software systems have been developed to support knowledge management in the firm. Such systems are "designed specially to facilitate the sharing and integration of knowledge" (Alavi/Leidner 1999: 2). Information technology allows for the codification and formalisation of knowledge as explicit information which can be easily accessed by others. We will call systems which contribute to the sharing of knowledge in the firm knowledge management systems (KMS). The method of knowledge creation which can be identified with KMS is the combination of knowledge (tacit to tacit knowledge). KMS store highly abstract knowledge, like articles and manuals, but also less abstract pieces of information, including client address data, sales statistics etc., and make them accessible and interpretable to all individuals in a firm (cf. Foster et al. 2003: 1).

Besides their great contribution to knowledge sharing between individuals, KMS also offer the possibility to create knowledge which exists independently from individuals in the firm. While the knowledge of an individual who leaves the firm is no longer accessible, information stored in databases remain in the firm. Such systems also offer the chance for collaboration, which can lead to better quality of the stored objectified knowledge (cf. Wasko/Faraj 2000: 160). Information systems also offer features which cannot be provided by any non-digital methods or technology.

Information technology is able to store, process and search nearly unlimited amounts of data and information which can be accessed from anywhere.

*Types of Knowledge Management Systems*

A wide range of different types of systems for the management of documents, processes, projects, and clients have already emerged. Such systems are characterised as information systems, while knowledge systems are usually identified as some kind of searchable document repository or knowledge database which are able to store categorised articles and other files. The content of such knowledge repositories is often exclusively created for storage in this database. Meanwhile, information and communication systems are increasingly also understood as knowledge management systems as well (cf. Alavi/Leidner 2001: 132). In this paper, we will not make a distinction between information management systems and knowledge management systems, since it is not possible to draw a line between pure information and information that contains abstract knowledge. Instead, the optimal utilisation and combination of all existing knowledge and information which contributes to the competitive advantage of the firm has to be accomplished in order achieve effective knowledge management.

Information technology also offers the possibility to define business processes, workflows and tasks. Such technologies are usually applied to provide coordination, but can be also leveraged to improve the knowledge management processes. While the contribution of articles in knowledge databases cannot be enforced, the daily use of the firm's process management tool is mandatory, since individuals receive their work orders in these systems. The definition of business processes and their management play an increasing role since there is a movement towards standardisation in corporate culture; Spender sees a trend from "craft to system" (1996: 51), thus from tacit to explicit knowledge.

*Requirements for Knowledge Management Software*

We consider our hypothesis "Knowledge Management Software can help to improve knowledge sharing by increasing the individual's motivation to share" confirmed by literature analysis. We have learned that knowledge is a source of competitive advantage. The objective of knowledge management is the optimal utilisation of this resource. The SECI-Model describes how new knowledge is created and shared by a constant conversion of tacit knowledge to explicit knowledge and vice versa. This process can be positively influenced by the use of knowledge management instruments. KMS are able to store and share codified knowledge and provide access to a group of individuals. To be accepted and

actually used by employees, the knowledge sharing dilemma has to be solved by changing the payoff structure. Based on the suggestions of Cabrera and Cabrera (2002) described above, we will formulate the requirements knowledge management software has to meet to efficiently conduct knowledge sharing. Each requirement focuses on the improvement of a certain mode of the SECI-Model.

- Reduce costs and increase benefits of knowledge sharing to promote knowledge externalisation: KMS should reduce the individual costs of sharing by making it as easy and quick as possible to share knowledge. Furthermore, it should increase the benefits of sharing by encouraging social recognition and feedback from others.
- Increase the value of knowledge to promote knowledge combination: KMS should increase the value of knowledge by automatically adding context information and connecting existent knowledge to new knowledge.
- Reduce the cost of searching to promote knowledge internalisation: KMS should reduce the cost of searching by automatically informing individuals about knowledge which might be relevant for them and provide an easy and effective search.

Later in the paper these requirements are used to review the influence on knowledge sharing of Web 2.0 and Enterprise 2.0 software.

## *3. Knowledge Sharing on Web 2.0 Platforms*

### *3.1 Characteristics of Web 2.0*

The success of Web 2.0 websites, like the online encyclopedia Wikipedia, video sharing platform YouTube or the social network Facebook have established new forms of communication and collaboration. In this section we want to investigate the hypothesis that "Web 2.0 software is successful in motivating individuals to share knowledge on the Web". We try to corroborate this thesis by explaining the incentives to share knowledge provided by such software.[1]

1 Since this is a very new and fast developing field, we will also make use of some Internet sources in this section. The author also uses his personal experiences when describing the functionality and use cases of common social media platforms like Facebook and Wikipedia, since functionality descriptions cannot be found in scientific literature.

The buzzword Web 2.0 has been heavily overused in public media and marketing for nearly every topic which is related to the World Wide Web. This might be due to the fact that there is no short definition. Web 2.0 is specified as the conception of a new generation of software and software development.

The version number "2.0" indicates that the web has improved significantly from what now can be called Web 1.0. Web 1.0 software is identified with early approaches to build up profitable business models on the web which collapsed with the burst of the "dot-com bubble" in 2000. O'Reilly, who made the expression of Web 2.0 popular in 2003, formulated a list of features that determine whether an application can be called a Web 2.0 platform:

- Services, not packaged software, with cost-effective scalability,
- control over unique, hard-to-recreate data sources, that get richer as more people use them,
- trusting users as co-developers,
- harnessing collective intelligence,
- leveraging the long tail through customer self-service,
- software above the level of a single device,
- lightweight user interfaces, development models, AND business models (O'Reilly 2007: 36 f).

These characteristics aim for user-centered software design, which focuses on the development of services which can be used by individuals at low costs and with high benefits. In contrast to that, web and software development before Web 2.0 often focused on the implementation of a large quantity of features requested by the client; the actual user needs received only low priority. This resulted in software which was often uncomfortable to use and had therefore only limited success.

### *3.2 Knowledge Sharing With Social Media*

Implementations of Web 2.0 technology are usually social media platforms. They can be broadly categorised in two groups which differ in the way they create new knowledge. The first group, which comprises social networks and blogs, focuses on knowledge created by communication. The second group of social media, which includes Wikis and folksonomy projects, aims on the collaborative generation of knowledge. It should be noted that collaborative content generation

often also involves some kind communication, but the main objective of such platforms is the generation of knowledge.

Both groups of software manage explicit knowledge. Collaboratively generated knowledge, like a Wikipedia article, isusually high quality, since it has often been edited and corrected by several authors (cf. Stvilia et al. 2008). Knowledge generated in communication, like on Facebook or Twitter, has the characteristics of messages and can only be fully understood by knowing its context, e.g. author, time of publication, recipient, hyperlinks and tags. First, we will describe characteristics of collaboration-based knowledge sharing. Second, communication-base sharing will be explained.

*Collaboration-Based Web 2.0 Software*

The first group of social media platforms aims at the collaborative creation of purposeful knowledge, e.g. encyclopedia articles, answers to specific frequently asked questions, collections of links to certain topics or open source software. Compared to the information shared in communication-focused social media, the collaborative creation of knowledge takes more effort. Such software usually also makes use of some lightweight moderated or democratic mechanisms to coordinate work (cf. Viegas et al. 2007).

Wikis are powerful tools to manage a database of knowledge articles, which usually contains the knowledge of several authors. The fact that an article has many authors and can be instantly edited has two advantages: (1) Lower costs: Due to collaboration, every author only has to contribute a small share to the article and does not have to write the whole article in one piece. This causes lower individual costs for the externalisation of knowledge. (2) High content quality: Because many authors continuously edit an article, everybody agrees on the created knowledge, which is more precise and objective compared to an article written by a single author (cf. Lee/Lan 2007: 60). Wrong or imprecise information can be corrected by other authors. Although all Wikipedia visitors also have the chance to contribute to an article, only a small group of people actually contributes. Less than 10% of the users are responsible for 90% of the contributions, while most users read, but never contribute to Wikipedia (cf. Ortega et al. 2008). High visitor numbers let us assume that the use of Wikipedia for knowledge acquisition is attractive, while most users refuse to contribute even though changes to Wikipedia can be made within seconds or minutes.

"Folksonomy" projects are another example for the collaborative creation of content. In folksonomy software, individuals annotate and categorise huge amounts of information by adding

common tags to this content. The phrase folksonomy stands for "a taxonomy created by the people" (Peters 2009: 154). Such software systems are used on the Web to categorise bookmarks, e.g. on the social bookmarking platform Delicious, or images, e.g. in Flickr. While in Wikis, software quality is assured by the fact that many authors correct each other, folksonomy projects leverage from the fact that important knowledge will be tagged by a large group of users, while unimportant content will not or only seldom be tagged. These are only two types of collaborative-based Web 2.0 platforms; however, others also exists, e.g. open source projects, which focus on the collaborative development of software.

*Communication-Based Web 2.0 Software*

The basic concept of social media communication platforms is to provide low-threshold contribution possibilities and to offer simple, but intelligent tools to access messages shared with other (cf. Burke et al. 2009: 945). Communication is based on simple data models, and usually provide the individual only a single text field to share his or her content, which is sometimes even limited to a certain number of characters (140 characters at Twitter and 420 for Facebook status messages). Although there are also powerful search mechanisms, most messages are accessed by using some kind of aggregator on their front pages (e.g. "News Feed" on Facebook and "What's happening" on Twitter ), which show a stream of messages considered to be useful for the author. This information gets enriched automatically with context information, like author information (e.g. mutual friends and interests you have in common with the author), related messages or topics (e.g. by tagging and linking), addresser and recipient. Many messages on Facebook and Twitter are addressed to a certain person, but still visible for a group of people or even publicly. Communication in social media is usually a "many-to-many communication" (Keeble/Loader 2001: XX). Every person is both recipient and contributer of information. In practice, the news aggregator keeps communication flowing by being very effective in showing interesting messages to individuals. The algorithms used by the aggregators are sometimes quite complex (Guy et al. 2010: 197); in some cases, they only show all actions in reversed order. Readers can respond directly to these messages by typing into a text field which is usually placed directly below the message and without leaving the current page, which therefore is very quick and with very low costs. Common concepts of communication-based knowledge sharing are micro-blogging platforms, blogs and social networks. We will give a short introduction to micro-blogging platforms and social networks.

The front page of Facebook contains the "news feed". This is a news aggregator, which displays actions and updates of the user's virtual friends and group, which might be interesting for the user. This is achieved by complex and learning algorithms (cf. Freyne et al. 2010) and is an important reason for Facebook's huge success. Facebook succeeds in giving the user an interesting overview of thousands of information entities by evaluating user behavior, e.g. what the user liked, who he is communicating with, what he comments on, where he lives, and – when the exact position can be determined on mobile phones – what is happening around him. On the other hand, it takes only a matter of seconds to click the "Like"-Button or to post a comment, while the individual never has to leave the front page. New information is even pushed in live without reloading. Micro-blog and blog posts or Facebook status messages usually have only dozens to a few hundred readers, and they can easily get ten or more comments. Participation rates on communication-based platforms are very high; in an online study, 88% of Facebook users stated that they update their status, thus share information, at least once a week (cf. Köbler et al. 2010: 4).

### *3.3 Implications for Enterprise 2.0 Knowledge Sharing*

We have shown that social media can – from a knowledge management perspective – be categorised into two groups, which focus on knowledge generation by communication, respectively collaboration. Both types externalise tacit knowledge from individuals to explicit knowledge stored in databases, provide knowledge combination by enriching data with context information and offering comfortable access to this knowledge, which makes internalisation for individuals as easy as possible. Therefore Web 2.0 platforms support three of four modes of the SECI-Model: Externalisation, combination and internalisation. The only mode of knowledge conversion not supported directly by social media is the socialisation of knowledge, since tacit knowledge resides in human heads and is not accessible to technology as long as it is not converted into explicit knowledge.

Our hypothesis "Web 2.0 software is successful in motivating individuals to share knowledge on the web" can be confirmed for both types of Web 2.0 knowledge sharing. It can be summarised that the reason for effective knowledge sharing are low-threshold contribution possibilities, useful responses and social recognition for authors. Communication-based knowledge sharing proves to have high participation rates, since every individual is both author and receiver of messages. In addition to that, such tools can be used easily: Questions are answered very quickly because they are read by several recipients. News is spread very often more quickly than with "official channels"

like press releases and public media. Wikis show a relatively low contribution rate compared to communication-based knowledge sharing. A reason for that might be the differences in terms of social recognition: While knowledge shared on Facebook will read be and most likely also responded to by Facebook friends, authorship in Wikipedia has a lack of transparency and shared knowledge cannot lead to any positive reaction or recognition. However, Wikis provide a unique way for the generation of collaborative knowledge, which creates knowledge of high quality by leveraging collaborative intelligence.

## *4. From Web 2.0 to Enterprise 2.0*

### *4.1 Current State of Information and Knowledge Systems in Enterprises*

As we have seen, both collaboration- and communication-based knowledge sharing platforms are effective in knowledge sharing. In this section, we try to corroborate our main hypothesis "Enterprise 2.0 is effective in conducting knowledge sharing in the firm". We will concretise this working hypothesis by formulating five hypotheses on how collaboration- and communication-based knowledge sharing tools can improve knowledge sharing in the firm. These new hypotheses will be verified in the case study.

Meanwhile there is hardly any firm in the developed world, which does not use some kind of knowledge management information system (cf. Spender 2006: 238). Because every company has unique requirements for information and knowledge management systems which depend not only on the information and knowledge which needs to be managed, but also existing processes and firm culture, companies often use several information systems which are connected or integrated with each other, like solutions by SAP or IBM.

Such information management systems, which are often summarised with the expression enterprise resource planning system (ERP), may include client and supplier relationship management, supply chain management, project management, content management systems and others. Tools which focus on communication, like email clients and groupware, are often used as separate solutions. Enterprise software usually runs on intranet or Internet server and can be accessed with a client application, while in the past systems were often only accessible via generic applications, e.g. former versions of Lotus Notes. Synchronously to the development of the Internet, many companies

established intranets during the 1990s, which are similar to the Internet, but are only accessible within the company network. Web browser-based applications have the advantage that they do not require installation and can be used on any device which has access to the Internet or intranet

*Barriers*

The use of enterprise information software is often complicated by several barriers, which increase individual costs of using the software. Some enterprise information systems can only be used on devices for which the proprietary software was developed (e.g. Windows computers) and sometimes only within the companies' intranet, which prevents remote access, e.g. from home offices and on business trips. Other barriers which make the use of information systems expensive are access restrictions, bad software ergonomics and usability.

Many companies use strict access restrictions within their information systems to protect their intellectual property and privacy of the clients. Individuals have only access to information, which is considered important for their work. Access to other information is prohibited and has to be requested from the management. Staff from the R&D department is often not able to access data from client relationship management, although it may contain a lot of interesting feedback from clients, which could be used for product enhancement. Access restrictions limit knowledge sharing and the creation of common knowledge (cf. Foray 2005: 78), thus the knowledge, which is shared by all employees. Protection of intellectual property is also an important implication of the knowledge-based view of the firm, but overprotection has a negative influence on knowledge sharing. Access control has certainly not only a negative influence on the access to existing knowledge, but also on the attitude of the individuals towards contributing information to systems, because they know that there is only a very limited number of people who have access to that information. This lowers the expected social recognition.

There are numerous reasons which are responsible for bad software ergonomics and usability: Confusing and unclear interface design, huge forms with a lot of required fields, slow loading times, unexplainable behavior, unfixed errors and bugs in the software and missing documentation, support and training (cf. Nielsen/Loranger 2006: 56). Bad software ergonomics are time consuming and lead to frustration. The lack of user-friendliness causes high costs in using information systems and has negative influence on both disposition to share and benefits of accessing the information systems. Another barrier is the need to get knowledge entities approved by managers, which makes

knowledge sharing expensive for both employees and management (cf. Ardichvili et al. 2003: 70). Firms must encourage their employees to share as much knowledge as possible and should avoid unnecessary control mechanisms. The existence of these barriers increases the cost of knowledge sharing and therefore conflicts with the requirements for successful knowledge sharing formulated in section 2.5.

*Role of the IT Department*

Information technology (IT) is a relatively young and fast developing tool for enterprises. When it became common in the 1980s and 90s, many managers and employees had very little knowledge about the background and the possibilities of these technologies (cf. Buckman 2004: 87). This is why all questions concerning information technology were delegated to and solved by an IT department. From the perspective of the regular staff, IT personnel spoke a foreign language, while IT experts believed others had nothing to contribute to information technology since they lacked background knowledge. Therefore they often ignored suggestions and feedback of members of other departments. The communication barrier between those who make software and their users is not a problem limited to enterprises, but a common problem in software development, which resulted in feature-oriented software development and poor usability. These are also characteristics shared by Web 1.0 software. Software developers focused on implementing requested features while paying little attention how they would actually be utilised by the users.

Although this problem has not yet completely been solved, common knowledge about information technology has increased dramatically during the last two decades. This eases communication between normal and IT staff and allows the users to articulate their requirements for software tools. Hence, Buckman proposes a change in IT culture by turning the IT department into a knowledge transfer department which does not focus on providing information to management, but on the movement and transfer of knowledge (cf. Buckman 2004: 93).

On the other hand, software developers have found ways to improve usability and flexibility of their applications. Methods of improving usability, e.g. user testing and agile development, like in Web 2.0 software development, have become increasingly common in enterprise software development, but are still far away from becoming standard. In his annual intranet design report, Nielsen identifies several trends, which describe the increasing implementation of Web 2.0 characteristics in enterprise software. Enterprise intranets today are “based on simpler thus more-used

features" (2011). He sees a trend towards implementing Web 2.0 features like comments, ratings and participation rewards. Besides, there was an increase from 30% to 60% among the participants from 2010 to 2011 who also had a mobile website. Nielsen sees continued trends in task-centered information architecture, news and dashboards, blogs, improvement of search quality and trainings. All of these improvements somehow remove barriers from knowledge sharing.

### *4.2 Comparing the Web and the Firm*

Before trying to integrate Web 2.0 concepts into enterprise software, we want to investigate how a firm is comparable or different to the Web with regard to knowledge sharing.

#### *Culture*

The users of Web 2.0 software communicate with others because they know them in real life or because they have a common interest or hobby. In Web 2.0 software, they form a virtual community with its own culture consisting of formal and informal conventions on how to behave and how to use the provided tools and functions, which aim to provide effective communication (cf. Babbier 1996: 68). The community in Web 2.0 software also provides feedback to platform developers and requests new features.

An organisation which wants to use knowledge management software already has an existing culture, communication and coordination processes. When collectively using software, employees would usually not see themselves as a community, but still as coworkers or colleagues using a software instrument. What a firm could learn from the web is to understand the use of software as an enriching cultural element, which has to be embedded appropriately into corporate culture (Robey / Boudreau 1999).

#### *Motivation to Share*

While both, users of Web 2.0 software and corporate information systems use software tools to share information, they do it for different reasons. The former use the software voluntarily to connect with friends, as a substitute for other communication (e.g. phone, text message, or e-mail) or to form virtual communities of interest (cf. Brandtzæg / Heim 2009). The latter use it because

their management wants them to. This is an important difference: Information is shared on social media platforms by individuals because it is beneficial for them to do so. Employees have to use the provided software, even if they would prefer other media for communication and knowledge sharing.

This is why firms should provide demonstrations and training for their members, in which the use of the application is taught to convince employees of the benefits of Enterprise 2.0 software. On the other hand, firms also have the possibility to give monetary benefits for sharing and respectively are also able to fire people who are not willing to use software tools to share their knowledge. While the use of software tools for certain business processes can be enforced by the company, the willingness to not only provide required information in a certain process, but also to share knowledge beyond that can only be successful if the individuals are willing to do so.

*Information Access*

Another difference, which was already mentioned before, is that most of the information generated in Web 2.0 software, especially in collaboration-based knowledge sharing, is usually publicly accessible on the Internet. Social networks also usually offer access control, which allows knowledge to be shared only among a small group of people. The more people who can access an information entity, the higher the chances are that this knowledge will be used for the creation of new knowledge.

We have already identified strict information access control as a barrier for content sharing. In the same way public access to information contributes to information sharing in Web 2.0 software, firms should try to make as much information publicly accessible within the firm and protect only sensitive information.

*Kinds of Knowledge Shared*

We have learned in the previous section that Web 2.0 software is able to share different kinds of knowledge, which can be broadly categorised into communication-based sharing with messages, and collaboration-based sharing, where knowledge is represented as articles, tag clouds or complex forms like source code. The concept of Web 2.0 software, however, is not limited to certain kinds of knowledge, but only suggests the use of simple data models, which can be flexibly applied by users.

Enterprise information data is usually stored in large databases, which are often too complex for efficient use. But since the whole IT infrastructure relies on these databases, they cannot be replaced by simple structures easily. To benefit from the increase in knowledge sharing provided by user-friendly Web 2.0 software, unnecessary existent data models have to be replaced, and their presentation to the user as an interface has to be simplified.

*Competition*

A public web platform has usually a lot of competitors, which offer similar functionalities. This is why Web 2.0 platforms are optimised to provide a good user experience. Especially the first steps of a visitor, like the start page, the registration process and the first step on a platform are designed to be as clear and easy as possible (cf. Burke et al. 2009). This competition leads to easy, but still powerful platforms, which try to gain a large share of their target group. Since companies usually offer only one information system for a specific task, employees cannot choose between different applications; therefore, there is no such thing as competition between software within one firm. However, there is competition between different solutions that management can choose from when searching for a suitable KMS. Therefore, these solutions compete with each other. Management does usually not choose software because of end-user interests like user-friendliness, but for other reasons like customizability and reliability. This is why traditional enterprise software is not optimised for usability in the same way the Web is.

We can summarise that even there are differences between the Web and the firm like access restrictions, there do not seem to be major reasons why Web 2.0 knowledge sharing could not also be applied in Enterprise 2.0 software.

### *4.3 Collaboration-Based Enterprise 2.0 Software*

In this section, we try to apply Web 2.0 knowledge sharing concepts to the firm and discuss how they affect the SECI-Model and the individual benefits in knowledge sharing. Unlike communication-based Enterprise 2.0 Software, Wikis have e already been used for knowledge sharing in many firms.[2] A reason for that might be that Wikis are similar to the classical concept

2 30% of enterprises surveyed in a McKinsey study reported in 2007 that they already use Wiki software, according to Happel/Treitz 2008: 1 comparing McKinsey 2007.

of storing knowledge in document repositories, but furthermore allow collaboration and easier editing. Various free and commercial Wiki solutions exist, such as the free MediaWiki,[3] which is also used for Wikipedia. As we have seen earlier, writing Wiki articles is relatively expensive for individuals and is characterised by a relatively low contribution rate compared to communication-based knowledge sharing. It also lacks benefits like feedback and social recognition, because the authors are usually not visible on a Wiki page.

*Effect on SECI-Model*

As mentioned before, three of the four modes in the SECI-Model can be supported by information systems: Externalisation (tacit to explicit), combination (explicit to explicit) and internalisation (explicit to tacit) of knowledge. How do Wikis influence knowledge conversion in the SECI-Model? The externalisation of knowledge seems to be the most problematic element in the use of Wiki software: It is relatively expensive to share knowledge in an article, since one person has to be the first to create that article. This is a task that can last from a few minutes to hours, because the author has to find a structure and has to formalise his tacit knowledge. In addition, writing knowledge articles cannot be enforced by management, but is a voluntary task. Wikis also contribute to the combination of knowledge, especially by linking certain words to the corresponding Wiki articles. Furthermore, Wikis contribute relatively little to knowledge combination by adding context information, since its data model only consist of a plain text with links. Wikis are very effective when it comes to the internalisation of knowledge. When explicit knowledge is embedded in a comprehensive article, which provides a lot of context information for anybody to understand, it can be easily understood and therefore transferred very effectively to tacit knowledge.

*Motivation to Share in Wiki Software*

In the SECI-Model, the expensive externalisation of knowledge, thus the composition of articles, can be identified as the reason for low contribution rates. This is due to the high costs and little individual benefits of Wiki article authoring at an individual level. The high costs are caused by the fact that the individual who wants to share knowledge first has to navigate to the Wiki

3 http://www.mediawiki.org (accessed: 10.01.2014).

and search if there is not already an article about the topic he or she wants to write about. The knowledge generation itself is costly, too, because the author has to do all the intellectual work of converting his tacit to explicit knowledge by first finding a structure for the article and then writing an universally understandable text about it. The benefits for the author are relatively small, since contributions are often not immediately recognised and responded to by others. It is hard to tell for readers which author contributed to an article, since the resulting Wiki article is a product of collaboration. In order to increase individual benefits for sharing in Wiki software, social recognition for contributions could be increased in Enterprise 2.0 Wikis. One improvement could be to show a list of contributors and the percentage of contribution next to the article. Employees who contribute a lot to the Wiki could also be publically and honorably mentioned by the management.

We can summarise that Wiki software proved to be very effective in the web and is increasingly used in enterprises for collaborative knowledge sharing. Little social recognition for the authors could be a limiting factor for knowledge sharing. We will rephrase this into two hypotheses about the use of Wikis in enterprises, which will be tested in the case study later:

> Hypothesis 1: Wikis are effective in creating relevant knowledge in Enterprise 2.0 software.

> Hypothesis 2: The lack of social recognition for Wiki contributors has negative influence on knowledge sharing in Enterprise 2.0 software.

### *4.4 Communication-Based Enterprise 2.0 Software*

While Wikis are already relatively common in enterprises, communication-based Enterprise 2.0 software still remains in a niche existence. Because of its high efficiency in knowledge sharing in the web, it sounds very promising to utilise such software also in firms.

As examples for successful communication-based knowledge sharing on the web, we mentioned Facebook and Twitter, which both allow easy knowledge sharing, by lightweight and limited forms, and access, by using intelligent information aggregators, which summarise all information considered relevant to the user. Because of the low-threshold ways to respond, e.g. a comment box directly under the message, contributors will most likely receive immediate recognition and responses. A broad range of communication-based knowledge sharing software for enterprises already

exists, sometimes also referred to as Enterprise 2.0 software. Examples include the commercial project management tool Basecamp,[4] which can be considered a true Enterprise 2.0 application, because a lot of Web 2.0 characteristics are already used by 5 million users, and the commercial software-as-a-service platform Salesforce,[5] whichhas extended its broad range of products with the tool "Chatter",[6] which tries to add Facebook-like communication to its information systems in order to increase collaboration and communication.

Although such software promises to provide much better sharing of knowledge, it still finds relatively little application in firms. From a knowledge management perspective, such platforms bring out a paradigm shift from an explicit documentation via knowledge articles (e.g. in Wikis) to documentation through communication. Instead of understanding the creation of explicit knowledge as a separate task, knowledge creation can be integrated within regular business processes and by leveraging necessary and already existing communication processes for knowledge creation and sharing (cf. Jung et al. 2006).

*A Sketch of a Basic Communication-Based Knowledge Sharing System*

To provide the reader with an idea of what a basic communication-based Enterprise 2.0 software looks like and how it can be used for knowledge sharing in the firm, we will describe a stereotypical sketch of such a system. This sketch can also be understood as a simplified description of the project management system used in the case study later in the paper.

Enterprise 2.0 software runs on an Intranet or Internet server and can be accessed via web browser. Every individual with access to the system is provided with a user account which gives him access to certain – or for knowledge sharing even better – all knowledge entities in the system. If an individual has a problem, support request or idea, he or she can share this with others in a message. In technical terms, such a message and all its responses are called a ticket, case or task. Depending on the type of information system, e.g. project or client relation management, the individual has to provide some basic categorisation information, e.g. the project or client it relates to. The ticket can have a specific recipient which will be notified via e-mail, or be addressed to all. If the communication is part of a business process, the recipient is at the same time the next

4 http://www.basecamphq.com (accessed: 10.01.2014).

5 http://www.salesforce.com (accessed: 10.01.2014).

6 http://www.salesforce.com/chatter/whatischatter/ (accessed: 10.01.2014).

responsible person in the workflow. The message will also be accessible for other project members. Unlike on Facebook or Twitter, which only offer a single text box for the message, a ticket in Enterprise 2.0 software usually also requires the entry of a title for easier browsing and searching. Some systems also allow for the setting of a status (e.g. "new", "unsolved", "solved", "waiting for feedback") and priority. After formulating a message, and optionally adding links or files, the message gets published by the user.

Explicit recipients of the ticket will be notified via e-mail. All others will be notified on the real time information aggregation feed, which is most effective when placed on the front page of the application. This feed summarises all messages, which are considered relevant for the individual. While some Enterprise 2.0 applications simply show a chronologically ordered list of the last messages and comments, larger companies with a high frequency of new knowledge shared require a more intelligent software solution which filters and prioritises information for the user, e.g. by analyzing the interests and competences of the user, by evaluating his past contributions and rating the importance of the ticket, e.g. by the number of responses it received and time of publishing. The individual can then directly respond to the message in the aggregation feed or after on the ticket summary page. Responses to tickets, like on Facebook or Twitter, usually consist of a single text box and allow a very low-threshold response, since the user does not have to request a new page or fill up long forms or enter a title. When the ticket is embedded in some business process, the individual can also choose the next recipient of the ticket when commenting it.

Each ticket is also shown on an summary page, which contains the starting message, all responses and meta information, e.g. the person in charge in the workflow, status of the workflow, related information entities like Wiki articles or other tickets, files uploaded in the communication process and related code changes in software development. While some of this information has to be provided explicitly by the authors, the information system tries to automatically summarise suitable and valuable information to automatically provide as much context as possible to reduce costs of knowledge generation.

Besides accessing tickets via the news aggregator, tickets can also be listed by category, project, or other parameter, and found via a search function. These interfaces are usually used when searching the information system for specific knowledge, e.g. to check if a certain problem has happened before or when the last contact to a specific client was made.

*Effect on SECI-Model*

The sketch of communication-based Enterprise 2.0 software above should give us a rough idea how such systems work and how they can be used to share knowledge. While Wikis were identified as being effective in knowledge internalisation, communication-based Enterprise 2.0 software is effective in externalisation, combination and internalisation of knowledge. Like Web 2.0 software, Enterprise 2.0 software offers a low-threshold and fast communication channel and clearly arranged access to relevant knowledge by an information aggregator. By monitoring this aggregator, everybody stays informed about all information and events important to him or her and can directly react and respond, which maintains the flow of communication and collaboration. The success in establishing continuous communication leads to an effective and sweeping externalisation of knowledge in the SECI-Model.

A single message taken out of context would probably not be very informative and may not be considered as knowledge. The achievement of Enterprise 2.0 software is to combine messages to knowledge by categorizing, combining and enriching them with context. When a problem was solved in a ticket, its summary page contains a problem description, information about why this problem happened, names of the responsible employees, information about how time consuming the problem was and a solution. This example shows why such software is effective in combination of knowledge in the SECI-Model.

We can describe two different use cases, in which communication-based Enterprise 2.0 software contributes to the internalisation of knowledge: First, knowledge is shared in the workflow. Recipients get informed by mail, while other stakeholders get informed by the news aggregator. Second, knowledge can be accessed with the search function. This is what makes communication-based knowledge sharing systems so powerful: Just by using the system for communication and collaboration processes, which have to take place anyway, the information system evaluates this knowledge and makes it utilizable for other use cases. If e-mail and phone would have been used for communication, one might find single e-mails in his archive, but there would be no such thing like a clear summary he could easily access.

We can summarise that communication-based knowledge sharing systems in the firm have a sweeping effect on all three modes of knowledge sharing, which can be influenced by software. It provides a cheap way of externalizing knowledge, combines it to create suitable and informative summaries and offers various ways to clearly access to this knowledge. This leads to continuous

creation of new knowledge by the conversion from tacit to explicit knowledge and vice versa. While sharing in Wikis is usually not embedded in a workflow, communication-based systems are able to establish a constant flow of knowledge conversion, which leads to the generation of collective knowledge and at the same time stores objectified knowledge, which can be accessed independently from individuals.

*Motivation to Share*

Communication-based knowledge sharing systems stand out in creating very inexpensive externalisation of knowledge. The efforts for writing a message are not higher than using any other system for written communication, like e-mail. Since the application automatically adds context (e.g. project information, recipient, time of publishing), externalisation requires less deliberation and intellectual efforts than writing an abstract knowledge article in a Wiki. Knowledge sharing is also quite beneficial, because the software assures the recognition by both recipient and other coworkers and why the author will most likely receive feedback and therefore social recognition.

Not also sharing, but also receiving information is very beneficial with such systems. They provide a unique overview of all tasks and events in the firm relevant to the individual, which cannot be supplied by classical knowledge sharing instruments and software. Furthermore, communication-based Enterprise 2.0 software provides a database of all previous communication, events, tasks and problems in the firm, which can be adequate and helpful for individuals in future situations. The internalisation of the stored knowledge might require higher searching costs compared to a Wiki platform, because individuals often have to browse through several tickets until his or her question is fully answered. However, not only a few articles, but sometimes thousands of messages over a broad range of topics are stored in the knowledge database. From an organisational perspective, they provide the firm with a huge database of objectified, explicit knowledge, which can be used for various other knowledge management activities.

*Improving Wiki Efficiency With Communication-Based Systems*

Communication-based knowledge sharing can also contribute to the generation of more abstract and universally usable knowledge in Wiki articles. The ticket summary can be used as an inspiration or even copy-and-pasted into the Wiki article. The ticket can also be linked in the article and used as

a source. Furthermore, social recognition in Wikis can be improved by including all Wiki changes in the syndication provided by the aggregator. When an individual creates or edits a Wiki article, coworkers will be notified in their feed, and can recognise the information and re-edit the article. This does not only lead to benefits for the author, but also the higher rate of contributions to Wiki articles. Again, we will summarise our findings in three hypotheses we will try to test in our case study:

> Hypothesis 3: Communication-based software is effective in creating knowledge in Enterprise 2.0 software.
>
> Hypothesis 4: The social recognition for authors in communication-based knowledge sharing has a positive influence on knowledge sharing in Enterprise 2.0 software.
>
> Hypothesis 5: Integration into communication-based software can improve Wiki efficiency in Enterprise 2.0 software.

## *5. SME Case Study*

### *5.1 Background*

Look4 Company GmbH[7] is an Internet firm, which was founded in 2002 and is located in Freiburg im Breisgau, Germany, currently employing 4 people. Clients of Look4 are suppliers of optic products, other software studios for the optic industry and optometrists. The company is specialised in the development of electronic data interchange (EDI) standard formats and its implementations. The company created and maintains systems for product data distribution, ordering and web shop solutions for Wöhlk, Johnson&Johnson Vision Care, Bausch&Lomb and CooperVision, among others. Most of its products are developed and maintained in cooperation with Microstep Information Technology AG,[8] which is specialised in the development of applications for investment and private banking, e-business and information extraction.

7 http://www.look4.de (accessed: 10.01.2014).

8 http://www.microstep-it.de (accessed: 10.01.2014).

Besides using a web shop in the browser, these systems allow opticians to use their ERP software to directly import product data and place orders which are directly transferred and confirmed by the suppliers' ERP systems. Before that, product data was distributed as print catalogs and orders had to be placed via phone or fax. Suppliers need individual Business-to-Business (B2B) shop applications for ordering, because of the different ERP systems which have to be connected to the shop and the requirement to design the shop according to the corporate identity of the supplier. The case study describes the knowledge and information management in the development of such a shop application.

In shop development, tasks are split clearly between Look4 and Microstep. Look4 is responsible for client acquisition and communication, support, conception and design. Microstep performs the actual development and maintenance. Since five similar shop systems have been developed so far, the development has become a routine job compared to other projects, although the development process lasts 3-6 months and consists of about 20-40 man-days of work.

This case study describes the development of a B2B contact lens shop application for Johnson&Johnson Vision Care for German, Austrian and Swiss clients. The development was started in August 2010, and the shop was first released in January 2010. Since then, the shop has already been extended several times by follow-up projects to allow a broader group of clients to order. This was the first shop application and the second project developed with the support of the project management software Redmine. The author participated in that project as a developer and describes the development based on the survey, the knowledge stored in the Redmine and his experiences.

### *5.2 Knowledge in the Development Process*

A lot of knowledge creation and conversion occurs during such a project. Smooth workflow heavily depends on the knowledge and skills of the team members and routine in cooperation with other team members. This tacit knowledge is barely codified in the firm at the moment. At the beginning of a project, the client shares his expectation with the project manager via phone and e-mail. The project manager, the CEO of Look4, has to restate this requirement as a development concept. These requirements have to be discussed with the developers who make suggestions on how to implement the requirements of the client. The project manager will continuously communicate with the client and share the knowledge he learned with the team members. In the development process,

there are a lot of workflows and dependencies which have to be followed, e.g. when integrating the design: In the described case, the design of the brand website was used as a starting point. The project manager at Look4 shares his knowledge about how the client expects to adapt that design for shop use with the developer. The developer creates an HTML version of the design and sends it to the developer at Microstep who is responsible for the development of the shop application. The developer implements the design and sends a link with the test application back to Look4 to make change requests.

Another communication intensive step is the testing of the different interfaces of the shop, namely the web-interface, the order interface to optometrists' ERP systems and the interfaces to the ERP system of J&J for order and client data exchange. The shop is first tested by a Look4 employee and later by clients of J&J. Problems have to be analysed and described in a way that allows the developer at Microstep to repeat and solve it.

In the conception phase, a relatively high amount of knowledge and information exchange is performed in meetings or telephone calls. Within the actual development, the project management tool Redmine is consistently used for nearly all communication and coordination processes. Only in hold-up situations like unplanned client feature requests or difficult problems and errors is oral communication used.

### *5.3 Redmine as an Enterprise 2.0 Application*

Redmine is an open source project management tool, which is distributed under GNU License; thus, it is possible to copy, distribute and modify it without any limitation. The application runs on a web server and is accessed via web browser. Redmine integrates both collaboration- and communication-based knowledge sharing. Namely, it offers a communication-based ticket system, a Wiki, source code management, forums and management of news, documents and files. A news aggregator also exists which shows all recent actions in the user's projects. Unfortunately, this feature is hidden deeply in the application and not placed on the front page as suggested in this paper. Therefore, we must assume that this feature is not even known to all users. The data model of Redmine is relatively lightweight; however, the form to create a new ticket consists of 12 fields, while only the title is required.

Redmine can be considered a Web 2.0 application, but could be more effective in meeting the requirements formulated in section 2. Knowledge sharing is relatively easy, since the user is

required to fill only one field. Since a ticket always has a recipient who is notified via e-mail, the author will most likely receive a response and therefore the benefit of social recognition. However, the idea of the news aggregator is not solved perfectly, because the aggregator is not even linked on any page and shows Wiki contributions only as an option. Because of that, Redmine fails to share knowledge with team members who are not directly involved in a ticket and also fails to provide social recognition for Wiki contributions.

In the described project, the communication-based ticket system, the Wiki and the source code management functionality of Redmine were used. Within the project knowledge, 41 tickets and 5 Wiki articles were created. The tickets can be grouped into 19 bug reports, 19 feature requests, 2 support requests and 1 idea. Bug reports are created when an error occurs; solved tickets contain solutions or discussions involving several team members on how a problem can be solved. Feature requests tell developers to integrate or modify a specific feature and are used for communication until the final implementation is approved by the project manager.

### *5.4 Evaluation*

The inquiry was performed as an online survey.

> Hypothesis 1: Wikis are effective in creating relevant knowledge in Enterprise 2.0 software.

Although there was no explicit advice by management to compose Wiki articles, 5 articles were created during the project. They contain descriptions of the developed interfaces and summarise different installation environments and test accounts, which are needed anytime a team member wants to log into the system to reproduce a reported bug. The number of articles can be considered an adequate number to the size of the project.

In the survey the majority of team members state that they consider the knowledge shared in the Wiki important to the project[9] and use the Wiki to share knowledge, which would not be documented elsewhere.[10] Team members use Wikis multiple times per month

9 Question 18: "The Redmine-Wiki documents important knowledge about the shop development": agree (4), Partially agree (1).

10 Question 15: "I share knowledge in Wiki articles, which would not be documented elsewhere" strongly agree (3), agree (1), strongly disagree (1).

to share[11] and find useful knowledge in Wiki articles even more often.[12] Therefore, we can corroborate the hypothesis in this case study.

> Hypothesis 2: The lack of social recognition for Wiki contributors has negative influence on knowledge sharing in Enterprise 2.0 software.

Authors of a Wiki article can only be identified in the article history in Redmine. While Redmine actually contains a news aggregator feature, it is only used by one team member.[13] Therefore, Redmine does not contribute to the social recognition of Wiki authors. However, we can assume in such a small team, members often know about the author of the article, since most knowledge shared corresponds to a certain role in the project which can be identified with a certain team member.

Most team members think that their articles are read by other team members.[14] Therefore, there does not seem to be a lack of social recognition; even Redmine does not contribute to that. A reason for this can be the small team size, which makes it possible to identify the author simply by the fact that he or she is the only one who could share that knowledge. Since we cannot identify a lack of social recognition and Wiki usage is considered effective, we cannot corroborate this hypothesis in the case study. However, it still could be verified in larger teams.

> Hypothesis 3: Communication-based software is effective in creating knowledge in Enterprise 2.0 software.

During the project, 41 tickets with numerous responses were created, most of them to request new features or to report a bug. Knowledge is shared in tickets by team members several times a week.[15] All members agree that tickets improve knowledge sharing in the development process[16] and that tickets are used to share more information than would be shared with other media like phone or e-mail.[17]

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11 Question 3: "I create or update a Wiki article...": multiple times a month (4), multiple times a week (1).

12 Question 21: "I find answers to my questions or help for a problem in Wiki articles ...": multiple times a week (2), multiple times a month (2), never (1).

13 Question 4: "I learn about new information on Redmine by watching the News Aggregator": 1 out of 5.

14 Question 17: "I think that my Wiki contribution to Wiki articles are read by colleagues": agree (3), partially agree (1), disagree (1).

15 Question 2: "I create or update a ticket ...": multiple times a day (2), multiple times a week (2), multiple times a month (1).

16 Question 9: "Tickets simplify and improve knowledge sharing in shop development": strongly agree (3), agree (2).

17 Question 12: "Important information is shared in tickets, which would not be shared via phone or e-mail": strongly agree (2), agree (3).

Furthermore, all team members state that ticket creation and updating is simple and fast[18] and most say that tickets create a better overview of projects.[19] Most team members search multiple times a week for tickets to solve new problems[20] and all find useful information multiple times a month.[21] Based on these responses, the hypothesis can be fully corroborated in this case study.

> Hypothesis 4: The social recognition for authors in communication-based knowledge sharing has positive influence on knowledge sharing in Enterprise 2.0 software.

The number of tickets and amount of responses seems adequate for the size of the project. There were many more tickets created and responded than Wiki updates made in the project.

A majority of team members states that they get responses to their tickets[22] and think that the knowledge they shared is recognised by others[23]. However, discordant responses show that not all team members are satisfied with the recognition of the shared content. In contrast to Wiki article updates, ticket updates are also shared via mail. However, team members gave nearly identical responses for tickets and Wikis when asked if they think the knowledge shared by them was recognised by colleagues, which is surprising. A reason for that could be that team members might already expect feedback when sharing knowledge in a ticket, while they expect no feedback when composing a Wiki article. Although there was more knowledge shared in tickets then in Wikis, we cannot fully corroborate the thesis based on the data collected in the case study. However, the hypothesis was also not refuted and could still be verified.

> Hypothesis 5: Integration into communication-based software can improve Wiki efficiency in Enterprise 2.0 software.

18 Question 8: "Creating and updating Tickets in Redmine is easy and quick.": strongly agree (3), agree (2).

19 Question 10: "I get a better overview in projects, I participate in": strongly agree (3), agree (1), strongly disagree (1).

20 Question 13: "How often are you looking for solved tickets when having a new problem?" once a day (1), multiple times a week (2), multiple times a month (2).

21 Question 14: "How often do solved tickets actually help you with your problem?" multiple times a week (1), multiple times a month (4).

22 Question 7: "I receive feedback on the questions asked in Tickets": strongly agree (2), agree (1), partially agree (2).

23 Question 6: "I think, that the knowledge shared by me, is actually recognised by colleagues.": strongly agree (1), agree (2), partially agree (1), disagree (1).

As we have already seen, Redmine integrates the Wiki updates into the news aggregator; however, this aggregator is hidden, only used by one team member[24] and does not show Wiki changes on default. Therefore, tickets can have only limited influence on Wiki article authoring. Most team members agree that the ticket summary pages can make Wiki article composition easier[25] and 4 out of 5 team members state that they have already composed or updated an article as a reaction to a ticket.[26] Although Redmine's news aggregator does not contribute to social recognition of Wiki articles, this hypothesis can be corroborated in the case study.

## *6. Conclusion*

We can conclude that Enterprise 2.0 can effectively conduct knowledge sharing in the firm by making knowledge sharing for the individual easy and beneficial. Our case study shows that this can be archived by using both described "Enterprise 2.0" sharing technologies, Wikis and ticket-system. The basic strategy of knowledge management software is to find low-threshold and inexpensive ways to externalise tacit knowledge in the firm, enrich the knowledge automatically with helpful context information, and offer sufficient and easy access to knowledge internalisation. The more and faster knowledge gets shared in knowledge management software, the more new knowledge is created and distributed through the firm and contributes to the competitive advantage of the organisation, thus its economic success.

### *Collaborative Knowledge Creation with Wikis*

Wiki software proves to be an adequate technology for the collaborative creation of complex explicit knowledge and is already employed in many companies. The unique feature of Wikis is that they are able to create high-quality knowledge, because they use collaborative intelligence by making it very easy to extend and edit existent knowledge articles. Wiki articles allow for very easy knowledge internalisation and also provide links to related knowledge.

24 Question 4: "I learn about new information on Redmine by watching the News Aggregator": 1 out of 5.

25 Question 22: "The knowledge summarised on the ticket summary page can make Wiki article composition easier": strongly agree (1), agree (3), partially agree (1)

26 Question 23: "Have you already composed or updated a Wiki article as a reaction on an ticket": multiple times a week (1), multiple times a month (1), less frequent then monthly (1), never (1).

We hypothesized in our discussion that Wikis lack the adequate social recognition for authors, which might lead to a decrease in the motivation to share. However, it could not be confirmed in the SME case study that individuals feel a lack of recognition for their contribution. It is unclear, though, if this also holds true for larger companies.

*Leveraging Communication for Knowledge Creation*

Communication-based knowledge creation, which is, for example, used in Enterprise 2.0 ticket systems, represent a promising new way to create formalised knowledge in the firm, but only finds little application in firms today. It allows the generation of explicit knowledge by categorizing and summarizing knowledge created in communication and coordination processes. Such systems do not only provide the communication functionality of other media, such as e-mail, but can also increase the quantity and quality of the knowledge shared in communication by offering a clear overview and making knowledge sharing cheaper and more beneficial for individuals.
One lesson learned from the Web 2.0 is to provide low-threshold and inexpensive contribution possibilities. The possibility to directly comment every knowledge entity in "Enterprise 2.0" software constitutes an easy possibility for individuals to add knowledge to this knowledge entity. Users will more likely share knowledge if they do not have to start a specific application or request a new web page containing the form to do so.

Another lesson learned is the conduction of social recognition by using news aggregators, which results in immediate responses and provides a continuous flow of communication. These aggregators provide every individual with a personalised feed of all knowledge, which is considered relevant to the user. Unlike an e-mail inbox, such feeds do not only contain messages, which are addressed to the individual, but all relevant messages of projects the individual participates in and clients he or she is also in contact with.

Such news aggregators can not only improve the efficiency of communication-based systems, but could also include all new knowledge contributions which are made in other information systems used in a firm, e.g. Wikis. This would provide every individual with an easy tool to stay updated about all new knowledge created, give feedback and share his or her knowledge if possible.

*Establishment of Culture of Sharing*

It should be noted that the provision of Enterprise 2.0 software cannot conduct knowledge sharing alone, but this instrument must be integrated into a corporate culture, which actively encourages knowledge sharing. The important role of knowledge as a source of competitive advantage has to be constantly recalled among employees. Management has to set a good example by sharing relevant knowledge with employees, showing interest in their knowledge and effectively using the provided knowledge sharing tools. The strengths of knowledge sharing and the offered tools have to be actively taught and demonstrated to the individuals to convince them to adopt this culture.

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