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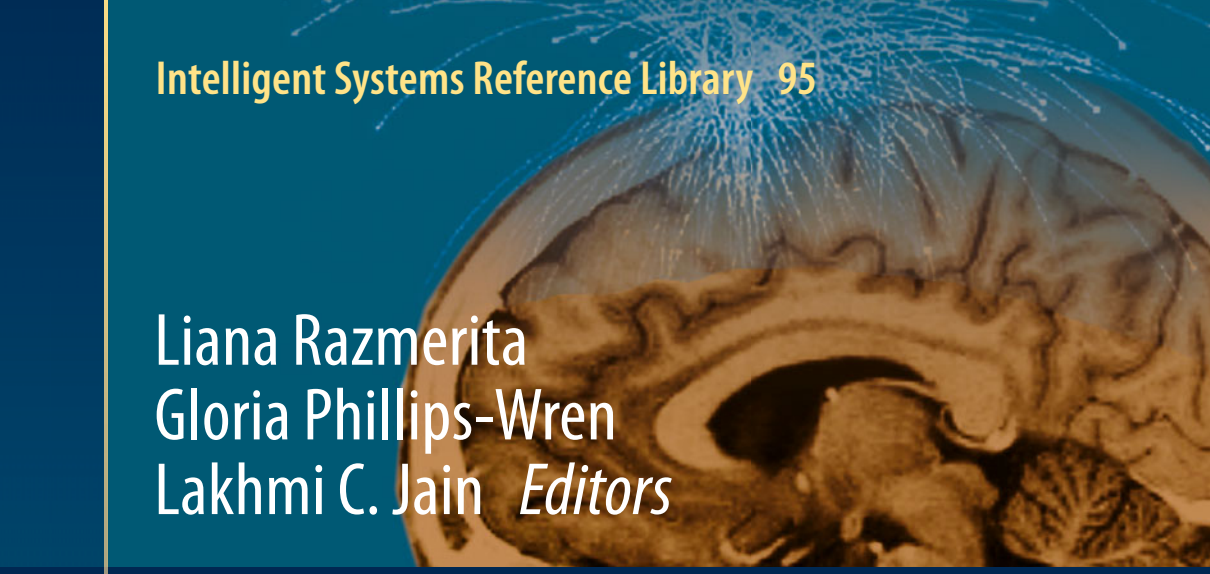

Liana Razmerita
Gloria Phillips-Wren
Lakhmi C. Jain *Editors*

Innovations in Knowledge Management

The Impact of Social Media, Semantic Web and Cloud Computing

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Foreword

According to one fairly ordinary definition, knowledge management is "the process of capturing, developing, sharing, and effectively using organisational knowledge".[1] You can easily find other definitions; experts, such as those who have contributed to this volume, can probably find reasons to quibble with this one. But this definition does, I suggest, share notable characteristics with most of the others a person, expert or not, might propose or favor.

First and foremost, this definition makes knowledge management seem like an *orderly* affair. There's *organization* to it. Its component activities can be subdivided and described; "capturing" is one kind of activity, "developing," "sharing," and "effectively using" are different kinds. Additionally, we can reasonably infer from these calm descriptions that the knowledge being acted upon is *compliant*—when we seek to capture or share it, it largely does what it is told, flowing to where we want it to go, or staying where we want it to stay. Also, this knowledge that we manage with our processes is, presumably, manage*able*—that is, it doesn't overwhelm us with its quantity or forcefulness. Finally, in the terms of this definition, and others like it, knowledge management is largely accomplished and governed by our deliberate *intentions*; we mean to do it, and the activities we consider within the scope of knowledge management are purposeful.

Such a thoroughly domesticated notion of knowledge management, though, seems increasingly out of date. *Knowledge*, which once seemed like a rather tame notion, has, in the era of the Web, social media, high tech surveillance, and big data, become raucous. Or to be more exact, if knowledge needs to be "justified, true, and believed" to qualify as knowledge (as Plato suggests[2]), each one of these qualities has, in recent years, become more complex and contestable, and the ways in which people establish or claim them have proliferated and become more varied.

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[1]Davenport, Thomas H. (1994). "Saving IT's Soul: Human Centered Information Management". *Harvard Business Review* **72** (2): 119–131.

[2]The *Theaetetus*, Plato, circa 369 BC.

Knowledge has grown up from a good little boy to a raging troublemaker. Consequently, knowledge management seems less and less like librarians' work and more and more like trying to achieve some kind of order amid revolutionary uprising. Which is the reason we very badly need books like *Innovations in Knowledge Management*. There's always been a need to manage knowledge better, but today this knowledge has become more urgent.

Arguably, the biggest reason is that the sheer *amount* of knowledge that needs to be managed has exploded. Sometime in 2012, the amount of data created in a year, globally, surpassed 2,000 billion gigabytes. Seventy-five percent of all digital data is now created by consumers, mostly using devices they carry around all the time, on their person (today mostly smartphones); this will only increase, of course. Some of the information being created and routinely captured is different in kind that what was available before; more and more, for example, data and information arrive tagged with location information.[3] Data and information are not exactly knowledge, if they are not yet justified, true, and believed. Much data may never become knowledge. But there can be little doubt that as the volume of data and information increase, the quantity of knowledge that we must manage threatens to overwhelm us with its quantity.

The increasing quantity of knowledge has powerful effects. Information that people could once reasonably expect to stay hidden no longer does. It's as if the world, not so long ago, kept its knowledge in well-defined puddles, like the puddles of rain water that persist after a storm. You can intentionally move water from one puddle to another with a bucket, or you can splash a little from one puddle to another on purpose or by accident, but the water didn't use to just flow elsewhere by itself. Now, though, our knowledge puddles have grown and grown and grown, until levies overflowed and boundaries between puddles vanished; the water has continued to rise to constitute a flood. Within the new flood of knowledge, currents move where they will, and quantities and types of knowledge that would have stayed out before now mix and swirl with quantities from far away, forming new and unexpected combinations that escape intentions. Ask a police department whose officers have been smartphone-recorded treating a citizen badly, or a thuggish leader trying to manage his image whether the knowledge they want to manage can be *easily* managed. It used to be that "what happened in Vegas, stayed in Vegas"—no longer; we must now reclassify this principle as fallacy (the "Puddle Fallacy of Knowledge Management"?).

Moreover, amid overflows and the current, some items of knowledge become unexpectedly *amplified*. The dynamics of this amplification of knowledge, which causes some items of knowledge to gain more attention than others, is poorly understood, as of yet. A recent article in the *New York Times* called "How One Stupid Tweet Blew of Justine Sacco's Life," shows just how impactful this

[3]Patrick Tucker, Has Big Data Made Anonymity Impossible?, *Technology* Review, May 7, 2013, http://www.technologyreview.com/news/514351/has-big-data-made-anonymity-impossible/.

phenomenon can be.[4] Though intention plays a part in this phenomenon, as people use social media to try to "hold people accountable" for misstatements and misdeeds, the collective effects are more complex and uncontrollable.

These are just a few of the challenges faced by purveyors of the new knowledge management. This potent and exciting new story about how knowledge behaves (and misbehaves) means the need for research on knowledge management is more urgent than ever. And this book, with its emphasis on social networking and media, context awareness, real-time sense making, and storytelling, answers the call for research that can help us understand the evolving frontier. The distinguished authors you will meet in the pages that follow can guide you toward achievement of favorable outcomes even amid the new seeming chaos.

One suspects that *knowledge*, as it manifests in our technology-enhanced reality, has not finished surprising us. But the ideas in this book will help make you ready for whatever new reality comes to pass…

Robert D. Austin

[4]Jon Ronson, Feb 12, 2015.

Contents

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His interests focus on the artificial intelligence paradigms and their applications in complex systems, security, e-education, e-healthcare, unmanned air vehicles, and intelligent agents.

Part I
Managing Knowledge, Projects and Networks

Chapter 1
Advances in Knowledge Management: An Overview

Liana Razmerita, Gloria Phillips-Wren and Lakhmi C. Jain

Abstract This chapter briefly overviews the evolution of KM from a historical perspective and discusses core concepts associated with the management of knowledge, projects and networks. We introduce theoretical perspectives that are used in the KM literature, discuss the concept of a networked-centric collaborative organization, and present future technologies in KM including the management of knowledge using social media and intelligent techniques.

Keywords Knowledge management · Background · Managing networks · Social media · Personal knowledge · Collective knowledge

1.1 Introduction

Innovations in Knowledge Management (KM): The impact of Social Media, Semantic Web and Cloud computing is one of the first books aiming to discuss recent developments and trends in the management of knowledge work. In particular, this book revisits and presents different perspectives on the management of knowledge in modern organizations in terms of human factors, organizational culture, knowledge platforms, and technical infrastructures under the influence of novel Information and Communication Technologies (ICT) in the social media age. As a result of recent ICT

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evolution (and of web technologies), Knowledge Management (KM) has become "less costly, more cloud-based, ubiquitous, standardized, and mobile, but also more personalized and more effective in meeting individual needs" [1]. Due to social media integration, KM technologies support more effectively business communication, social networking and "strategic self-presentation" [2].

Social media technologies are seeping into organizations, transforming business processes and raising performance [3, 4]. Social media opens innovative avenues to manage knowledge processes by facilitating new ways to externalize, share, create knowledge and innovate through co-creation processes, crowdsourcing or synergistic articulation of personal into collective knowledge [5]. However, these knowledge processes thrive only through active use and human interaction, and a critical mass of users is needed [6–8]. Previous research has also shown that human factors or a strong people orientation play a critical role in managing knowledge. Other significant factors are organizational culture and senior leadership support [9–13]. Next to these factors, technology or ICT has also played a crucial role in the success or failure of various knowledge management initiatives especially when the KM system was not perceived relevant, useful, and easy to use.

Wikis, blogs, social networks, tags and folksonomies make possible the transformation of a corporate intranet towards *Enterprise 2.0* through emergent collaboration of distributed, autonomous peers [14]. According to McAfee [15], who coined the term, Enterprise 2.0 does not focus on capturing knowledge itself but rather the practices and output of knowledge workers. The correct deployment of social technologies in a corporate context will result in better communication and collaboration, more effective knowledge management and faster innovation. Apart from *Enterprise 2.0*, numerous synonym terms have emerged for the new approaches to manage knowledge using social media such as: *Enterprise Social Networking, Enterprise Social Software, Enterprise Social Platforms and Social Business*. The term "social business" seems to be more generic as it is associated with the use of social media within and outside the organizational boundaries. According to Vatrapu [16], "social business is an organization that strategically engages, analyses and manages social media to structure organizational processes and support organizational functions in order to realize operational efficiencies, generate comparative advantages, and create value for customers, shareholders, and other societal stakeholders."

Furthermore, new ICT has the potential to reinvent the future of the work and core concepts associated with the management of knowledge work. These "irremediable" transformations of organizational processes and work practices have been acknowledged both by researchers and in consultancy reports [3, 4]. There is a transformation of Knowledge Management to various types of enterprise systems platforms trying to integrate principles of social media applications in order to better support knowledge sharing, communication, "how knowledge work is done" rather than trying to optimize knowledge processes and the associated work flow (e.g. ERP). Thus, it has recently been argued that email, the prevailing way of communicating and sharing information in enterprises over the past two decades, could be gradually reduced or even replaced in the future. The overuse of email in

organizations leads to reduction of productivity of highly skilled workers [17] or stress due to an overwhelming amount of time spent on reading and writing emails.

In order to provide background on knowledge management for the trends and new ideas discussed in the following chapters, this paper is structured as follows. Section 1.2 briefly overviews the evolution of KM from a historical perspective. Section 1.3 discusses core concepts associated with the management of knowledge, projects and networks. Section 1.4 introduces theoretical perspectives that are used in the KM literature. Section 1.5 of the chapter discusses the concept of networked-centric collaborative organization. Section 1.6 deals with the management of knowledge using social media. Section 1.7 presents a summary of ideas and the organization of the volume.

1.2 The Evolution of Knowledge Management (KM)—A Historical Perspective

Even though the roots of KM date back to the early decades of the previous century, KM as a research field was established in the 1990s with cross-disciplinary contributions by scholars from various disciplines including organizational behavior, strategic technology management, organizational learning, computer science and artificial intelligence. Since then it has been acknowledged by numerous scholars and practitioners that organizations need to continuously create, capture and reuse knowledge in order to remain competitive. To provide a definition: "KM is explicit strategies, tools and practices, applied by the management, that seek to make knowledge a resource for the organization [13]."

KM is a process facilitating knowledge-related activities and the management of knowledge work. Managing knowledge work is an important endeavor for organizations, since knowledge-based capital is a central source of value creation and competitiveness in the knowledge and digital economy. Traditionally, organizations employ ICT, also associated in the literature with terms like knowledge technologies, enterprise systems and KM systems, in order to support the management of knowledge processes. Hence, organizations have spent large amounts of time, money and other resources on different types of technologies—and sometimes inappropriate technology—in order to support their KM efforts [18]. Furthermore, many KM initiatives have not been used and therefore failed to deliver value in organizations because of lack of motivation and participation or lack of adoption of knowledge-sharing behaviors [19]. Among other factors influencing the success of KM systems identified in the KM literature as presented in [20] are: individual/human factors (e.g. motivation, time, perceived usefulness), organizational culture (e.g. rewards, incentives, specific routines and way of working that promote knowledge sharing), managerial support and technology-related issues (usability, integration of different existing systems).

KM methodologies and technologies must enable effective ways to elicit, represent, organize, re-use, and renew this knowledge [21].

Traditional knowledge processes associated with KM are: knowledge creation, knowledge acquisition, storage, transfer, sharing and application (or re-use) of knowledge. Traditionally, KM is associated with knowledge processes, various methodologies, and the use of knowledge technologies or KM systems that ensure that knowledge assets are improved and effectively employed within organizations. The goal of managing knowledge is to leverage and improve the organizational knowledge processes and assets in order to improve knowledge practices, workflows, organizational behaviors and thus to make better decisions and improve organizational performance [22].

More recently, social media have come into play and brought new perspectives for the management of the knowledge work, both in terms of opportunities and challenges [5, 23–25]. As represented in Fig. 1.1, improved knowledge processes lead to intermediate improved organizational processes such as improved communication, collaboration, innovation which again should lead to improved products, services, relationships with partners and customers and to improved organizational performance. In the social media age, due to technological innovation, new streamlined organizational processes may rely on: collective intelligence, collaboration through networks of internal or external collaborators (e.g. open innovation) and business communication with customers or business partners using social media platforms.

1.3 Managing Knowledge, Projects and Networks

Knowledge is a very complex concept and it may be discussed and classified in different ways. Knowledge has been defined as a "justified true personal belief" and a source of competitive advantage for individuals. According to Drucker [26]

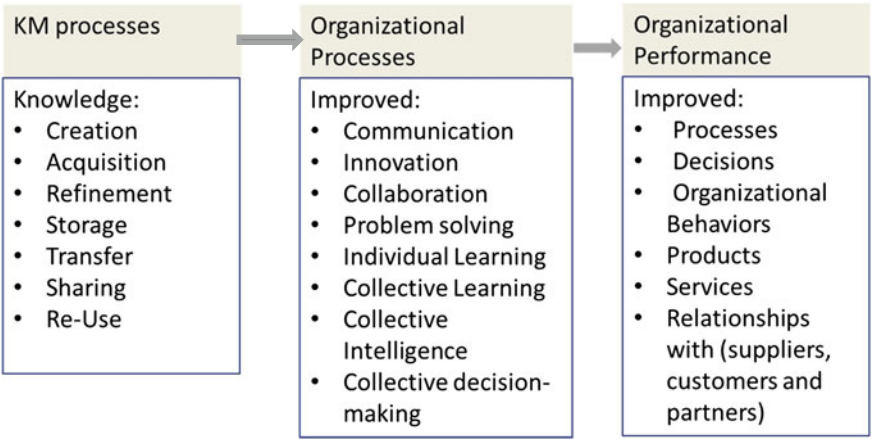

Fig. 1.1 Knowledge processes in organization in the social media age adapted from [22]

success in the knowledge economy "comes to those who know themselves, their strengths, their values and how they best perform." There are different dimensions of knowledge that can be considered. Among the most common forms of knowledge discussed in the literature are: tacit versus explicit or personal versus public or organizational/collective knowledge. Polanyi [27] and later Nonaka [28, 29] have popularized the term of tacit knowledge.

Personal knowledge can be perceived as a private good or a source of power and, therefore, certain employees may be reluctant to share it. Knowledge is also considered an intangible asset for both individuals and organizations. As emphasized by Nonaka [30] "in an economy where the only certainty is the uncertainty" the only source of competitive advantage is knowledge. Personal knowledge is often associated with the tacit dimension of knowledge while collective knowledge is associated with both explicit knowledge and organizational knowledge.

Knowledge in both its tacit and explicit form is an intangible asset for organizations that needs to be captured, reused and leveraged within organizations. Tacit knowledge resides in the minds of people and it is accumulated over years of education, training and personal experience. Tacit knowledge consists of insights and hunches, and is more difficult to articulate and therefore more difficult to share or communicate or make explicit. Explicit knowledge can be more easily shared or communicated in different forms.

In order to manage knowledge and business processes, organizations have implemented KM systems as repositories of knowledge, Enterprise Systems (ES) or Enterprise Resource Planning (ERPs). KM systems have been associated with other more or less sophisticated ICT solutions such as yellow pages of employees and experts, repositories of "lessons learned", groupware technologies (e.g. Lotus Notes) or discussion forums. KM systems can be databases or data warehouses enhanced with a front-end application where knowledge such as "best practice" types of knowledge, or lessons learned from various types of projects, are captured and codified in order to be reused. Through various KM initiatives and the use of KM systems, organizations attempt to store, share and deploy knowledge in an attempt to prevent knowledge loss or "reinventing the wheel".

A survey conducted by Davenport in 2005 [31] has found that the communication technologies used most by knowledge workers are email (100 %), corporate intranets, instant messaging and text messaging, corporate websites, information portals, or corporate extranet. Based on the findings of this survey, it is interesting that the terms KM systems and groupware technologies are not even present, McAfee [15] concludes that KM systems and groupware technologies should be considered an outdated technology (or at least the names of these technologies). Going beyond the debate that tries to define what could be considered an up-to-date technology, we would like to provide a more recent overview of communication technologies in use today.

A more recent study related to the use of ICT for knowledge-sharing within Danish organizations, conducted in 2013, [10] shows that even though the main communication channels are still email and face-to-face meetings, other technologies such as IM/chat and Intranet, social media platforms (e.g. Yammer, Chatter,

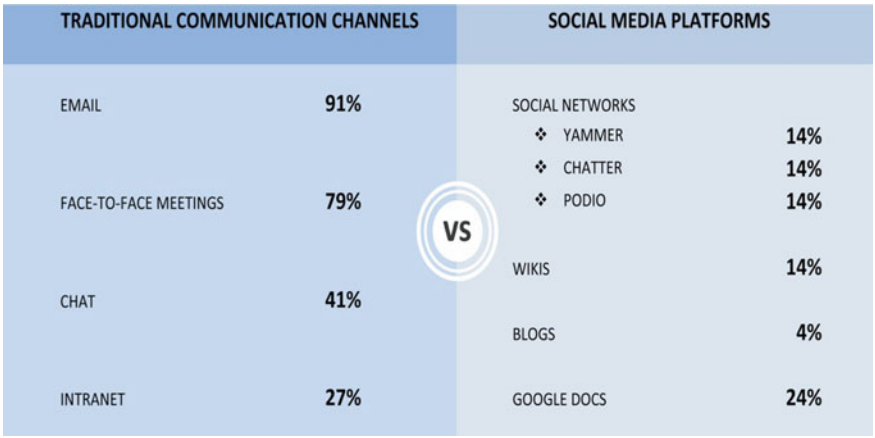

Fig. 1.2 Knowledge sharing and communication technologies in Danish organizations published in [10]

Podio), blogs, wikis and Google Docs have started to be adopted and used in certain organizations. As illustrated in Fig. 1.2, in the 21st century knowledge workers in Denmark still share knowledge primarily through email (91 %), face-to-face meetings (79 %), chat (41 %), Intranet (27 %) and Google Docs (24 %). However, new ways to share knowledge and communicate in organizations are social media platforms: Yammer (14 %), Podio (14 %) and Chatter (14 %), wikis (14 %) and blogs (4 %). These platforms still score low compared with traditional communication channels.

According to a study published by McKinsey [17] the average employee spends an estimated 28 % of the work week reading and answering e-mails, 19 % searching and gathering information and 14 % communicating and collaborating internally. Thus, this report [17] argues that "improved communication and collaboration through social technologies could raise the productivity of interaction workers by 20–25 %."

Knowledge processes are an organizational endeavor but they rely on individual, social and collective endeavors and therefore *motivation of participation* is a key human factor for KM initiatives to be investigated. Several cases have shown that many KM initiatives failed because people are not aware or not motivated to participate and exchange knowledge through technology. Motivation of participation can be viewed through different theoretical lenses which will be briefly outlined below.

1.4 Theoretical Perspectives in KM

Even if network-centric, social, collaborative processes of managing knowledge are gaining importance, the management of knowledge remains something profoundly personal. People are still ultimately driven in their actions by personal motives, and

when they contribute to the collective effort it is either because of expected personal benefits ranging from monetary value, increased intangible capital (such as reputation), social capital or self-accomplishment or because they are prompted to do so through the organizational culture, by leadership or by managers [5].

Social-psychology theory and research helps to explain both individual and collective motives, and user behavior and participation in knowledge exchanges and interactions. In such systems, participants engage in knowledge exchanges because they are perceived as interesting or important (self-determination theory [32]), they perceive a tangible benefit such as visibility or reputation (social exchange theory [33] or social dilemma theory [34]) and/or because it contributes to certain individual needs such as the desire for self-accomplishment (self-efficacy), the desire to belong to a group or the enjoyment of helping others (altruism). A direct consequence of this is that enterprise systems that harness collective intelligence have to include a stronger personal dimension [5] where users are recognized for their contributions, where users are rewarded, or where users perceive a personal benefit beyond contributing to the collective knowledge pool even when it indirectly benefits the group and/or the organization as well [35]. This is a radically different approach to that adopted in knowledge management systems, in which the individual benefit of the participant is not obvious or is perceived as being to the detriment of the individual (e.g. because "knowledge is power").

New "collective intelligence" systems aim at supporting social processes and harnessing "collective" knowledge while the collective value emerges as part of processes providing benefits for both the individuals and the organizations. In the case of social networking systems, the participation in knowledge exchanges is made visible, which may lead to the increase of the reputation recognition or social capital of the contributor [11]. In Chap. 3, O'Leary brings into discussion three other theories that are relevant for KM: the Least Effort Theory, the Pecking Order Theory and the Social Exchange Theory.

1.5 Towards a Network-Centric Collaborative Approach

Business software tools and organizational processes are redefined using technological innovations associated with the evolution of the web. Recently, both consultancy reports and academic articles have started to discuss the potential role of social media in a business context. Social media (SM) change organizational processes [3] and bring new opportunities and challenges to organizations. Social media facilitate multimodal knowledge communication both internally and externally with customers, stakeholders or business partners.

In general, social media are Web-based and mobile technologies that enhance human communication and create dynamic, interactive dialogues [36]. Kaplan and Haenlein [37] defined social media as "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, which allows the creation and exchange of user-generated content". They identified six different

types of social media: collaborative projects, blogs and microblogs, content communities, social networking sites, virtual game worlds, and virtual social worlds. These technologies enable co-creation of content, development of collective intelligence, broad reach to a user community without regard to geographic boundaries, immediate accessibility without regard to time constraints, ease of use without regard to place, and a permanent electronic record for future reference. On the other hand, there is a lack of control over content and accuracy that makes social media challenging for KM applications.

1.5.1 Networked Organization

Technologies break down traditional boundaries of time and space and transform organizations and organizational structures. Businesses can be structured around virtual teams and networks which interact, communicate and collaborate using new technologies. The rise of social media facilitates the production, distribution and consumption of products and services by increasingly following the principle of "Give according to your abilities, receive according to your needs" or GARN [38]. The question one may ask is: Could the GARN principle be applied to an organizational context?

An organization can be viewed as a system of cooperative interaction between individuals, and this even extends to the relation of the individual to a larger system (i.e. group, the organization or even other organizations) that prompts the necessity of the immediate actor to contact other individuals in the organization or even outside the organization boundaries. This view of organization reinforces the need to focus on networks.

The use of use social software in knowledge-intensive organizations leads to the development of networked organizations. Networked organizations have virtual modes of organizing more open-ended collaborative forms of innovation and product development [39]. Within these organizations, the primary mode of production is knowledge and this means of production is owned by the knowledge workers who are granted autonomy and are empowered to act autonomously in managing their work and knowledge. These new type of enterprise systems are emergent and may be introduced through a bottom-up approach as a "grass root" initiative, especially in small-medium enterprises, as described in [40] since the participants in the knowledge processes are self-directed agents who are interested in expressing, and managing efficiently, their personal knowledge or/and their social capital. Social media platforms are cheaper or even free alternatives to traditional KM systems that open the opportunity to communicate and collaborate within and/or beyond the organizational borders. Moreover, the actors participating in knowledge exchanges may not be employed by the organization itself, as is often the case in community of practices or in open innovation.

Furthermore, using social media, concepts such as collective intelligence, crowdsourcing or open innovation have gained momentum, reflecting this shift

towards knowledge processes that are inherently social and network centric. This hyper-connected space creates numerous opportunities for social exchanges and interactions and may lead to a "massive interaction overload" [41], which may distract the attention of knowledge workers.

Due to the fact that people are more connected to each other through mobile devices, social media platforms and apps for the new "on demand" economy solutions or services seem to emerge. According to a recent article published by [42], "freelance workers available at a moment will reshape the nature of companies and the structure of careers." The above-mentioned article cites a study by Pfizer, conducted in 2008, according to which highly skilled workers spend between 20 and 40 % of their time on routine work-entering data, producing Powerpoint slides or doing research on the Web. In order to mitigate this problem, knowledge-intensive organizations are contracting more work to the market in order to save costs and "free up" their highly skilled workers so they can "focus on the things that add the most value".

While in the first phase of KM, which can be named a document-centric perspective or "content-centric", the emphasis was on encouraging employees to share, create and codify knowledge using various information systems, in the second phase the emphasis is on exploiting the social dimension of Web 2.0 technologies and in particular social-collaboration processes in order to create new knowledge through collaborative work and exploit knowledge networks or networks of practice. Traditionally these knowledge networks existing within companies have the role of optimizing the flow of knowledge in organizations [43]. According to Hansen's earlier studies, the way the company organizes its units and people has an impact on the knowledge flow, the effectiveness of knowledge-sharing and consequently the performance of organizations.

Networks of practice are self-organizing, open-activity systems focused on shared practices and facilitated by computer-mediated communication [44]. These networks rely on both human links and technology and are important for effective knowledge sharing and organizational learning.

1.6 Managing Knowledge Using Social Media

Globalized society along with the digital revolution brings new opportunities and challenges for both knowledge workers and organizations. Companies need to innovate faster and knowledge workers are under pressure to solve problems more quickly, learn new skills, respond within shorter timeframes and work more efficiently.

Using new KM technologies organizations and individuals become more connected, and possibly more "social", but KM should be more personal and targeted to users' needs [8, 31, 45]. Modern KM is decentralized, more flexible, less costly and can be configured and designed for special practices by individual knowledge workers.

KM should, thus, become relevant for individual knowledge workers who ideally will perceive it to be more effective, enabling them to engage in more interactions and enhancing performance of tasks. However, if knowledge workers don't see the benefits of participation and online interaction through social media, they may not engage in such platforms and perform only activities considered important for their daily tasks.

Furthermore, users shape the way technologies are actually implemented in everyday practice because most technologies are "open-ended", meaning that most technologies can be used in multiple ways. Individuals and groups can use the same technology in different ways for different purposes and may adapt technology in the way fitting their personal needs or interests [46].

In the social media age, managing oneself and personal knowledge becomes as important as managing collaboration or managing knowledge in networks. The ubiquitous nature of social media blurs the personal and professional sphere; it brings new possibilities to externalize knowledge, and to improve communication and collaboration. The concept of personal Knowledge Management (PKM) dates back to late 1990s [47], however most of research in KM has been associated with organizational KM and only recently the concept of personal KM has started to be discussed and redefined through the use and influence of the social media [48]. Knowledge management technology may be also be used for strategic self-presentation and impression management [2].

Social media makes possible the management of both personal and collective knowledge through collaborative platforms and tools enabling a varying degree of interaction and control. Knowledge processes may be facilitated by social media, but benefits and challenges may be discussed at both individual and organizational levels [5].

A study reported by [9] focusing on the adoption of social media by several big IT consultancies in India emphasizes that cultural dimensions also need to be considered for knowledge-sharing using social media. Social media adoption by IT consultants is low due to both personal and organizational factors. Significant factors that precede the social media adoption at work, calculated through a cost benefit analysis, are: "It enhances my contacts and networks", "lack of perceived usefulness", "it is strongly supported by the management" and "social media usage in the personal life". The study also points to organizational factors that may impact the adoption of social media: having a good strategy along with top management support, leading by example, incentives for knowledge-sharing, an enabling context for knowledge sharing and a chief knowledge or "social media" officer.

Tensions between KM and SM have been also identified and discussed from a micro and macro level perspective by [23] including individual, group and organizational levels. According to a study conducted by Gartner, the vast majority of "social collaboration" initiatives fail due to a lack of purpose or a 'provide and pray' approach, which leads to only 10 % success rate [49].

Therefore, the authors of this chapter argue that the adoption of social media in organizations is beneficial and will be integrated in the future but it has not yet "commoditized". SM management is still a challenging task owing to various

factors and in particular organizational culture (e.g. established working routines), individual factors (e.g. time constraints, lack of perceived benefits) and even technological factors (complexity, lack of support or training).

A crucial step for an organization that is concerned with the strategic use of social media for both internal or external communication (social media engagement) is the creation of a social media strategy which should be aligned with the corporate strategy [16]. Social media policies and guidelines for employees should accompany the social media strategy for the organization. Such guidelines and policies can help employees understand what type of information and resources can or should be shared through social media.

Furthermore, companies need to consider the use of huge amounts of unstructured social data generated through social media conversations. Social media analytics relying on both textual analysis and social network analysis could further guide the organization on network of actors involved in online interactions, topics discussed, and various metrics, KPIs or associated sentiment analysis.

1.6.1 New Approaches and Technologies for Capturing/Acquiring Knowledge

Intelligent paradigms utilizing sophisticated artificial intelligence techniques are being integrated in virtually every field, including engineering, science, healthcare, aviation, architecture, art and business. Knowledge management is no exception. People are demanding more from systems, and companies are offering more to remain competitive. For example, some banks are able to approve loans for their customers within few minutes of receiving their online application using combined knowledge from many different sources. This speed (and hopefully accuracy) is only possible by using paradigms such as intelligent clustering to sort out the applications in the accept/reject zone. Businesses have realized that knowledge can be extracted from the vast quantity of data available today.

There is a tremendous interest among researchers and practitioners in the development of ideas from the fields of big data, data analytics, cloud computing, and business intelligence. Organizations, groups and individuals generate a huge amount of data (often referred to as big data) from sources such as social media, sensor networks, images, acoustic and transactions. These data can be stored and accessed using concepts from cloud computing (CC). Even with CC issues of privacy and security, the low initial capital investment and shorter start-up time for data storage and computation are attractive [50].

People want to connect everything with everything. Thus, connecting data and processing a variety of data types will play a big role in knowledge management techniques in the future. Intelligent paradigms are key to processing big data for knowledge acquisition.

Data-driven intelligent learning algorithms can be used to fuse limited intelligence in a knowledge management system. The main attributes of intelligence are learning, adaptation and self-organization. Researchers are using various paradigms such as Artificial Neural Networks (ANNs), Expert Systems (ESs), Fuzzy Systems (FSs) and Genetic Algorithms (GAs) to implement intelligence in a system. Expert systems mimic humans in a very limited sense by transferring the knowledge of humans to the computer. For example, artificial neural networks are computing systems that attempt to mimic the human brain as a biological problem-solving mechanism. ANNs can learn to find a solution through a process of training. GAs are modelled on the principle of biological evolution and try to find a solution to a problem for which no obvious optimization method is available. These paradigms are successfully used in processing data in knowledge management systems, but there are weaknesses associated with these paradigms. The trend is to fuse these paradigms to offset the demerits of one paradigm by the merits of another paradigm. For example, GAs can be used to evolve NNs automatically.

Organizations have realized that intelligent paradigms will play a major role in acquiring data, extracting knowledge from big data, and managing knowledge for competitive advantage. With their significant resources, Facebook, Google and LinkedIn are directing their efforts toward enhancing and using intelligent paradigms in their systems. As researchers develop new intelligent techniques and make them more widely available and accessible, knowledge management systems of the future will increasingly incorporate intelligence as a key component.

1.7 Conclusions

Innovative technologies are changing, disrupting businesses, organizational practices and shaping the future of the work. Innovative ICT, and, in particular social media, will impact the management of knowledge work initiatives, strategies and practices. In particular managing knowledge using social media has the potential to improve communication and streamline business processes in organizations.

Social media platforms bring new opportunities for the management of knowledge (e.g. knowledge sharing, externalization of knowledge, collaboration, and coordination), management of projects and networks but they are not a panacea for typical issues of KM (e.g. participation, engagement).

In summary, this chapter:

- examines the evolution of KM from “document-centric approaches” or content-centric approaches towards project-centric or network-centric collaborative approaches
- presents technological innovations associated with the management of knowledge in the social media age
- discusses opportunities and challenges opened by social media
- surveys new approaches and technologies for capturing or acquiring knowledge.

1.7.1 Organization of the Book

The book brings into discussion emerging trends in the field of KM due to technological innovations. The book is organized in 3 sections: the first section, entitled **Managing Knowledge, Projects and Networks**, discusses knowledge processes and their use, reuse or generation in the context of an organization. The second section, entitled **Managing Knowledge using Social Media: factors influencing adoption and usage**, focuses on the role of social media for managing knowledge and discusses the factors that influence employee's acceptance and participation. The third section brings into discussion **New approaches and technologies for acquiring knowledge**.

Chapter 1: Razmerita, Phillips-Wren and Jain present an overview of KM and associated innovations.
Chapter 2: Schacht and Maedche emphasize the importance of knowledge reuse as "knowledge oscillates between its discovery and its loss". Through various KM initiatives and the use of KMS, organizations attempt to store, share and deploy knowledge to prevent knowledge loss or "reinventing the wheel". An effective KM strategy facilitates not only capturing knowledge, but also prepares it for reuse. The authors propose a methodology for project reuse through the development of the "lessons learned sessions" and the "double-cycled lessons learned".
Chapter 3: O'Leary discusses the "bifurcation" of KM in enterprises beyond traditional content capture towards facilitating collaboration. New software capabilities such as Enterprise Social Networking (ESN) have facilitated interaction between users but have also created challenges that cause tension in firms. The article develops potential theories to help explain KM use: the Least Effort Theory, the Pecking Order Theory, and the Social Exchange Theory, and applies them to the supply and demand of personal knowledge in both content and collaboration settings. A case study is presented to illustrate the concepts and issues.

The article points to potential research opportunities, including theory development for KM behavior, in-depth case studies, turning collaboration messages into knowledge, and generating data that can offer new uses of collaborative technologies for KM.

Chapter 4: The process of building "networks of practice as new supra-organizational entities" through social media is studied by Cudanov and Kirchner. Communities of practice available on social media may act as a supplier of knowledge for employees and facilitate the formation of networks of practice. Their study indicates that knowledge workers rely more on web communities of practice than getting help from colleagues. The usage of social media in this context appears to have a similar function to a guild that may impact the employees' sense of affiliation and even their loyalty. As knowledge can be created and shared easily in decentralized ways on the Web, the question of securing knowledge and protecting knowledge from "spilling over" needs to be considered.
Chapter 5: Martensen, Ryschka and Bick address the question of how social applications and Enterprise 2.0 applications are used for KM in organizational

contexts. They develop a comprehensive classification system for the organizational use of social software and validate it through qualitative interviews with expert management consultants. Their system contains four categories: knowledge sharing, knowledge seeking, communication and collaboration. By understanding stakeholder perspectives, design and use of social software can be enhanced for KM.

Chapter 6: The Kirchner and Stegman study emphasizes some factors that impact the successful adoption of social media. The article discusses factors that impact employees' motivation to share knowledge. According to their study, companies adopt social media internally for four main reasons: (1) for better collaboration and communication; (2) for better project management; (3) for improved knowledge management; and (4) for improved productivity.

Based on case studies, the article discusses factors that need to be considered by companies before deploying social media. The chapter concludes that "employees will share their knowledge, but only if an exchange can be expected in return". This viewpoint is in opposition to an "altruistic" perspective of knowledge sharing/donation.

Chapter 7: Calero Valdez, Schaar, Bender, Aghassi, Schuh and Ziefle focus on providing a theoretical background and empirical research on social media acceptance. Their findings reveal that understanding users' (emotive) needs is critical when dealing with sensitive communication and data. They recommend a systematic user-centered approach when designing a social media based knowledge exchange. Their results show that "respecting user diversity in regard to willingness to disclose personal information lower the entry barriers for using such a system, while explicitly defining social norms for communication improves the perception of daily use by establishing a consistent and matching etiquette".

Chapter 8: Grambow, Oberhauser and Reichert discuss context-aware and process-centric knowledge provisioning. The authors present an introduction to the topic including technical challenges to the provisioning of contextually-relevant knowledge to knowledge workers. A solution based on the context-aware software engineering environment event driven framework is presented.

Chapter 9: Heitmann, Dabrowski, Hayes and Griffin suggest near real-time social recommendations for the enterprise. The authors argue for a need to combine Semantic Web technologies with standardized transport protocols to provide an open source layer for aggregation of distributed social platforms in the modern enterprise. The architecture for such a distributed social platform is presented.

Chapter 10: Simoes, Antunes and Cranefield propose a storytelling approach for enriching knowledge in business process modelling. The authors contrast the workflow paradigm with the storytelling approach for process modelling and process-oriented knowledge management and emphasize the advantages of their approach for externalization of knowledge.

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Chapter 2
A Methodology for Systematic Project Knowledge Reuse

Silvia Schacht and Alexander Maedche

Abstract Managing what we know appears to be one of the challenges of the Knowledge Age that seems to be an insoluble mystery. Despite 40 years of research in the knowledge management field and an overwhelming amount of research providing knowledge management strategies, practitioners are still struggling in managing what they know. Project teams, for example, are repeating mistakes and reinventing already known solutions. In this chapter, we discuss research results in the knowledge management field and emphasize the importance of knowledge reuse. As knowledge only provides an added value when it is actually applied, we focus our research specifically on knowledge reuse and present a new methodology for systematic project knowledge reuse.

Keywords Knowledge reuse · Knowledge management process · Project knowledge · Lessons learned

2.1 Motivation

Since the existence of mankind, knowledge oscillates between its discovery and its loss. In the early Middle Ages (3rd–6th century), for example, an incredible amount of knowledge has been destroyed. Therefore, this period of time is often referred to as the Dark Ages. Primarily, literature of the Greek era has been destroyed for religious and political reasons. In consequence, only a very small fraction of Greek literature is today available for our society. However, not only literary masterpieces

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fall victim to religious and political changes, but also inventions and technological knowledge. One famous example is the invention of the steam engine. Only few people know that the steam engine has been invented in the late antiquity (1st century). In this time, the power of steam was used to open large-sized, heavy gates of temples automatically. In the Dark Ages this knowledge has been lost. It took over 1600 years until scientists rediscovered the power of steam as driving mechanism. Finally, it took another 130 years until James Watt realized the potential of steam engines and heralded the start of the industrialization era. This example illustrates the devastating impact of knowledge loss. One can hardly imagine where our society would be today, if the knowledge of the steam engine had been preserved in that time.

Today, valuable knowledge is no longer destroyed in such a scale. In times of the Knowledge Age, people are more aware of the importance of knowledge and its power than ever. Nevertheless, valuable knowledge still gets lost. Especially companies feel the bitter sting of knowledge loss again and again. Whenever employees leave the company, they take their knowledge with them and large parts of their experience will be lost. Whenever an idea or best practice is not documented—perhaps because its value is not recognized—it will be lost. Whenever lessons learned of a project (e.g. the handling of certain stakeholders) are not externalized, the knowledge will be lost. Effective knowledge management (KM) in companies is, therefore, necessary to preserve knowledge and prepare it for its reuse. In particular, projects can benefit from a sophisticated KM strategy, since projects are highly complex resulting in heterogeneity of knowledge. Reasons for this fact are often grounded in the definition of projects as "*...a temporary endeavor undertaken to create a unique product or service*" [1, p. 4]. Project teams have no time to document their key insights because projects are always short in the resource of time. Team members are joining and leaving the team during the project duration and thus, knowledge is also joining and leaving. These are only few of the reasons why knowledge in projects is often not externalized. When knowledge is not documented, subsequent projects have no possibility to benefit from the insights already experienced within the organization. In consequence, they tap into the same trap, repeat previously done mistakes and reinvent the wheel by developing already known solutions.

Due to the issues of managing knowledge in practice, many researchers focused their work in the field of KM. Some researchers define the term 'knowledge' and distinguish it from other terms like 'information' or 'data' (e.g. [2, 3]). Others develop taxonomies of knowledge by defining various forms of knowledge (e.g. [4, 5]). Most researchers in the information systems (IS) discipline follow one of two basic paradigms: Either they study factors influencing KM like organizational structures and culture (e.g. [6–9]), trust between individuals and in the organization (e.g. [10–13]), or social interactions and communications between individuals and teams (e.g. [9, 14–16]). In doing so, researchers follow the behavioral science paradigm aiming to understand phenomena related to KM. Or researchers aim to solve issues related to KM following the design science paradigm. Within this research stream researchers develop models like KM maturity models (e.g. [17, 18]) or models measuring effects

of KM activities (e.g. [19–21]), or researchers design and implement KM systems (e.g. [22–24]). Over time, quantities of results have been collected by various researchers resulting in increased attempts to structure research results between 1996 and 2001. In this time, some researchers aimed to develop and provide a KM process enabling researchers to categorize their results among the process phases. However, the interpretation of these process phases is not used consistently by researchers resulting again in confusion and uncertainty for novices. In addition, some process phases like knowledge documentation and transfer are more studied than others. In particular, knowledge reuse is often omitted by researchers [25].

In this chapter, we first discuss typical KM process phases, involved roles and supporting technologies. Building on this discussion, we present a new project knowledge reuse methodology consisting of three parts: (1) a double-cycled lessons learned process, (2) the introduction of two new roles involved in that process, and (3) the definition of a knowledge-centric project management process. In order to illustrate the results of our work, we close the third section by presenting some results of our methodology's realization in a case company. Finally, in the last section we summarize this book section and discuss the contribution of our work for practitioners and researchers.

2.2 Knowledge Management: Processes, Roles and Technological Support

There has been done much research in the field of KM. Because of this work, we today know what knowledge is and how it differs from data and information, which kinds of knowledge exist and how they can be transformed, and which IS can support individuals in creating, documenting, sharing and transferring knowledge. We also have a rough understanding on activities necessary to enable effective KM in organizations and on roles that are involved in the KM process.

Within our own research on KM, we realized increased efforts of researchers to structure KM research results along KM process phases and its activities between 1996 and 2001. However, there is still no established process referenced by all researchers. For example, Alavi and Leidner [4] as well as Gold et al. [26] developed a KM process consisting of four process phases. Unfortunately, both processes coincide only in two of four phases. When shifting the perspective of considerations from the process phase level to the level of activities, the models even diverge further. One example is the unclear and inconsistent usage of the terms application and reuse. While Gold et al. [26] define knowledge application as "*... the actual use of knowledge*" [26, p. 191], Markus [27] makes a clear distinction between knowledge application and knowledge reuse. According to Markus, knowledge reuse consists of the activities of (1) define a search question, (2) search for experts and expertise, (3) select appropriate knowledge, and (4) apply identified knowledge [27]. Alavi and Leidner [4], Gold et al. [26] and Markus [27] are only

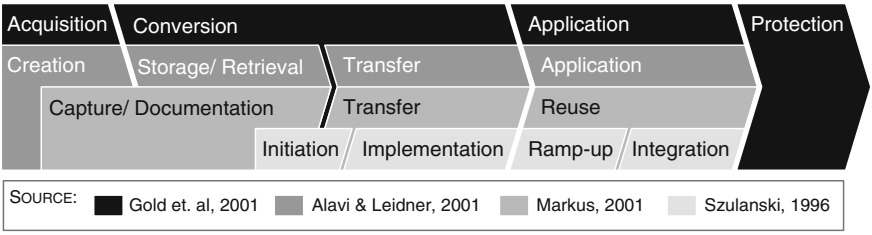


Fig. 2.1 KM process phases of several research articles

some examples of literature discussing KM processes that are varying in process phases and its involved activities. Figure 2.1 exemplarily illustrates KM processes of various researchers and demonstrates the overlaps and differences between these processes. Since our research aims to provide a methodology for effective knowledge reuse, achieving an understanding of the entire KM process was a first step of our work. We, therefore, intensively studied existing literature on KM processes, the activities and involved roles and technologies. The key findings of our efforts will be briefly presented in the following subsections.

2.2.1 The Knowledge Management Process

As previously mentioned, there exist varying KM processes in the literature. Because process phases and activities are somehow overlapping and partially labeled inconsistently, we suggest an integrated KM process combining the findings of the existing literature. Figure 2.2 summarizes the integrated KM process consisting of five process phases.

The **first phase** contains all activities related to the acquisition of knowledge. Within knowledge acquisition, knowledge is obtained either by creating new knowledge or by searching for knowledge existing in available knowledge bases

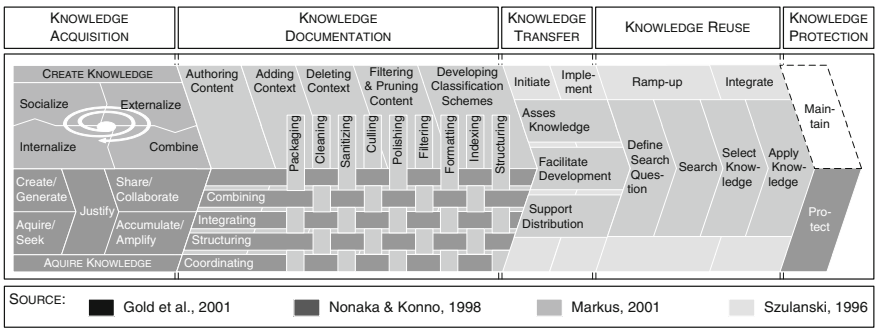


Fig. 2.2 Integrated KM process

[26]. According to Nonaka and Konno [28], the creation of new knowledge "*...is a spiraling process of interactions between explicit and tacit knowledge.*" [28, p. 42]. There are four modes of knowledge transformation which will result in new knowledge when combined:

1. Socialization where tacit knowledge is transformed into new tacit knowledge,
2. Externalization where tacit knowledge is documented into explicit knowledge,
3. Combination where explicit knowledge results in new explicit knowledge, and
4. Internalization where individuals integrate explicit knowledge into their routine and thus, transforming it into tacit knowledge [28].

In case, knowledge already exists in a knowledge base available for individuals, it can be acquired by search. After its justification—the basis for agreement [28]—knowledge will be shared or accumulated in order to gather the needed knowledge [4].

The documentation of knowledge is the **second phase** of the integrated KM process. In this phase, knowledge is captured, documented, stored and prepared for its transfer and its subsequent reuse. Preparing knowledge for its reuse is, however, a complex endeavor, since many requirements have to be fulfilled. At a first glance, some of these requirements seem to be contradictory. Ackerman and Halverson [29] summarize this issue as "*... the coexisting requirement for contextualization, de-contextualization and recontextualization. To use information as a memory, one must remove the detail that provides context, making the information into a boundary object. However, at the same time one must consider how others will use it later as a resource in their processes; otherwise, subsequent users of the memory will not be able to properly recontextualize it.*" [29, p. 47]. In consequence, the most challenging task in the second KM process phase is to decide which contextual information is necessary for an effective knowledge reuse. Another issue of the second KM process phase is the storage of knowledge. Unless knowledge is not stored in a way that it can be retrieved by others, it is useless. Thus, the development of classification schemes is also an important task in this process phase enabling on the one hand knowledge providers to tag their knowledge and on the other hand knowledge seekers to retrieve it [27].

After its documentation, knowledge has to be transferred from experts or knowledge bases to those who are seeking for knowledge. The **third phase** of the integrated KM process—the knowledge transfer—starts, "*...when both the need and knowledge to meet that need coexist within the organization [...].*" [30, p. 28]. After the initiation of knowledge transfer, knowledge resources flow from the knowledge source to the knowledge receiver [30]. Typical tasks in the phase of knowledge transfer are (1) assessment of knowledge reuse needs, (2) support of knowledge distribution by helping users to use the knowledge and organizations to understand whether there exists a need to adopt new best practices, and (3) facilitation of knowledge development [27].

Although Szulanski [30] subsumes the knowledge ramp-up and knowledge integration into the process of knowledge transfer, we shifted these activities into the **fourth phase** of the integrated KM process. We suggest naming this KM process phase knowledge reuse. According to Szulanski, the knowledge ramp-up

begins, when "*...the recipient starts using the transferred knowledge [...].*" [30, p. 29]. In line with other researchers (e.g. [26, 27]), we interpret the first usage of transferred knowledge as knowledge reuse and thus, perceive this activity as part of the fourth process phase. In order to reuse knowledge, knowledge consumers have to be aware of the search question. What is the knowledge used for? Which kind of knowledge is needed? After the definition of a suitable search question, various sources are searched for the required knowledge. Such sources contain both, externalized, documented knowledge and experiences possessed by experts. From the resulting pool of usable knowledge, the most appropriate knowledge has to be selected and finally applied [27].

The **fifth process** phase contains all activities that are related to the protection of knowledge. Only few researchers consider these activities as an essential part of the KM process; and researchers mentioning the need for knowledge protection define this process phase in our opinion too narrow. Gold et al. [26], for example, perceive the protection of knowledge as an activity necessary to secure the knowledge "*... from illegal or inappropriate use or theft*" [26, p. 192]. Because knowledge also follows a life cycle, we also include the maintenance of knowledge in the fifth KM process phase. After the reuse of knowledge, individuals can decide whether the used knowledge is still valid and thus, are able to keep knowledge up-to-date.

2.2.2 Roles in Knowledge Management

In the existing literature, there is only little work discussing the roles involved in a KM process. In general one can distinguish three different roles: (1) individuals who have knowledge, (2) individuals who need knowledge, and (3) individuals who support the transfer between the first two kinds of roles (see Fig. 2.3).

The role pooling individuals who possess knowledge can be subdivided into two types. First, *knowledge producers* create and generate new knowledge. They are the originators of knowledge and responsible for externalizing tacit or explicit knowledge by documenting or sharing it [27]. Second, *knowledge providers* are individuals possessing the knowledge and transferring it to knowledge seekers.

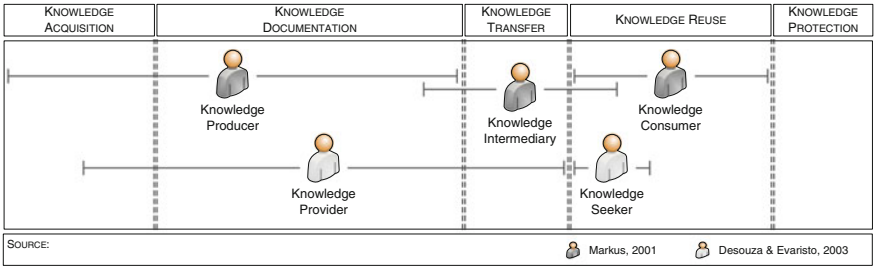


Fig. 2.3 Roles involved in KM process

Knowledge providers are thus responsible for the contribution of knowledge to a central knowledge base [31]. Both, knowledge producer and provider can be united in one single person. However, while knowledge producers create new knowledge, knowledge providers are known in an organization for possessing a specific knowledge and, therefore, are requested to share their knowledge.

Similar to knowledge producers and providers, individuals that are searching for knowledge and applying it (second role) can be subdivided into two distinct groups. On the one hand, there are *knowledge seekers*. Knowledge seekers are aware that a specific kind of knowledge is needed. They formulate the search question and either consult knowledge bases or contact knowledge providers. On the other hand, *knowledge consumers* are those people who are applying the knowledge. It is also possible that knowledge seeker and consumer are represented by the same person. In order to reuse knowledge, knowledge consumers can either directly apply the gathered knowledge (verbatim reuse approach) or combine various sources of knowledge to a new one. This approach of knowledge reuse is also called synthesis [32] and, when applied, it transforms a knowledge consumer to a knowledge producer.

A third role involved in KM process is the *knowledge intermediary*. There exist only few articles mentioning this role rather than describing and explaining it. One of these articles is the work of Markus [27]. According to her, the knowledge intermediary is a person "*...who prepares knowledge for reuse by eliciting it, indexing it, summarizing it, sanitizing it packaging it, and who performs various roles in dissemination and facilitation [...]*" [27, p. 61]. However, a detailed description of the knowledge intermediary, its tasks and role in the entire KM process remains open.

2.2.3 Technological Support of Knowledge Management

Especially in the field of IS research, there exists a tremendous amount of literature regarding technologies that support effective and efficient KM. Within the attempts of structuring KM research results between 1990s and 2001, Alavi and Leidner [4] provide a comprehensive overview on various technologies implemented as KM systems in organizations (see Fig. 2.4).

Knowledge Acquisition	Knowledge Documentation	Knowledge Transfer	Knowledge Reuse	Knowledge Protection
• Computer-mediated communication, collaboration & coordination • Computer-based learning • Intranet • Data warehousing & mining	• Computer-mediated Query languages, multi-media databases, document management systems • Intranets • Groupware • communication, collaboration & coordination • Computer-based learning • Intranet • Data warehousing & mining	• Intelligent agent software • Expert directories • Social networks • Video technologies	• Codification and automation of organizational routines (e.g. workflow automation systems) • Rule based expert systems • Social networks	

Source: Alavi & Leidner, 2001

Fig. 2.4 Technology supporting KM in various process phases

Most technology listed by the authors can be classified to the group of computer-supported cooperative work (CSCW) systems or—when preferring the more modern terminology—to the group of collaboration technologies. CSCW systems respectively collaboration technologies deal with the communication, coordination and cooperation among individuals, groups, teams and organizations engaging in a common task and pursuing a common goal with the aid of electronic technologies. Since communication, coordination and cooperation are key elements of knowledge exchange, it seems to be only consistent that collaboration technologies are used as support in KM processes. Although in meanwhile a large amount of new technology has entered the market as well as organizations, most of them still cover only the process phases of knowledge documentation and transfer (e.g. databases, wikis, blogs, RSS feed technology, etc.). For the creation of new knowledge or the improvement of knowledge reuse technology plays only little or even no role [33]. Because many KM systems focus on the storage and retrieval of documented knowledge, they do not live up to their purpose as KM systems. Rather they are pure storage bins that are used only sporadically in practice [7] as KM system. Especially in knowledge-intensive tasks, people prefer to contact their colleagues directly [32, 34]. In order to enable effective KM in all process phases, companies should therefore follow a hybrid model composed of (1) centralized KM systems (e.g. repositories) for knowledge storage and transfer, and (2) decentralized KM systems (e.g. social network systems) for knowledge creation and reuse [31].

2.2.4 The Need for a New Project Knowledge Reuse Methodology

Many research questions seem to be addressed and answered in the KM field. Thus, practitioners should be able to manage their knowledge in a very efficient way based on the results of existing research. But is that really true? Are really all issues in KM resolved by research? Do practitioners only have to read the publications of researchers in order to manage what they know? Or, is there a need for a new methodology for project knowledge reuse? Considering both, the perspective of research as well as practice, we would answer the last, but central question clearly with yes.

From practitioners' perspective, the answer to our central question asking for a need of a "new" knowledge reuse methodology seems to be much more obvious than from researchers' perspective. Till this day, companies are struggling to manage what they know. While some managers are aware, that their KM strategy requires some improvement and the management of knowledge is a permanent topic which needs to be addressed, others did not even notice that their KM strategy is inefficient and results in duplication of effort. For example, few years ago we got to know a company where the KM strategy not only had to be improved, but even had to be designed and implemented. This company is a venture capital investing

large sums of money in start-up companies. The venture capital employs about 20 employees discovering new companies, rating their potential and negotiating cooperation. Although many activities are similar for all employees, the company did not maintain a common knowledge base. Contract templates and company assessment sheets were stored at individuals' storage drives instead of a shared database. Now one might think the introduction of a common database would be a first step to an improved KM. However, the venture capital already had such a common database. The database was especially designed for the purposes of the venture capital. For each assessed company, employees had to enter the data, store related documents and maintain the course of negotiation. A closer look into the database revealed low adoption. For many assessed companies data were missing. For other companies data sets exist twice or even three times. Some employees even told us that it often happens that they independently contact the same companies. This is not only waste of resources, but also damaging the reputation of the venture capital. Nevertheless, the head of the company rejected our offer to improve their KM strategy on the grounds that they already have an expensive database and do not need newfangled technologies.

From researchers' point of view, we also would answer the question for the need of a new methodology with yes. Due to the tremendous amount of research results, there exist today tons of books and millions of scientific publications addressing knowledge, its management and best practices to handle it. Although some researchers tried to structure key findings in KM within a process, the resulting process still requires more definition and a consistent use in terminology. In addition, since the KM research area exists since more than 40 years, many results are at least partially outdated. As Allee [35] already states, "*With the explosion of knowledge creation in every profession, knowledge has a limited shelf live and can quickly become obsolete.*" [35, p. 10]. This statement also applies for knowledge gathered within the KM research community itself. So, which knowledge is still true? Figure 2.5 presents an overview on various knowledge-related themes that changed over time.

Due to significant changes in societies and the rapid development of technology, lots of research results have to be reconsidered. In particular in the context of IS,

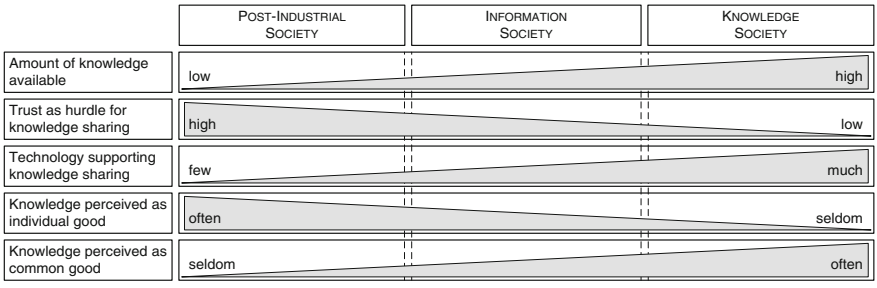


Fig. 2.5 Change of knowledge-related themes over time

significant innovations of recent years illustrate an increasing demand for rethinking research results. In the IS community, knowledge is studied following either the behavioral or the design science paradigm. "*The behavioral science paradigm seeks to develop and verify theories that explain or predict human or organizational behavior. The design-science paradigm seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts.*" [36, p. 75]. Researchers observing the phenomena in a certain topic area aiming to understand and explain them follow the behavioral science paradigm. For example, trust is one factor influencing individual or organizational behavior to capture, share and reuse knowledge. Thus, trust is perceived as a typical objective for studies in behavioral science research (e.g. [10–13]). Trust is also a good example demonstrating the need to revise various research results. Only few years ago, knowledge has been an intangible asset of employees that needs to be hoarded and secured. In consequence, trust has been a much higher hurdle for knowledge sharing than today. Due to the growth of the internet and the emergence of the Knowledge Age, individuals are more and more willing to share their knowledge even without knowing each other. In consequence, research results regarding trust determined some years ago might not be valid anymore. In addition to aging research results, behavioral science must also face some criticism that it does not provide any guidelines helping practitioners to design a KM strategy being most appropriate for them. When researchers design and develop KM systems, they follow the design-science paradigm aiming to solve a research problem based on practical issues. Here again, time gnaws on the validity of some KM research results. The wide distribution of information technology in the late 20th century enabled companies, to store data, documents and knowledge in databases, repositories or other storage media and make them accessible whenever needed. Over time, many researchers noticed that such knowledge repositories or databases are not sufficient for effective KM and only used sporadically [5, 6, 26, 27, 37]. In addition to databases or repositories, newer technologies like wikis—as a representative of Web 2.0 applications—are also explored for their potential use as KM system. In their work, Hasan and Pfaff [38] describe wikis as the "*next generation*" of KM systems, as they solve many disadvantages of traditional systems like lack of currency or high effort of implementation [38]. Another advantage, highlighted by the researchers, is a higher adoption of wikis compared to other KM systems. However, in contrast to Hasan and Pfaff's work, Grudin and Poole [39] examine in their research "*...challenges in adoption and long-term sustainability that contribute to a high wiki mortality rate.*" [39, p. 7]. Regardless whether KM systems belong to traditional CSCW systems or more modern Web 2.0 applications, most of them do not fulfill all requirements for effective KM. Rather many KM systems designed by researchers and practitioners neglect results gathered in the behavioral science.

In summary, KM-related results—gathered by following the behavioral science approach—purely aim to understand and explain phenomena without providing guidelines for practitioners. Although research results of the design science approach provide some solutions to KM-related issues, they often focus only on functionalities rather than also considering factors like individuals' behavior,

organizational structure, trust or preferred communications. Thus, during our search for a research gap, we realized a need for more attempts to structure KM research results in order to enable researchers to find a research gap as well as practitioners to define and develop a KM approach based on research results. However, we are also aware that structuring the entire KM process and its related research results is a complex purpose. This purpose is even so complex that we strongly believe it could not be managed by only one group of researchers. In order to sharpen our research interest, we therefore decided to focus our research on one KM process phase. Based on a comprehensive view on the KM process, we selected the knowledge reuse phase as subject of interest, since knowledge reuse seems often to be omitted by both researchers [25] and practitioners and is still a key challenge for organizations. Most studies concentrate their work on the collection, storage and transfer of knowledge, while research on knowledge reuse is still sparse. In consequence, companies develop KM strategies focusing on capturing, storing and transferring knowledge. Whether knowledge is finally applied is neither supported nor measured by the company. However, knowledge can only create an added value within an organization, when it is effectively applied [40].

2.3 Project Knowledge Reuse—A Methodology

At the end of 2009, we were approached by a large financial service provider asking for implementing a new and innovative KM approach. Because our research interest focuses on the reuse of existing knowledge, we agreed to conduct a joint research project in order to improve knowledge reuse in projects. In a two-years lasting project, we executed a research project following the paradigm of Action Design Research—a special kind of Design Science Research—as introduced by Sein et al. [41], because we primarily wanted to solve issues in knowledge reuse. In a first step, we analyzed the status quo regarding knowledge reuse in projects in the case company by conducting 27 semi-structured interviews (also see [43]). Within the interview series, we interviewed employees possessing various roles in the company to cover all perspectives of employees on knowledge reuse. All interviews were done by two researchers—one performing the interview and one taking some notes. In addition, the interviews were recorded with the permission of the interviewees. Following, we analyzed the data and extracted codes by performing an inductive coding approach as described by Thomas [42]. Once again, two researchers independently analyzed the transcripts and extracted those statements that seemed to be important for interviewees because they are mentioned frequently, dominantly or significantly. The codes were identified by using a software for qualitative data analysis called Max-QDA. The resulting 212 codes were then clustered into 51 categories and finally summarized to five key topics. Based on the resulting codes and categories, meta-requirements on a project KM system were identified and translated to appropriate design principles. Using the design principles, we developed a first concept of our project knowledge reuse methodology and

involved two focus groups to get feedback from company's experts. Based on the results of this pre-evaluation, we refined the design principles as well as our concept and implemented the interventions in the case company. Actually, we are performing the evaluation of the effects originated by our interventions. A detailed description of our research design can be found in [43]. In the following, we report from our experiences gathered in the case company by implementing the project knowledge reuse methodology aiming to enable project teams to share and reuse project knowledge.

2.3.1 Types of Lessons Learned Sessions

In order to enable knowledge reuse, the projects of the case company conduct so-called lessons learned sessions at the end of each project. In such sessions either the entire project team or only a selection of team members are meeting each other to discuss project-related experiences. These experiences were documented and stored at an organizational storage location. However, within our analysis phase, we also noticed that project-related experiences are reused only seldom. When asking for reasons, interviewees mentioned a low perceived benefit of such lessons learned sessions, since the project is already completed. In most cases project team members are employed in a new project having no time to be concerned with "old" stuff. One project manager explained the low benefit by stating:

> Often, you think: 'You have solved the problem. This is great. Now you can continue in your work.' You do not see the necessity to document the insights.

As possible solutions to increase the benefit of documenting lessons learned and thus increase project-related knowledge reuse, some interviewees called for lessons learned sessions conducted at earlier points of time.

By considering interviewees experiences with lessons learned sessions, we identified three types of lessons learned sessions varying in two dimensions (see Fig. 2.6). The first dimension is the impact of identified lessons learned on knowledge reuse. The more lessons learned gathered and documented in such a session are prepared for its reuse, the higher is its impact for knowledge reuse. The

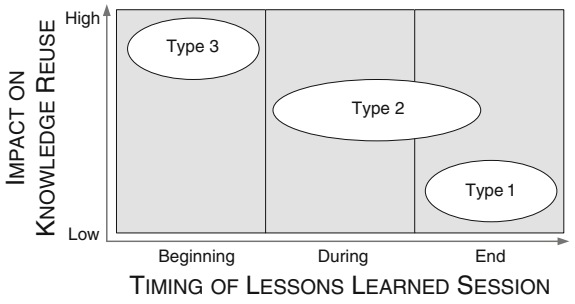


Fig. 2.6 Types of lessons learned sessions and its impact on knowledge reuse

second dimension for categorizing lessons learned sessions is the timing of a session. Depending on the time when the lessons learned session is conducted within the project, the resulting findings will have varying impact for inter-project and intra-project learning and thus knowledge reuse.

Type 1: Cope with the past. This type of a lessons learned session is usually conducted at the end of a project. Within the document analysis based on documents provided by the case company, many project-insights seem to refer to such a type 1 lessons learned session. Project-insights recorded in the documents either contain accusations against third parties or chorus of praise for the own team. Thus, within such a session participants either get the space to get their frustration or disappointment off from their chest when the project was challenged or even has failed. If the project was completed successfully, this meeting is used to carry off the bays and to give oneself a pat on the back. Considering the impact of knowledge reuse in an organization, such a session provides the lowest value.

Type 2: Recapitulation. In most cases, projects teams conduct a lessons learned session for recapitulation when the project is completed. In this case, the session serves to collect project-related experiences in order to share them with other projects (inter-project learning). In contrast to type 1 lessons learned sessions, here project teams do not only focus on past, but prepare their results for future projects. Unfortunately, project resources are often scarce. Thus, most team members are employed in other projects when the lessons learned session is scheduled. In consequence, the participants perceive the session as waste of time and thus, collect project insights often half-heartedly with limited value for others.

With regard to knowledge reuse, recapitulating lessons learned sessions are more effective when they are conducted during the duration of a project enabling not only inter-project learning but also intra-project learning. By conducting a type 2 lessons learned session within project's runtime, project teams can improve their own processes and thus enable a successful project completion. Furthermore, team members are more often aware of the benefit of such a session.

Type 3: Preparation. This type of lessons learned session has the highest effect regarding knowledge reuse. Project teams conduct the session at project's beginning or at the beginning of a new milestone. Using methods like brainstorming or storytelling, participants can share their experiences from previous projects and draw attention on possible traps and issues. Based on findings of this session, they are able to prevent already known situations challenging the project.

Since type 1 has only slight impact on knowledge reuse in organizations, we did not consider this type in our further studies. In order to enable organizations to reuse knowledge based on lessons learned sessions of type 2 and 3, we developed the project knowledge reuse methodology as presented below.

2.3.2 *Project Knowledge Reuse Methodology*

Companies are typically using lessons learned to transfer experiences of one project to another. However, these experiences are often only documented, but never reused. In order to foster the knowledge reuse, we therefore designed a new project knowledge reuse methodology consisting of three parts. First, we designed a *double-cycled lessons learned process*. Depending on the purpose of the lessons learned session, projects have to follow one of the cycles. The processes of both cycles contain all activities necessary to conduct effective lessons learned sessions. Second, we defined new *roles involved in this lessons learned process*. The first role is the lessons learned expert possessing the methodological knowledge on capturing, documenting, storing, transferring and maintaining project insights. The second role we call topic expert who has experience in a particular field and thus, possesses content knowledge. Both roles can be classified as knowledge intermediaries as defined by Markus [27] supporting project teams to gather and apply project-related knowledge. Third, since many companies are performing their projects according to the Project Management Institute (PMI) standard (see [1]), we included the lessons learned process into PMI's Project Management Body of Knowledge (PMBOK®) guide resulting in a *knowledge-centric project management process*. In the following, we will discuss the knowledge reuse methodology and its parts in more detail.

2.3.2.1 Double-Cycled Lessons Learned Process

The double-cycled lessons learned process is core of our knowledge reuse methodology. Depending on the type of planned lessons learned sessions (type 2 or 3) the project team has to follow one of the cycles as depicted in Fig. 2.7.

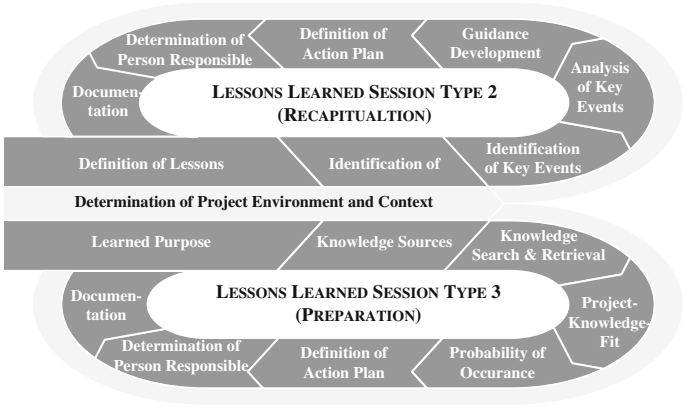


Fig. 2.7 Double-cycled lessons learned process

At the beginning of each lessons learned session, project teams have to become aware of project's environment and its context. This first step enables the team to speak the same language within the entire project duration by developing a common transactive memory system (TMS). In order to define the contextual background, team members should be able to answer questions like: What is the proposed result of the project? Which resources are allocated for the project? Who are the stakeholders in the project? What is the benefit of the project? There exist many various ways to gather the characteristics of a project in order to capture its contextual background. Our case company, for example, has defined a catalogue of questions available to all project managers. Knowing project's contextual background, team members are able to identify knowledge sources that may provide valuable insights. Such sources can be either documented knowledge stored in databases or repositories, or experts possessing the required knowledge. While the first two steps are independent from the particular lessons learned purpose, the following activities differ depending on the type of lessons learned session.

One of the most common purposes of conducting a lessons learned session is the recapitulation of the project in order to gather insights that might be helpful for other projects (inter-project learning) or even for the actual, running project (intra-project learning). Within our interviews one technical specialist explains the necessity to recapitulate project insights as following:

> Lessons learned are a useful thing. People get insights into the experiences of others and you can benefit from these experiences.

Such a type 2 lessons learned session requires the definition respectively reassessment of the project context and environment although the project is already running. In many projects not only the targets are moving, but also stakeholders, vendors, technology, etc. Therefore, the reassessment of project context serves as good entry point into the lessons learned session. When all team members are aware of the project environment, the brainstorming phase begins. Within this phase, the project team uses various methods to identify those project-related events that had a significant impact on project's success or failure. Here, methods such as brainstorming or time-lining may be helpful. A good overview on various creativity methods that can easily be used in such a lessons learned session is provided by Gray et al. [44]. The methods presented by the authors can also be used in order to analyze the origins of identified key events. By using, for example, a method called "5-Whys" the project team is able to dig deeper for reasons and influencing factors of selected events. The results of the analysis phase will be used in order to develop some guidance on how to manage such events. The guidance then result in an action plan defining all activities necessary to prevent or foster the particular event. One or more employees are selected as person responsible to keep team's eye open for that event. Finally, all the findings and guidance gathered in the lessons learned sessions will be documented and stored at a central knowledge base being available for all employees.

Focusing on an increase of knowledge reuse within an organization, the implementation of type 3 lessons learned sessions is more effective. A project

manager explains the benefit of reusing lessons learned based on a vivid example. He said:

> It's like experiences done by parents. They share their experiences with their kids. Based on these experiences the kids can build and extend their own wealth of experiences but consider known topics at the same time—topics like: Fire is hot, do not touch.

Similar to kids growing wealth of experiences, project teams can benefit from previous projects by taking time to sit together, collecting experiences from other projects, and brainstorming on possible risks. The team can prepare for critical situations. When a project team plans to conduct a lessons learned session for preparation, it has to follow the lower cycle of our double-cycled lessons learned process. In a first step, the team members scour the identified knowledge sources for knowledge that may fit to the project. Thus, they always need to have project's contextual information in mind. After the identification of knowledge that may fit to the project, it needs to be assessed and rated. From all selected project insights, the team together estimates the probability of the event described in this finding and tries to rate its impact on the project. Here, for example, methods used in risk management can be applied. Depending on the probability of occurrence, the team develops an action plan and defines a person responsible tracking the particular event similar to the steps described in the upper cycle. All the findings, activities and persons responsible that were identified and discussed in the lessons learned session have to be documented, stored centrally and transferred to the entire project team.

2.3.2.2 Roles and Responsibilities

Within our interview series, employees requested more support to manage project-related insights beginning with the capturing continuing with the documentation, storage and transfer up to the reuse of project-related knowledge. On the one hand, they called for more support regarding the process of performing lessons learned sessions. On the other hand, they also stated an increased demand for resources with dedicated time. Conducting a lessons learned session in project teams often raises a lot of issues for the project managers. One project manager being a novice called stated:

> If there would be a bit more quite natural tools available enabling you to perform such a session more qualified, rather than somehow construct it by yourself. That would be helpful.

In a lessons learned session, each participant should have equal rights in order to gather all experiences—even those which, for example, regard to the management skills of project managers. No one should be afraid to contribute or fear some kind of punishment. Thus, the project manager should also be perceived as a participant of the session having the same rights and duties than the other participants. However, often the manager hosts the lessons learned session making it impossible

to preserve the state of being equal. In order to solve this dilemma, one interviewee told us that he uses the support of a colleague. He describes his experience as following:

> As a first step, you have to define the group of participants – people who should attend the lessons learned session. Following, you have to plan and convoke a meeting, and search for a moderator – someone who approaches the topic as neutral as possible in the broadest sense. This might be someone out of the project office who accompanied the project but is not involved in decisions or critical situations in order to enable neutrality.

By employing the colleague as a neutral moderator being responsible to organize and moderate the session as well as calm down heated discussions, the project manager solved the dilemma. Therefore, we took up this idea and designed a new role we called *lessons learned expert*.

According to the classification of Markus [27], the lessons learned expert acts as a knowledge intermediary. When studying existing literature, there are only few roles involved in the KM process acting as a knowledge intermediary. One of these roles is the Chief Knowledge Officer (CKO). According to McKeen and Staples [45], CKOs exist in firms since the early 1990s. They are responsible to develop a strategy on how companies should handle their intellectual assets and foster an according corporate culture of learning [46]. Thus, CKOs as described in literature (e.g. [45–47]) operate on a strategic level. Another role discussed in existing literature is the knowledge broker. The role of knowledge brokers is mainly studied in relation to knowledge transfer. Lind and Persborn [48] identify five key activities of the knowledge broker facilitating knowledge transfer: (1) support the knowledge consumer to formulate his/her knowledge need, (2) find an appropriate knowledge source for the consumers need, (3) connect the knowledge consumer with the knowledge source, (4) find problems for the knowledge producer, and (5) supply with an infrastructure supporting the intermediation between knowledge consumer and knowledge producer [48]. Thus, the knowledge broker primarily connects knowledge seekers with knowledge providers. Later on, other researchers study the role of knowledge brokers as translators between science and practice [49] still focusing on knowledge transfer. A recent work of Meyer [50] extends this role. According to her, knowledge brokers facilitate knowledge creation, sharing and use by establishing and maintaining "*...links between researchers and their audience* via *the appropriate translation of research findings.*" [50, p. 119]. Typical tasks of the knowledge broker include the organization of seminars, the development of a knowledge database, or the fostering of the TMS by producing plain-language booklets. Nevertheless, Meyer [50] also concludes that there is still a need to define and specify the role of the knowledge broker in more detail. Within our status quo analysis, the employees interviewed by us also called for more support on the operational level.

We, therefore, extended the role of knowledge brokers resulting in the lessons learned expert. Lessons learned experts are—like knowledge brokers—responsible to connect knowledge seekers with knowledge providers. Before a session, lessons learned experts identify in cooperation with the project manager appropriate

knowledge sources in form of documented lessons learned and employees known as experts in a particular topic. They are also planning and organizing lessons learned sessions. In addition, they are designing the progress of lessons learned sessions considering various methods appropriate to project's actual situation and the purpose of the session. Within the session, lessons learned experts are responsible to slip into the role of a newbie in order to enable project-external employees to understand and reuse the collected lessons learned. Thus, they have to contextualize, decontextualize and recontextualize project-insights. After a lessons learned session, the expert has to document the collected knowledge in a short, understandable, and partially standardized (e.g. by using templates) format. Finally, the documented knowledge has to be stored centrally and maintained with regard to usefulness and up-to-datedness by the lessons learned expert.

The second role introduced in the case company as valuable support for knowledge reuse is the *topic expert*. While lessons learned experts possess process knowledge required to perform lessons learned sessions, topic experts will be involved in the project due to their topic-related knowledge. Thus, lessons learned experts serve as a kind of service, while topic experts can be seen as a kind of consultant. In each lessons learned session, the project manager or even the entire team has to brainstorm in cooperation with the lessons learned expert, which knowledge is required for the next step and which employee in the company has the knowledge. For example, in one lessons learned session conducted in the case company, the project manager of the predecessor project served as topic expert consulting the follow-up project. The topic expert is then consulted in case of issues and invited to share his or her knowledge in the lessons learned sessions. The tasks and required skills of both roles are summarized in Table 2.1.

Table 2.1 Role definition of lessons learned and topic expert

	Lessons learned expert	Topic expert
Role	Service	Consultant
Tasks	– Connect knowledge providers and knowledge seekers – Plan and organize LL sessions – Design LL progress – Moderate LL session – Slip into the role of a newbie – Document LL – Contextualize, decontextualize and recontextualize LL – Store LL centrally – Maintain LL	– Search for appropriate LL – Prepare LL for project – Present LL in project team – Consult project team
Skills	– Moderating – Organizing – Quick-wittedness	– Experienced in a topic area – Solution-oriented – Communicative

LL lessons learned

2.3.2.3 Knowledge-Centric Project Management Process

Within the analyses of case company's state-of-the-art on handling project knowledge, employees reported that they are following the project management guidelines according to PMI. However, when studying the PMI framework [1] we realized a subordinate role of knowledge and its management. Although, according to the framework knowledge reuse should happen in nearly all project phases, it does not provide any guidelines regarding time and procedure of knowledge reuse. In addition, the framework suggests gathering project-related knowledge only at project's end in order to share the experiences with other projects (inter-project learning). We, therefore, refined the PMI framework by hybridizing the project management process with the double-cycled lessons learned process. Figure 2.8 depicts the resulting process.

As described in PMI framework, project teams should follow the classical project life cycle consisting of (1) project planning and preparing, (2) project execution, and (3) project closure. In all the phases, the project also has to monitor and control project work [1, p. 40]. However, within the project planning phase, we suggest to conduct a first lessons learned session as preparation. In this session, the entire project team brainstorms which events could happen in the project and how to prevent or foster them. In this session, topic experts should be invited in order to share their experiences and provide project-critical knowledge. Based on the results of this session, the team is able to develop an appropriate project plan including the allocation of resources (e.g. time, knowledge sources, experts, team members) necessary for further lessons learned sessions. Depending on size and duration of project, lessons learned sessions should be performed after each milestone. In this session, the project team has to follow both, the purpose of recapitulating previous activities and preparing next steps. These sessions enable project teams to adjust the project plan and learn from experiences gathered by themselves as well as other

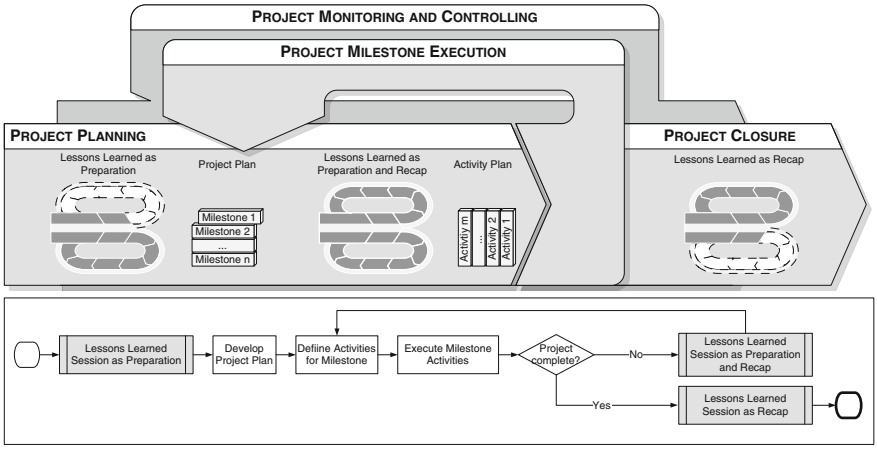


Fig. 2.8 Knowledge-centric project management process

projects. During project's duration, the team should seek advice from topic experts of various topic areas. Finally, at the end of a project, the team has to collect all the project-related findings that might be interesting and helpful for other projects, prepare the insights and share them company-wide. We suggest employing a lessons learned expert in all these sessions.

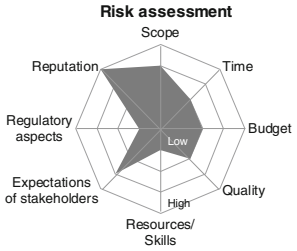
2.3.3 *Exemplarily Implementation of the Project Knowledge Reuse Methodology*

In December 2011, we started a pre-test of the concept (consisting of the double-cycled lessons learned process, the roles of topic and lessons learned experts, and the knowledge-centric project management). In cooperation with employees of the case company, we have chosen a project being in the mid of its processing time. In order to observe the effects of the planned interventions, we decided to introduce the single parts of our interventions step by step beginning with the introduction of the expert roles. Thus, the primary goal the pre-test is the implementation of lessons learned experts and topic experts, introducing them in a project environment and determining the degree of knowledge reuse. We, therefore, decided to design the lessons learned session in a mixed way. By following step 1–4 of the double-cycled lessons learned process, the team of our test project was not influenced by any interventions. Only the project manager was pleased to assess his project and support us by the selection of appropriate topic experts. Step 5–7 highly differs from company's traditional way of performing lessons learned sessions. Thus, we skipped these steps, since they also had no impact on the effectiveness of experts. Finally, step 8 was done by one researcher because as researchers we already prepared a research diary. Thus, we had to document the procedure and results of the lessons learned session anyhow. In the following, we describe step by step the procedure of the pre-test.

S**tep 1—Assessment of project environment and contextual background**. As already mentioned, we asked the project manager to assess his project based on the questionnaire developed in the case company. This questionnaire asks for basic project details as well as supports project managers to assess their project with regard to its complexity and possible risks. The results of the assessment are summarized in Fig. 2.9.

Step 2—Selection of knowledge sources. In cooperation with various employees of the case company as well as the project manager of the test project, we selected both, a lessons learned expert and a topic expert as sources of knowledge. Within the case company, employees can train their moderating skills by attending a moderating course on a voluntary basis. We selected one of the employees who completed the course successfully. For the selection of the topic expert, we took the advantage to test project's special situation. Because the observed project has a direct predecessor, we nominated the project manager of the predecessor project as being the topic expert.

Project details	
Budget available	> 2m €
Team size	50 to 100 person
Duration	18 months



Project complexity	Low	Medium	High
Degree of required experiences			X
Dependency to other projects			X
Dependency to external organizations	X		
Degree of change related to:			
- Strategy			X
- Processes			X
- Products		X	
- Infrastructure	X		
- Applications		X	
- Architecture			X
- Interfaces		X	
- Data		X	

Fig. 2.9 Project-related details

Step 3—Identification of key events. In consultation with test project's manager, we planned and designed the lessons learned workshop. The duration of the workshop was planned to be 3 h. From more than 50 active project team members, 20 members possessing various roles in the project (e.g. test manager, application owner, business analyst) were selected and invited to participate the workshop. All invited project team members attended the workshop. In order to identify key events, we conducted a kind of brainstorming session. Each participant was asked to answer following four key questions:

1. What do we want to reduce in our project? (Reduce)
2. What do we want to eliminate in our project? (Eliminate)
3. What do we want to increase in our project? (Increase)
4. What do we want to create in our project? (Create)

Prior to the session, we divided the participants in two groups. One group was asked to prepare the project insights by themselves before the lessons learned session. During the lessons learned session, this group was asked to discuss and consolidate their findings. The second group had to collect the insights ad hoc within the workshop. Both groups were pleased to write down their insights on post-its and stick them on whiteboards prepared by the lessons learned expert. The resulting whiteboards are depicted in Fig. 2.10. In total, 99 insights were collected

Fig. 2.10 Project findings collected by group 1 and 2

Table 2.2 Selected project insights

Number of collected insights	Reduce	Eliminate	Increase	Create	Total
Group 1	13	15	18	12	**58**
Group 2	9	7	18	7	**41**
Total	**22**	**22**	**36**	**19**	**99**

by both groups and clustered into the categories reduce, eliminate, increase and create as summarized in Table 2.2.

Step 4—Analysis of key events. After the identification of those events having an impact on the project, all participants clustered the findings according to their content. Main goal of the clustering was the elimination of duplicates and the bundling of topics that are overlapping, related to each other or even contradictious. In consequence, the 99 insights identified in step 3 resulted in 22 clusters of topics. These clusters can be again categorized based on cluster's relevancy for knowledge reuse. We identified four main categories listed from low relevancy for knowledge reuse to high relevancy: (1) topics regarding the project team (e.g. team culture, communication, co-working), (2) topics regarding project management (e.g. time management, resource management, project planning), (3) topics regarding IT projects in general (e.g. documentation of IT projects, testing of software), and (4) topics regarding the particular project. The categorization of all lessons learned and its related clusters is summarized in Table 2.3.

After clustering the identified lessons learned, the topic expert presented his findings he has prepared previous to the workshop. In sum, he presented twelve insights. Although, all lessons learned provided by the topic expert have some relationship to the project and might be useful for projects in general, we perceive only nine of the lessons learned as being of particular value for the test project. The remaining three lessons learned were highly generic discussing the topics of (1) communication within the project team, (2) distribution of information within the project team, and (3) project team etiquettes. These insights relate more to general guidelines for projects. Out of the resulting nine project insights, four findings presented by topic expert have not been discussed in the lessons learned workshop. However, some participants agreed that the value of these insights might be valuable in further project activities. Regarding the remaining five out of nine

Table 2.3 Topic clusters and themes identified by project team and topic expert

	Project team	Project management	General IT project topics	Project-specific topics
Number of LL	43	31	9	16
Number of LL clusters	8	8	3	3
Number of LL provided by topic expert	3	3	5	1

LL lessons learned

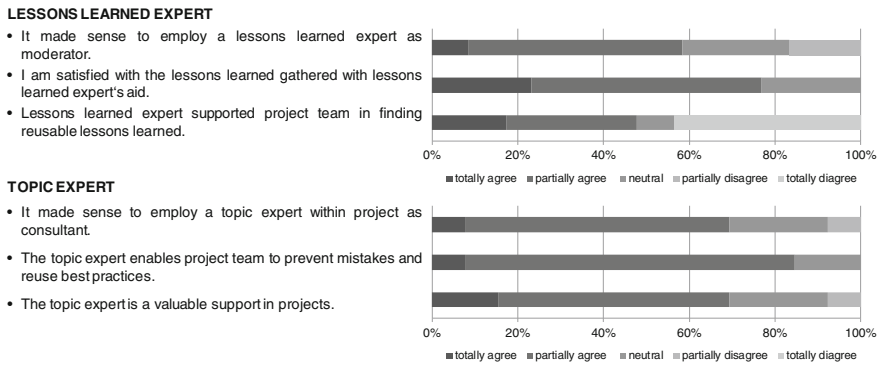


Fig. 2.11 Assessment of lessons learned and topic expert

project insights, the workshop participants mainly agreed that they could have helped the project team if they were already known at project start.

At the end of the workshop, we conducted a brief evaluation asking the participants to assess the value of both, the lessons learned and topic expert. Most of participants agreed to experience an added value due to the employment of the lessons learned expert. In particular, participants were very satisfied with lessons learned collected with the aid of the expert. The added value of a topic expert is also realized by most participants. 11 out of 13 participants who answered the questionnaire agreed that topic experts have the possibility to enable project teams to (1) prevent mistakes and (2) reuse existing best practices (see Fig. 2.11).

2.4 Summary

In this article, we present a methodology to increase knowledge reuse within and among projects. Till this day, there exists only little work on knowledge reuse. Researchers and practitioners often assume that systematic collection, storage and transfer of knowledge will automatically result in good knowledge reuse. However, our observations reveal that this assumption is not true.

Our project knowledge reuse methodology consists of three main parts: (1) a double-cycled lessons learned process providing a step-by-step guidance for practitioners on how to conduct a lessons learned session in order in improve project knowledge reuse, (2) the definition of two roles as knowledge intermediaries enabling project teams to find appropriate knowledge (sources) and to gather, document, store, and transfer their own experiences, and (3) a knowledge-centric project management process suggesting to conduct lessons learned sessions not only as recapitulation at the end of a project, but also at its beginning and during its runtime as preparation of next steps. In order to demonstrate our practical experiences with the methodology, we also provide some insights into the cooperation

with our case company and the implementation of our interventions. As a result of a pre-test, we have seen strong evidence that the role of the lessons learned expert is strongly accepted by workshop participants and is perceived as an added value. Furthermore, feedback of the workshop participants also indicated a clear added value of the employment of a topic expert. After this pre-test, we are currently evaluating all interventions developed in the Action Design Research process following a hybrid qualitative and quantitative approach.

Our research contributes to practice and theory. On the one hand, practitioners will be empowered to improve knowledge reuse within their organizations in order to increase inter-project learning and intra-project learning. By introducing a step by step guideline managers will be able to execute their lessons learned sessions more efficient and effectively. On the other hand, our project knowledge reuse methodology is a first step towards structuring results of KM research. Within the methodology, we connect knowledge reuse activities, project management, and involved people to improve knowledge reuse. By focusing on knowledge reuse, our work follows the call of more research on this KM process phase (e.g. by [25]). Furthermore, it pursues and extends the work of Markus [27] as well as Meyer [50] by introducing and describing in detail a new kind of knowledge intermediary. Although not explicitly discussed in this article, modern technologies such as Web 2.0 applications play an important role within our methodology. Nearly all phases of the knowledge-centric project management can be supported by modern communication and collaboration technologies. For further readings, some of our experiences when employing such technologies in our framework are presented in [43].

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Chapter 3
Knowledge Management and Enterprise Social Networking: Content Versus Collaboration

Daniel E. O'Leary

Abstract Historically, most enterprise knowledge management efforts have been content-based; however, recently firms have begun to focus their knowledge management efforts into collaboration. As a result, enterprises are changing their knowledge management strategy, focusing on collaboration, using enterprise social networking (ESN). This bifurcation has brought attention to user's potential supply and demand of knowledge for tasks and decision making: Which do they use, content, collaboration or both? This paper investigates three potential theories to analyze that choice. In addition, the bifurcation suggests development of approaches to facilitate the integration of content and collaboration. Further, this paper investigates the role of personal knowledge management in collaboration and content generation. A case study is presented to illustrate some of the concepts generated in this paper. Finally, this paper proposes a number of potential research issues resulting from this investigation.

Keywords Knowledge management · Enterprise social networking · Least effort theory · Pecking order theory · Social exchange theory · Personal knowledge management · Social media

3.1 Introduction

A 2014 report by APQC, one of the leading organizations in the study and analysis of knowledge management systems, identified five key best practices for knowledge management[1]:

[1] http://www.apqc.org/new-apqc-research-details-best-practices-turning-knowledge-lasting-value-and-competitive-advantage, January 20, 2014.

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1. Let business leaders and experts determine what knowledge is critical but provide criteria to support their decision making.
2. When deciding to capture and transfer knowledge consider the ratio of tacit to explicit knowledge, the intended audience, and the rate of change.
3. Structure systematic knowledge transfer as a time-bound event with clear goals, milestones and outcomes.
4. Make knowledge broadly available unless there is a specific reason to restrict it.
5. Offer self-service tools to navigate, filter and customize the flow of knowledge—and provide a human support team as a last resort.

An analysis of these five best practices suggests that each of these best practices is "content focused," treating knowledge as an object. In particular, each of these best practices is aligned with categorizing and abstracting knowledge and capturing that knowledge in a database. As a result, from the perspective of these best practices, knowledge management is seen as largely a content issue, with knowledge treated as a "thing." Further, these guidelines generally focus on using organization hierarchy to guide, approve and manage the knowledge management capture and use.

However, recently, many firms have found capturing and managing content is problematic. For example, the professional services firm, PriceWaterhouseCoopers (PWC) recently suggested that Wright [54] "It is difficult to encourage people to put things into databases on the off chance that someone might want to find it there. … we do not put things into the system naturally." As a result, it probably is not surprising that recently, another professional services firm, KPMG implemented what they called a "strategic shift" in their knowledge management program towards enabling collaboration, moving from a portal/content centric approach to include a collaboration centric approach [4].

PWC and KPMG are not alone in their movement toward collaboration. Other professional services firms, including Deloitte and Ernst & Young (E&Y) also recently have adopted enterprise social media (networking) (ESN) to facilitate collaboration. Further, it has been suggested that by the end of 2013 roughly 90 % of the Fortune 500 had either partially or fully implemented ESN.[2] Similarly, according to a McKinsey study [10], 53 % of firms surveyed in 2012 were using ESN, up from 28 % in 2009.

ESN are internal tools (typically implemented on an intranet) that are designed to facilitate collaboration, communication and knowledge sharing, typically among employees. ESN has allowed a larger and more important role of the "crowd" from within the enterprise, encouraging, not limiting participation, and breaking away from hierarchical knowledge management.

The ESN movement has cast attention on knowledge management as having two primary approaches: manage content and manage collaboration. In general, if a content approach is used then the enterprise focuses on connecting the user and processes to content and if a collaboration approach is used then the enterprise

[2] https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Technology-Media-Telecommunications/dttl_TMT_Predictions2013_EnterpriseSocialNetworks.pdf.

focuses on connecting the user with other users, who may use either private or public content to help others generate ideas and solve problems.

3.1.1 Purposes of This Paper

This paper has a number of different purposes. First, this paper investigates the emerging bifurcation of knowledge management systems to include not only content, but a focus on enterprise network collaboration using social networking capabilities. In so doing, this paper examines the relationship between content and collaboration in knowledge management, analyzing some of the different roles of content and collaboration. Second, this paper also investigates potential theories aimed at better understanding which approach would we expect people to use—content, collaboration or both? Third, with the focus on both content and collaboration, an emerging question is how can enterprises begin to integrate content and collaboration? Fourth, this paper investigates the role of personal knowledge management in how knowledge is captured in content and collaboration. Fifth, this paper presents a case study to briefly discuss and illustrate some of the issues and concerns generated in this paper. Finally, this paper summarizes a number of research issues related to the discussion of content versus collaboration.

3.1.2 Outline of This Paper

This paper proceeds in the following manner. This first section has provided some background and motivation for the paper. In addition, this first section summarized the purpose of the paper. The second section of the paper provides a brief summary of some key background material, regarding knowledge management and social media. Section 3.3 briefly reviews enterprise social networking and some recent research in ESN. Section 3.4 summarizes a content model of knowledge management, while Sect. 3.5 investigates a collaboration model of knowledge management. Section 3.6 analyzes some potential theories for the use of knowledge, and introduces the least effort theory, social exchange theory and the pecking order theory of knowledge management. Section 3.7 analyzes the application of those theories to using content and collaboration approaches to share private knowledge. Section 3.8 provides some discussion as to how to ultimately begin to integrate content and collaboration. Section 3.9 provides a case study of a firm implementing an enterprise social networking capability. Section 3.10 summarizes some potential and emerging research issues. Finally, Sect. 3.11 briefly summarizes the paper, discusses the contribution of the paper and briefly examines some extensions.

3.2 Background: Knowledge Management and Social Media

The purpose of this section is to briefly review some background concepts in enterprise knowledge management and social media, particularly as it potentially relates to knowledge management.

3.2.1 Enterprise Knowledge Management

Enterprise knowledge management is literally aimed at trying to manage knowledge in an enterprise. An analysis of O'Leary's [25] original focus on enterprise knowledge management suggests that it had a definite content focus:

> Enterprise knowledge management entails formally managing knowledge resources in order to facilitate access and reuse of knowledge, typically by using advanced information technology. KM is formal in that knowledge is classified and categorized according to a pre-specified—but evolving—ontology into structured and semi-structured data and knowledge bases. The overriding purpose of enterprise KM is to make knowledge accessible and reusable to the enterprise.

O'Leary [26] appeared most focused on knowledge as content; however, he did suggest the importance of connecting people to people, and integrating collaboration into knowledge management systems. Specifically, O'Leary [26] was concerned with two primary issues: converting and connecting:

- Convert individual to group available knowledge
- Convert data to knowledge
- Convert text to knowledge
- Connect people to knowledge
- Connect people to people
- Connect knowledge to people

Although that discussion was heavily aimed at content there was still concern with collaboration issues. However, those discussions preceded the rapid growth of social media and Web 2.0 and their use for knowledge management.

3.2.2 Social Media and Web 2.0

In the initial years of the Internet, virtually all of the content was generated at different institutions' (company, government and university) web sites. However, according to Haley [14] over 50 % of the content on the Internet comes from individuals, typically using some form of social media.

Generally, social media is "cloud-based" and often referred to as "Web 2.0" or when used in a business context, "Enterprise 2.0" (e.g., [18, 33]). Social media replaces or supplements more traditional forms of communication, such as person-to-person communication, telephone calls or email.

Social media and Web 2.0 has been an active source of research. For example, Power and Wren [36] and others, have investigated the use of social media and Web 2.0 to support decision making.

Types of Social Media. There are a number of different types of social media that can prove useful in knowledge management efforts, including the following:

- Social tagging attaches tags to documents or other media that provides a description as to the content. For example, Delicious.com allowed user to tag different articles, while Flickr.com allows users to tag pictures. As an example of the use of tags, this article might be tagged with "social media" and "knowledge management." Since user information typically is captured as part of tagging, tags can be used to identify community networks.
- Wikis provide a medium in which encyclopedia-like materials can be captured and accumulated. For example, "Wikipedia," perhaps the best-known wiki, is considered typical of wikis, and is a merger of the terms "Wiki" and "encyclopedia." Further, wikis have been characterized as a medium where knowledge is captured from those who have knowledge to contribute (e.g., [28]). Finally, unlike most other social media, Wikis provide a medium where content can be collaboratively generated.
- Blogs are seen as providing a more individual opinion-based media, and typically more of an individual statement. However, blogs have been shown to generate substantial useable content for marketing, financial and other applications. In addition, researchers have investigated understanding the basic sentiment of the blog (e.g., [30]). Interested users can choose to follow a particular blogger, creating social networks of those users.
- Twitter, the best known micro-blog was originally generated to let people provide others with quick and frequent answers to the question "what are you doing?" Increasingly, such micro-blogs, as exemplified by Twitter, provide the ability to rapidly broadcast and re-broadcast news items, and communicate with others. As with blogs, Twitter provides an environment that allows individuals to make statements, rather than generate content collaboratively. Further, users can choose to follow Twitter accounts, serving to generate communities of users.
- LinkedIn is aimed more at a business-based audience but still provides the ability for development of networks of users and friends ("connections") in a manner analogous to Facebook, the most used social media. As with blogs and micro blogs, LinkedIn starts with the individual, and is not aimed at generating content collaboratively. However, networks of users can create communities of interest
- Enterprise social networking (ESN) is one of the key focuses of this paper. As a result, ESN is discussed in greater detail in Sect. 3.3.

These social media all generate content, but also provide communication mediums to exchange that content.

Characteristics of Social Media. Two principle emergent characteristics of social media are simply that individuals develop content to share with others and that the media allows users to link to other users. Social media tries to be social. This leads us to ask "what are some other such characteristics?"

Typically, there are a number of distinguishing characteristics of social media, in general, that make it amenable for use in enterprises, including

- Social media is easy-to-use.
- Social media takes information transfer from a one-to-one or a one-to-none experience and turns it into a one-to-many, or a many-to-many.
- Social media takes conversations and can turn tacit knowledge into text that can be captured, analyzed and reused.
- Social media allows users to provide original "news" to others by-passing (potentially dis-intermediating) news sources.
- Social media provides the ability for users to take information available in limited circles and re-broadcast it to others.
- Social media allows users to assemble disparate information and broadcast it to others.

As a result of these characteristics, enterprises are interested in adding social media capabilities. However, it is difficult to try and choose which social media best meet enterprise needs. One approach that includes many of the social media capabilities is enterprise social networking.

3.3 Enterprise Social Networking

Enterprise social networking (ESN) is social media aimed at enterprises. ESN has been called a [22] "… middle ground between fully embracing social media and banning them entirely. …" For enterprises, ESN provides a more controlled internal environment than a general social media.

Probably, not surprisingly, ESN has evolved over time. Initially, ESN referred to the loose confederation of social media that typically had been made available on a firm's intranet. As a result, it typically referred to the wikis, blogs, and other social media used internally, to network the company together. However, over time ESN has begun to refer to a set of capabilities and products. A list of some companies that provide ESN is given as Table 3.1.

ESN can remind users of specific social media. For example, it has been said of Yammer, one of the leading ESN products, that "Yammer looks like Facebook," while others have said that "Yammer is not Facebook it is Twitter."[3] Although there are contradictory views the "proximity" to well-known social media is clear.

[3] https://charliekneen.wordpress.com/2014/10/15/yammer-isnt-facebook-its-twitter/.

Table 3.1 Some enterprise social network (ESN) tools

Chatter
Connections
Convo
Jive
Kaltura
Podio
Present.ly
Social cast
Social text
Tibbr
Unison
Yammer
Zyncro

3.3.1 Definition

Researchers, such as Turban et al. [51] originally appear to define ESN as "… in-house, private social networks that are restricted to employees and members with whom they are affiliated or have a business relationship (such as retired employees, customers, and suppliers)." However, recently, ESN companies have begun to offer their own definitions. For example, Zyncro[4] suggests that an ESN is "A secure and private space where all members of an organization can have and participate in:

- the exchange of corporate information
- better internal communication
- centralized management of projects, documents and contacts,

all done from a social point of view, collaboratively building the company's knowledge and with complete integration with all management and productivity tools in your company."

ESN have capabilities somewhat similar to each other and to other social media, e.g., Facebook and Twitter. Turban et al. [51] suggest that ESN offer tools with capabilities "… identical to those provided by public social networks." Some of those key ESN capabilities typically are based on each user having their own profile where the users provide their description. Typically, users can "follow" other users, and other users can follow them. In so doing, ESN can promote the development of virtual communities across time and space.

[4]http://www.zyncro.com/en/overview/solutions/enterprise-social-network.

3.3.2 Limitations of Enterprise Social Networking

Although Gartner[5] and other research groups, still find much of enterprise social media early in their life cycle, there has been recognition of some potential concerns and other issues.

Limited Registration and Use—Natural Ceilings to Use. Unfortunately, some predict that ESN will not be fully used by employees. For example, as noted by Stewart [48] "About 30 to 40 % of employees where registration is required won't even register and of the ones who do register, another 40 to 50 % will neither post very often or even read other peoples comments when they are sent out. … It appears that there might be natural ceilings to people who want to participate on a social network." However, to fully gain the "network" benefits of ESN generally requires a large percentage of the enterprise to participate. Accordingly, an emerging research issue is understanding what portion of the firm needs to be a part of the network to begin to realize the overall benefits.

Conversation Knowledge is Difficult to Reuse. Typically, knowledge generated in collaborative settings is not easy to index and can be difficult to reuse. Although users can tag such knowledge, developing machine generated tags around conversations can be difficult.

Integration. Typically, ESN capabilities stand alone. As a result, enterprises face issues about integrating ESN knowledge with other knowledge management knowledge. Unfortunately, the collaboration and content structures typically are independent and not integrated.

Security, Privacy and Legal Concerns. Perhaps the biggest concern is about security and privacy. For example, such concerns caused initial resistance to implementing Jive within PWC [54]. In addition, apparently, in the United States and Europe there is substantial legislation about e-discovery resulting in additional concern about social media and ESN of digital information within enterprises as a result of legal action.

3.3.3 Other Issues Concerning ESN

There are a number of other issues involving the use of ESN including the following.

What is the Nature of the Active Population of ESN? In general, there is an expectation that younger demographics are likely to be the users of ESN (e.g. [44]). However, in one survey 40–49 year olds were 100 % more likely to use ESN than 20–29 year olds to make posts or to comment [48]. Further, some cultures appear more likely to use ESN than others [48]. This issue potentially limits the user base

[5] http://www.pressebox.de/pressemitteilung/gartner-uk-ltd/Gartners-2013-Hype-Cycle-for-Social-Software-Reveals-a-Wealth-of-Emerging-Innovations/boxid/620646.

of ESN. Further, the user base of ESN may be different than the content base, exasperating differences between the two systems and integration concerns.

How to Encourage Use of ESN? Once ESN has been implemented, enterprises are concerned with how to encourage use. As with virtually any information system technology, training, demonstration of success, documentation all provide an important role in facilitating use. However, Steward [48] suggests that the most important factor appears to be integrating ESN into existing business processes. Unfortunately, it can be difficult to actually embed collaboration into a work process. Further, embedding collaboration into processes can result in unpredictable outcomes as users wait for others to respond to their queries.

Cost—Benefit Analysis. In any case, ESN are relatively inexpensive. As a result, even just a few successes can provide sufficient benefit to offset the costs. However, at least two research studies examine cost—benefit issues in knowledge management in consulting firms. Based on the Indian consulting firm Infosys, O'Leary [31] found a strong correlation between knowledge reused and person days saved. Mukamala and Razmerita [21] examined information generated by consultants from all over India to study different factors associated with consultant use of knowledge management, including social networking.

3.3.4 Selected Previous Research on ESN

Since ESN is relatively new, there has been limited research regarding such integrated software. Up to this point there have primarily been case studies, analysis of communication data from case studies, aggregate analysis of the previous cases, firm use of ESN and analysis of the resulting changing role of knowledge management.

Although Turban et al. [51] generally preceded the broad-based adoption of ESN from companies, such as Jive, Tibbr/Tibco or Yammer, they indicate that they found one hundred case studies using social media in enterprise settings. Turban et al. [51] examined those one hundred case studies and provided a classification of cases into six primary applications: Knowledge Management, Collaboration and Innovation, Communications, Information Dissemination and Sharing, Management Activities and Problem Solving, and Training and Learning.

Most of the recent ESN research appears based on examining the messages developed at particular corporate settings, and drawing conclusions from those messages. Muller and Stocker [23] examined internal microblog postings Siemens' social media-based system References@BT. Their analysis focused on the top ten users. Reimer et al. [40] investigated the nature of the communications using Yammer at CapGemini, while Reimer and Scifleet [42] and Reimer et al. [41] analyzed the nature of communications using Yammer at Deloitte in Australia. Their findings include that ESN is used as an information sharing channel, a general place for basic crowdsourcing activities, a place for finding experts and expertise and a conversation medium. Riemer and Tavokoli [43] examined the communications at

the thread level. They found a number of different subjects: Discussion and Opinion, Event Notifications, Idea Generation, Informal Talk, Information Storage, Input Generation, Meeting Organization, Problem Solving, Social Praise, Status Updates and Work Coordination.

Berger et al. [6] focused on the nature of value adding users and examine their relationships using data developed from Yammer that was generated at a large consulting organization with over 100,000 employees. Their analysis focused on the top 1 % and 5 % of users being followed. Their research also found that a substantial percentage of the messages were "professional" (81 % of the likes and 94 % of the bookmarks).

From a different perspective, rather than focusing on the different message types, O'Leary ([32]) analyzed the recent enterprise knowledge management efforts at KPMG, including presenting a detailed case that illustrated a strategic change in KPMG's knowledge management system to account for increasing amounts of collaboration, as captured by using ESN. Mukkamula and Razmerita [21] analyzed ESN adoption in India by technology consulting firms and found limited adoption and use to-date. Razmerita [38] examined the use of an ESN in a volunteer organization analyzing benefits accruing to its use.

3.4 Content Models of Knowledge Management

This section briefly reviews different models of content in knowledge management.

3.4.1 Repository Versus Router Models of Knowledge

Two models of providing knowledge to workers are the "repository model" and the "router model." The classic knowledge management model is one of a large repository or database where knowledge is stored waiting for people to use it (Fig. 3.1). Typically, the repository model assumes that an enterprise establishes a large centralized knowledge base and users visit that knowledge base to choose the knowledge that they need. Further, the repository model typically assumes that management has responsibility to make sure that the repository contains the appropriate knowledge and that knowledge is up-to-date. The repository model assumes that the users can decide on and find the knowledge that they need.

In contrast, the router model of knowledge management is where people are provided with knowledge that they need to perform some task. Typically, management determines ahead of time what knowledge will be necessary to solve some problem, and that knowledge is "routed" to them. Router knowledge is likely to be in the repository, but to ensure that the potential user gets the knowledge the knowledge is routed toward them. With the router model, knowledge management system designers assume that the users will not necessarily know what knowledge

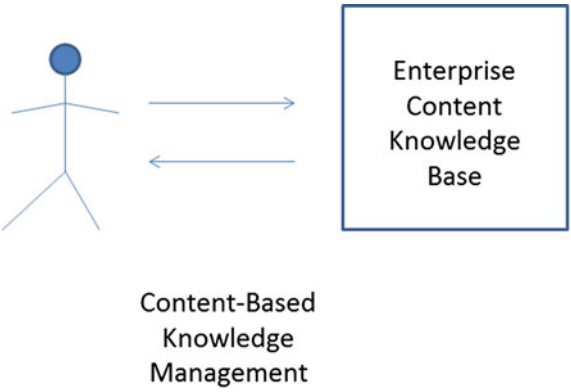

Fig. 3.1 Repository model

they need or be able to find the knowledge that they need, as a result the knowledge is "routed" to them.

The repository implicitly assumes users "pull" the knowledge that they need from the repository: Users browse the repository choosing the knowledge that they would use. In contrast, with the router model, knowledge is "routed" or "pushed" out to the users that are likely to need the information. Although the name "router" seems to have evolved out of Cognizant's work on embedding Web 2.0 into knowledge management [37], a number of other previous researchers have analyzed the notion of pushing knowledge to users.

3.4.2 Centralized Versus Decentralized Control

The repository model typically assumes a classic centralized view of knowledge, with centralized management responsible for generating and maintaining the repository. However, a contrasting model is a decentralized model where responsibility of knowledge is in the hands of those who ultimately generate and use the knowledge. Specifically, in a decentralized model the community generates the knowledge resources, ultimately based on what the users find relevant and interesting. In the decentralized model, knowledge resources could be kept centrally or in decentralized databases.

3.4.3 Prepare Knowledge Ahead of Time or Use Just-in-Time Knowledge

The repository model is designed to gather all the appropriate knowledge ahead of time. In order to accomplish that goal, requires both anticipating knowledge needs and then gathering the knowledge for those needs. Unfortunately, anticipating all

knowledge needs, a priori, likely is an impossible job, unless the problem is highly structured. In contrast, the notion of "just-in-time" knowledge is aimed at getting knowledge to those who need it, "just-in-time" to help them make decisions or solve particular tasks.

Social media can facilitate both models. As noted above, users can generate wikis of knowledge, or respond just-in-time to knowledge queries with blogs or micro-blogs. Further, search engines and tagging can be used to index social media contributions. In addition, social media contributions also can be embedded into processes. For example, a user of a process might create a blog in response to some difficulty associated with using the process and that blog might be linked to the process.

3.4.4 Embedding Knowledge Content in Processes

In some cases, knowledge management can be embedded in processes. Perhaps one of the better known uses of embedding knowledge content into processes is Cognizant [11]. At Cognizant, knowledge management content was used with workflow technology to provide an approach to embed content into processes. In a setting where the process was relatively structured, knowledge, such as checklists or other content, was embedded in the processes at the points where knowledge was needed. As a result, if a user had a problem, there was content available to answer their questions. This approach has been used in a number of different settings, including audits where users are provided substantial content support at different steps in the audit process.

3.4.5 Management Philosophy and Content

It has been argued that management philosophy influences both generation and access to the content. O'Leary [29] suggested that MacGregor's Theory X and Theory Y were useful vehicles for understanding the use of different knowledge management approaches. In general for Theory X, management assumes that management needs to organize the productive elements. As noted by McGregor [20] "Without this active intervention by management, people would be passive—even resistant to organizational needs." However, for Theory Y, the goal for "… management is to arrange organizational conditions and methods of operation so that people can achieve their goals best by directing their own efforts toward organization objectives"

The repository model is consistent with a "Theory Y" management philosophy where the users are given the freedom to find the knowledge that they think best fits their problem. However, the router model is more consistent with "Theory X" management philosophy where management provides users with recommended knowledge and solutions.

Similarly, embedding knowledge into processes is more consistent with Theory X, whereas letting users solve their own problems is more consistent with Theory Y. As a result, the type of management philosophy can influence the structure and processes put into place to manage knowledge processes.

3.4.6 Gathering, Preparing and Embedding Content for Centralized Repositories or Routers

Gathering, preparing and embedding content for the use of knowledge whether in a central repository or a router situation generally employs substantial organizational "machinery." There are a number of case study examples used to illustrate the organization structure and processes required. For example, Alavi [2] captures the organization structure of KPMG's knowledge management group, while Eccles and Davenport [11] provide Cognizant's model.

Analysis of these and other models illustrates some of the efforts that organizations make to ensure that the knowledge that is used is appropriate, correct and consistent with organizational goals and objectives, particularly if that content is embedded in a process. For example, at Cognizant there were multiple layers of knowledge officers associated with different practice areas. In addition at Cognizant a "quality manager" was responsible for certifying that the knowledge was both "valid" and "effective." At KPMG a decentralized approach, by group (e.g., human resources or telecommunications practice) was used, establishing ownership and management of knowledge. Knowledge went through a six phase process of acquisition, indexing, filtering, linking, distribution and application as KPMG tried to "bake" the knowledge into the firm's business processes.

Such structure and approaches are particularly important as knowledge is embedded in processes or if users are given open access to such knowledge. Otherwise, inappropriate, incorrect or inconsistent knowledge may be used by the system's users. Unfortunately, hierarchical efforts can slow the implementation of knowledge and increase the cost of such efforts.

3.4.7 Content Research in Knowledge Management

Content research typically is focused on content artifacts. From a research perspective, design science can focus on building structures to house content through the analysis of issues such as ontologies or taxonomies. In addition, content provides a wide range of artifacts that can be used as the basis of empirical analyzes. For example, O'Leary [27] empirically investigated change in a business process taxonomy, by analyzing the number of changes that occurred in the taxonomy. As another example, O'Leary [31] analyzed the extent of knowledge reuse by

analyzing the number of contributions to a knowledge base. The very nature of knowledge base content facilitates empirical research because of access to knowledge artifacts. As a result, it appears that much research on knowledge management has focused on content, organization of that content, accessing that content, etc.

In addition, there has been substantial content research relating to case studies about what and how enterprises actually do content management. For example, Eccles and Davenport [11] generated a case study of Cognizant's use of knowledge management and the embedding of content into their processes, while Alavi [2] examined KPMG.

3.5 Collaboration Models of Knowledge Management

The collaboration approach to knowledge management is to send out a communication expressing a problem or concern to potential collaborators, and have those collaborators send back recommendations to the originator. As a result, collaboration ultimately requires two (or more) participants. Collaboration with individual users can either gather knowledge content from the enterprise repository or solicit information from a number of individuals who have access to their own decentralized (individual) repositories (e.g., Fig. 3.2).

3.5.1 Push and Pull in Collaboration

Social media helps facilitate both the push and pull models of knowledge collaboration. For example, a blogger or micro-blogger might address a question to their followers, asking for information and knowledge about a particular topic or furnishing such knowledge, either pulling or pushing knowledge. In consulting firms, this also may be is exemplified when a micro-blog query or an email is sent out to a group of experts asking for responses about a particular topic, pulling knowledge toward the blogger.

3.5.2 Collaboration and Communication

Collaboration is executed using a range of communication-based approaches, e.g., email, telephone, etc., or through the use of ESN software. Introduction of multiple approaches to communication drives out other forms of communication. In the same sense that email has driven out some phone communications, there is some evidence that ESN software is decreasing the amount of email communications (e.g., Cannell [9]).

Since the development of the Internet, enterprises have depended on email as a basis of communication. However, from a knowledge management perspective there is a fundamental flaw of email: information gets "stuck" in private email repositories. Since email is a private exchange, knowledge embedded in emails is likely to be lost, unless someone works to bring the knowledge out. In contrast, communications executed in ESN are broadly available. As a result, enterprises are interested in using ESN since it removes information asymmetries associated with email and other forms of communication. However, there can be concerns with privacy and security as discussion information becomes public (e.g., Ashford [5]).

3.5.3 Embedding Collaboration into Processes

Some processes are particularly amenable to using collaboration. An example of such a process is the City of Boston's mobile app referred to as "Citizen's Connect." In that app for I-phones citizens collaborate with the city. As citizens encounter problems with the city's infrastructure (for example, graffiti or pot holes) they take a picture with their phone and send the picture to the city for appropriate processing. Citizen reports initiate the process and collaborate with the city in order provide information regarding the infrastructure. Using this approach mitigates the asymmetries of information, bringing citizen knowledge directly to the city's attention.

3.5.4 Management Philosophy

Implementing a collaboration model such as enterprise social networking, generally indicates that management has confidence in their workers and what their workers can bring to bear as part of this collaboration. As a result, in large measure, implementing a collaboration approach is consistent with McGregor's [19, 20] Theory Y approach to management.

3.5.5 Collaboration Research in Knowledge Management

Collaboration research in knowledge management has employed a number of approaches. Researchers have employed a range of methodologies, including simulation and empirical research. The primary artifact in empirical knowledge management collaboration research has been communication streams, e.g., email messages or social media communications (e.g., Ahuja and Carley [1]). Communication patterns provide one of the important theories associated with collaboration research in knowledge management. Networks of users can be analyzed to find key users. Further, although we might expect that the design science approach of

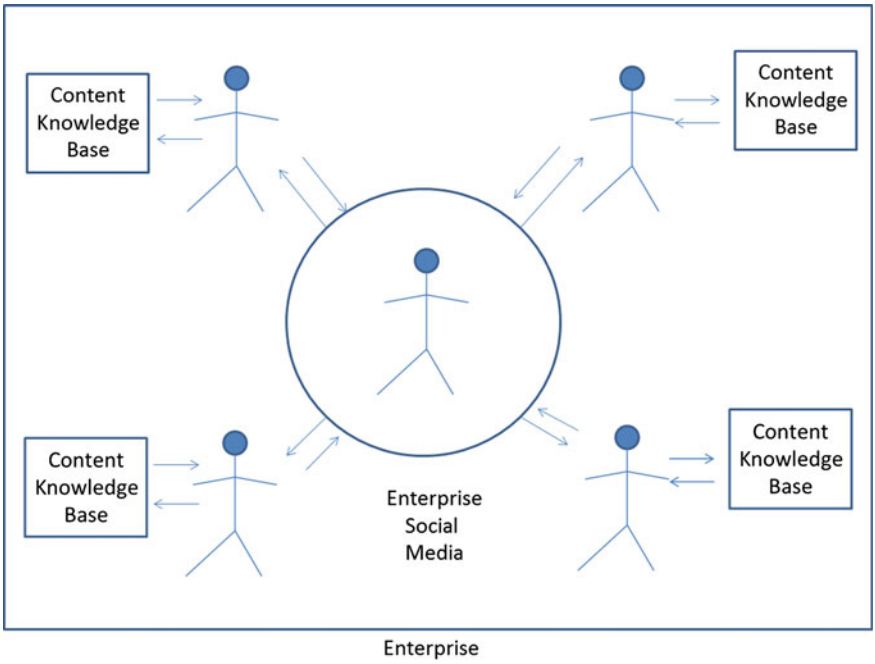

Fig. 3.2 Collaboration and distributed content

building systems that capture knowledge from communication streams would be a frequently analyzed issue, a recent Google scholar search "capture knowledge from communication" returned no hits.

3.6 Least Effort Theory, Exchange Theory and Pecking Theory

Simon [46] introduced the notion of rather than always optimizing, decision makers will instead look for good or satisfactory solutions. Such "non-optimal" search for decisions was referred to by Simon as "satisficing." At the base of satisficing is the development and use of a set of heuristics for investigating use of content and collaboration in knowledge management systems.

In the case of knowledge management and the choice facing a system user to either supply or demand content or collaboration, there are at least two alternative theories that can be used to explain user choices with a third theory used to explain the use of those theories for sequential subsequent decisions—if a user does not find what they need how do the proceed with their next choice?

3.6.1 Principle of Least Effort

It has been suggested that, in general, people follow the principle of least effort [56, p. 1, 55]: "The Principle of Least Effort means … that a person will strive to solve his problems in such a way as to minimize the total work that he must expend in solving both his immediate problems and his probable future problems." There are a number of different names given to the "principle of least effort," including the "principle of least action" and "path of least resistance." Swanson [49], describing communication "It is tempting to propose a 'principle of least action': The design of any future information service should be predicated on the assumption (whether true or untrue) that its customers will exert minimal effort in order to receive its benefits. Furthermore, they will not bother at all if the necessary minimum is higher than some fairly low threshold."

There is some closely related research that suggests that researchers function under a "least effort" principled approach in what some might consider a knowledge management task. Piwowar et al. [35] found that researchers tend to more frequently cite research that employs shared research data, i.e., data that is available from others without the need to generate that data. Eysenbach [12] found that so-called open access journal articles are more frequently cited than those journal articles that are not open access. Wren [53] found that over one third of high impact articles could be found online in sources at other than the journal web sites, suggesting that easy availability on the Internet facilitated impact. Soong [47] found that a substantial portion of articles benefits in the number of citations, from open accessibility on the Internet. As a result of these and other research studies, it appears that users access and use that information that is most easily available, requiring the least effort, consistent with the use of the principle of least action.

What are some of the other implications for the principle of least effort in knowledge management? As with virtually everything, there is both a supply and demand for knowledge. As part of generating a knowledge management system, designers and developers need to facilitate both sides of the market. In particular, the principle of least effort suggests making any knowledge management system both easy to harvest existing knowledge and making it easy to contribute new knowledge.

From a technology perspective, the nature of social media helps facilitate both the generation of a supply and demand for knowledge. Social media is easy-to-use and facilitates generation of social networks of connections between people.

Finally, it appears that the least effort concept is considered, at least implicitly in knowledge management system design and development. For example, at KPMG [3, p. 18], knowledge management is "about enabling easy access to relevant content."

3.6.2 Social Exchange Theory

One alternative to least effort is social exchange theory. Social exchange theory suggests that when we contribute (including economic and non-economic contributions) to a group we create the equivalent of "capital" that provides us status, power, and other benefits. Social exchange theory has its foundations in the sociology of Simmel [45] and Weber [52]. For example, Simmel [45, p. 387] notes that "All contacts among men rest on the schema of giving and returning the equivalence. … Here gratitude appears as a supplement. It establishes the bond of interaction, of reciprocity of service and return service, even when they are not guaranteed." Blau [8] extends the work of Simmel, Weber and others and indicates that "Gratitude is like mercantile credit. … we pay our debts, not because it is right that we should discharge them, but in order to more easily borrow again." Blau [8] also suggests that "… status is derived from exchange …" and "Unreciprocated exchange leads to differentiation of power." Further, Blau [8] notes that "status is likened to capital inasmuch as each is expended in use but can be invested …." Blau [8] also notes that "A person who distributes gifts and services to others makes a claim to superior status." In summary, Blau [6] notes "An individual who supplies rewarding services to another obligates him."

What are some of the implications for using social exchange to view knowledge management? In the case of supply and demand for knowledge management, users would gain capital by supplying and expending capital by using knowledge or making requests to others for knowledge.

Notions of social exchange have been discussed both explicitly and implicitly previously in the knowledge management literature. For example, as noted in Markus [17] at Booz-Allen: "Consultants contribute for many reasons. But two reasons stand out: the system enhances their work and enhances their reputation among their colleagues." As another example, Markus [17] also notes that "Producers have the greatest natural incentives to create repositories that benefit themselves directly in use."

3.6.3 Pecking Order Theory in Finance and Knowledge Management

Least effort and social exchange theory each provide a vehicle to analyze initial and subsequent decisions by users. A so-called "pecking order theory" or "pecking order model" provides a generic approach to problem solving by suggesting that problems of a particular type are solved by using a typical sequence of problem solving approaches, typically done in a specific order referred to as a "pecking order." That pecking order can be based on different criteria, such as least effort or maximizing social exchange benefits.

As an example, a Pecking Order Theory was developed in finance by Myers and Majluf [24]. That theory states that firms will prioritize their financing sources (from internal financing to equity financing), based on the principle of least action (also called the principle of least effort). In particular, in finance, that principle suggests that firms choose financing options that are the easiest and least costly in a sequential manner. Accordingly, in order to meet financing needs, internal funds are used first, then debt and then equity.

If we apply pecking theory to knowledge management, this would suggest that a user would have a hierarchy of knowledge management preferences, and employ a sequence of knowledge management approaches for both the supply and demand of knowledge. For example, a user may first search for "content" that solves their problem, but being unsuccessful, turn to "collaboration" approaches to find information. Further, in the case of both content and collaboration, they are likely to search in particular areas for content and collaboration. For example, content pushed or routed to them is likely to be the first seen and used.

In terms of the Cognizant example [11] discussed earlier above, if the pre-specified knowledge content did not provide an appropriate answer to all of a user's questions, then the system allowed the user to send a question out internally to see if anyone could answer it. As a result, in this setting, it appears that the system was designed to first provide content in a first attempt to mitigate problems, but if the content did not work then the user was expected to either solve the problem themselves or send out a collaboration request.

There are a number of instances in the literature that illustrate the use of this theory. Szulanski and Winter [50] investigated the particular issue of capturing so-called best practices. They suggested that there were two primary approaches to leveraging available knowledge. First, as they note (p. 64) "managers … go straight to an expert source." Second (p. 64), "… managers consult documentation … that has been put together by one or more expert sources." Other approaches that might take longer or could be more difficult to access knowledge seem to be listed after these two approaches.

As another example, in general, academics often use a pecking theory approach to which publication source they will try first, second, etc. For example, academics are likely to try to publish a paper in a more prestigious journal first, and then a less prestigious journal if the first is not accepted.

3.6.4 Content and Collaboration Pecking Order

Within each of content and collaboration we can anticipate particular pecking orders. One heuristic that is likely to be used is to go from "locally" available solutions to more "global" solutions. (An alternative view of "locally" available is provided by Markus who refers to "similar others.") For example, from a content perspective, a user might look for content solutions locally that they have personally used, and then expand outward to other solutions. As another example,

from a collaboration perspective, if I have a question that I cannot solve, I am likely to ask someone that I know to determine if they know the answer. If they do not know the answer then I can expand my scope of inquiry to others in my department, office etc. As a last resort, I am likely to try some sort of global inquiry.

3.7 Contributing Personal Knowledge: Content Versus Collaboration

One of the key knowledge management concerns is getting users to contribute their personal knowledge, mitigating information asymmetries between users and the organization. Unfortunately, there has been only limited research aimed at personal knowledge management. Thus the focus of this section is to use the theories in the above section to analyze the supply and demand for personal knowledge in knowledge management in content and collaboration-based systems.

3.7.1 Supply and Demand of Personal Knowledge for Content

From a content perspective, ***supplying*** knowledge means getting knowledge added to the repository, processes, etc. Unfortunately, because of the knowledge management hierarchy and machinery, users know that knowledge contributions are likely to get edited, and possibly not included. As a result, the organization structure and processes associated with managing content potentially can inhibit people from being knowledge suppliers. From a social exchange perspective, as the costs of adding knowledge increase, the net benefit to the individual decreases. Alternatively, from a least effort perspective, any obstructions to being able to directly add information to a knowledge base can function to inhibit participation. Accordingly, under both approaches, personal knowledge can remain personal, creating information asymmetries between the individual and the organizational knowledge management system.

Further, as noted by Orlikowski [34, p. 7] there are other issues and costs that limit potential content supply in some environments, consistent with both theories, such as the loss of power: "The corporate psychology makes the use of Notes difficult: Particularly the consultant career path which creates a back-stabbing and aggressive environment. People aren't backstabbing consciously, it's just that the environment makes people maximize opportunities for themselves. I'm trying to develop an area of expertise that makes me stand out. If l shared that with you you'd get the credit not me…. It's really a cut-throat environment. Power in this firm is your client base and technical ability. … It is definitely a function of consulting firms. Now if you put all this information in a Notes database you lose power. There

will be nothing that's privy to you, so you will lose power. It's important that I am selling something that no one else has. When I hear people talk about the importance of sharing expertise in the firm, I say "Reality is a nice construct.""

From a content perspective, ***demand*** for knowledge content can be easily met, ***if*** the necessary content is contained in an easily accessed knowledge base. However, as noted above there are many reasons for why the content will not be captured and thus included in the knowledge base. Further, if the knowledge is not easily searchable, is not correct, not appropriate, or not available in a timely manner, user demand for content can be limited.

3.7.2 Supply and Demand of Personal Knowledge for Collaboration

What incentives do people have to collaborate with others? From a ***supply*** perspective, there may or may not be incentives to respond to the call for collaboration. Social exchange theory suggests that responding to such calls for collaboration builds social capital for the supplier of the information. As seen in Fig. 3.2, collaboration allows users to provide information from their own personnel knowledge bases without having to push the content through content-based organizational hierarchy and review. As a result, based on social exchange theory, benefit can be achieved without incurring the costs of organization review, potentially maximizing social capital. Similarly, based on the principle of least effort, users are more likely to supply knowledge in a collaboration setting than through a content setting because they can directly supply the knowledge without having to go through organization hierarchy and knowledge management systems controls.

From a ***demand*** perspective, a person has to initiate a request for collaboration, perhaps to gather information in order to solve a problem. Although getting responses to queries is a definite potential gain, unfortunately, the request for collaboration or help is a clear statement that they do not have adequate resources, understanding, etc. to solve the problem, suggesting limitations rather than strengths. Accordingly, there may be a cost to public recognition of those limitations. For example, the request for help could suggest that the requester does not have appropriate experience or cannot handle the demands of the situation without seeking outside help.

3.7.3 Content Versus Collaboration—Value of Contributions

An important emerging question is whether content or collaboration contributions are more valuable and what are the variables that lead to one being more valuable than another. Social exchange theory can be used to understand whether users will employ content or collaboration approaches to share their knowledge. For example,

if sharing through content-based approaches provides greater and longer lasting status than collaboration then users likely will attempt to distribute their knowledge through content based approaches. In academics, currently content-based approaches (e.g., journals, books or proceedings) provide longer lasting and probably greater social capital pay-off than alternative approaches, such as meetings. However, it is not clear if there is such a priority in enterprise settings.

3.8 Integrating Content and Collaboration

The bifurcation of content and collaboration often has led to treating the two separately, rather than integrating them. This separation can be seen in the way they are treated in processes and software with the partitioning of content and collaboration into separate settings. This section addresses when it is better to use collaboration or content or if content and collaboration should be integrated. Further, research where each is best used and how to embed and integrate the two is an important emerging research area. In particular, embedding and growing the content and collaboration together likely will be an evolutionary process that evolves as content and collaboration are merged over time.

3.8.1 Embedding Content or Collaboration into Processes

It is likely that there are settings where it is "better" to use content than collaboration or collaboration rather than content. For example, if knowledge is "structured" enough and "stable" enough then knowledge content can be embedded into processes so that users will have direct use and accessibility to the knowledge. For example, Cognizant [11] embedded checklists and other sources of knowledge directly into their knowledge management processes.

However, if the knowledge required for use in the process is less structured, less stable and less predictable, then it may not be sensible or feasible to embed the knowledge into the process. Instead, the process can be embedded with the ability to seek collaboration. Historically, this would mean physically communicating with a supervisor or co-worker or manager. As an example, below at PriceWaterhouseCoopers, gathering information for a consulting proposal, in an area where there has been limited work, appears to be a good application for collaboration. However, increasingly, virtual environments can employ a broader range of people from which to gather information, using tools such as ESN. This discussion is summarized in Fig. 3.3.

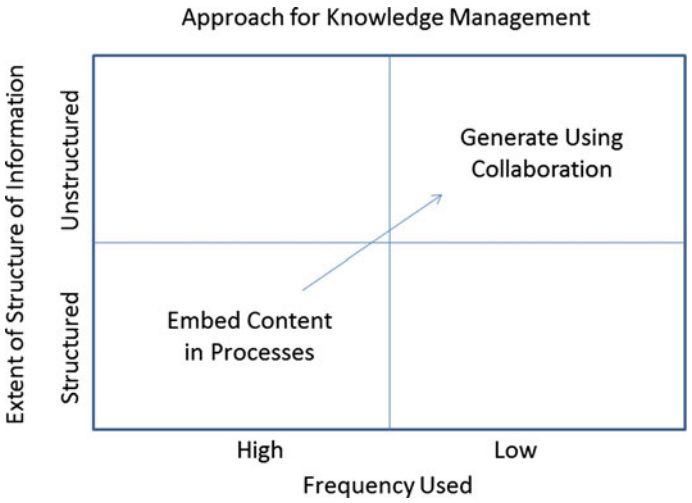

Fig. 3.3 Embedding content or collaboration into processes

3.8.2 Putting Content and Collaboration Adjacent to Each Other

As part of PWC's knowledge management system, there has been substantial discussion about the integration of content and collaboration. One approach to facilitate the integration is to allow for collaboration or commenting about content. For example, Levene [16] noted "You need your official content—best practice, regulations and policies—to sit in your social system, where people can embellish it by comments, referrals, enhancements, and star ratings. But you also need this idea of the bazaar, the market place, where your information goes to live, to breathe, to become useful. That's where people get together to talk dynamically, to exchange knowledge and help each other get value out of it."

3.8.3 Collaborated Content Versus Turning Collaboration into Content

Although this paper treats content and collaboration as two separate sources of knowledge, the two are closely related. From the enterprise's perspective, ideally, collaboration exchanges become content that can be used and reused. Recognition of content within the collaboration effort can be facilitated by tagging exchanges or tagging exchanged content (e.g., documents).

Wikis provide an example of the collaborative development of content or "collaborated content." Because they generate content, Wiki information can be

rapidly integrated into enterprise knowledge bases. However, collaborated content is different than turning collaboration discussions into content. Collaboration discussions are discussions. As a result, they are not designed for being content. Although such discussions might be tagged by the participants, there is limited research investigating the generation of knowledge management content from collaboration exchanges.

3.8.4 Emerging Research Issues Re Content and Collaboration

If content and collaboration are seen as two different sources of solutions, an important concern is does the "capital" or "status" that a user generates in "collaboration" "carry over" to "content" and conversely? Further, either collaboration or content is likely to be more visible than the other. In academics, content results in citations which provide a visible measure of influence. In contrast, in academics, collaboration, e.g., with Ph.D. students or junior faculty, typically has limited visibility and provides capital only with the particular actors. However, in an enterprise setting, it is not clear if one approach would dominate the other, and if so, which would dominate in its ability to generate social capital.

3.9 PriceWaterhouseCoopers (PWC) Case Study

This section provides a brief case study of PWC's use of enterprise social networking to illustrate some ESN capabilities. PWC is the largest of the professional services firms, known as the Big 4. PWC provides a range of auditing, consulting and tax services. The global firm has over 195,000 people, in over 758 locations, in over 157 countries.[6] According to Levene [15, p. 37] PWC's collaboration goal is "to provide one common social networking & collaboration platform that accelerates our ability to connect with each other and collaborate together to create value for ourselves and our clients." PWC's Paula Young, Global Knowledge Leader, suggested that [22] "By embracing a social business mindset we're making a large network feel small … (increasing) speed and reach."

In order to accomplish this goal and the sub-goals, PWC implemented "Jive", giving the system implementation the internal name of "Spark." Within the first six months, over 90,000 PWC people were using Spark [22].

Apparently, the core to PWC's use of Jive/Spark is each person's profile. People describe their background using informal descriptors or tags. People can "follow" other people but there is no need to have reciprocal following. An important

[6] http://www.pwc.com/gx/en/about-pwc/facts-and-figures.jhtml.

capability facilitating adoption is that "… it's also about making people mobile …" so that users can employ it using their mobile devices, as would be the case with other social media.

PWC has shared a number of stories about successful system use, including the following [15].

- On a Friday, a manager in Russia asked a question on Spark and got 23 replies from 17 countries by the following day.
- A proposal that PWC expected to take two weeks, was done in one week at a higher quality.
- One large international account required twenty partners and 3 account teams with members from 62 countries. In order to help coordinate the team they set up a Spark account. Spark was credited with providing a virtual community, where one had not existed before.

3.9.1 Motivation for Adopting Jive

Reportedly [54], one of the primary reasons that PWC moved to Spark was because many of the PWC employees told them that the way that PWC did things was "too old fashioned." Their knowledge management system had originally been based on Lotus Notes, so rather than argue with them they turned those employees into advocates of the new system. Accordingly, the previous concern had been on the content of knowledge bases.

The move to Jive also reflected corporate attempts to bring to the workplace what employees already had in their personal lives. Levene [16] noted "Think about how people see themselves benefiting personally. They want to collaborate at work as easily as they do at home, using similar social media tools. Also they want to promote their skills and be seen as the 'go-to person'. For that to happen they need to be able to connect with people and people be seen as the experts." This approach is consistent with a social exchange theory analysis of knowledge management contributions.

3.9.2 Key System Characteristics

Internally, Jive/Spark has provided management with a number of new capabilities to management. First, as noted by Levene [16] "A social system is also a good way to find and disseminate important information, and track the extent to which it is being read." As a result, Spark eliminates some of the asymmetries of information between employees and management so that management can track employee information awareness. Second, based on such information, management can generate and use social graphs, determining what people are looking at and finding out who are the key contributors in the corporate network.

Third, using ESN, enterprises can analyze the content of the collaboration exchanges and use those analyzes to better understand their employees. For example, as noted by Levene [16] "… with social tools you can measure things like positive versus negative sentiment, and understand whether people are taking any notice. You can focus your change management efforts on those areas. Or you can use the star rating system—where people in your community who you respect point out really good content—which pushes it up the results list. That way you can find information much more dynamically."

3.9.3 Impact of Culture on ESN

If ESN actually work then not only will the system facilitate collaboration, but the enterprise culture is likely to be affected. As noted by Levene [16] "Instead of trying to change the culture to fit the technology, let social tools reflect the culture of your organisation, allowing it to become more agile, more alive."

3.10 Emerging Research Issues

There are a number of emerging research concerns based on the issues discussed in this paper. This section lists a number of those potential research issues.

- Do users employ least cost, social exchange or pecking order theories in their use of knowledge management systems? Empirical analysis of actual ESN use could be investigated to clarify the extent to which users actually use the promulgated theories.
- To what extent do content and collaboration have the same visibility in enterprises? Generally, in academics, content is easier to capture and cite. Has that visibility been affected by ESN?
- From a social exchange perspective do content and collaboration contributions provide the same social exchange capital? Does one dominate the other?
- How can we capture knowledge from communications? There has been limited research in gathering knowledge from email and other sources (e.g., [14]).
- In the case of ESN queries for collaboration, are users most likely to look "locally" or do we find that users look "globally?" Which is most likely to come first? To what extent is "localness" a function of such issues as department or geographic location? To what extent do "true" global experts emerge and how long is that expertise sustained?
- PWC suggested that the ESN would make the large corporate network feel small and increase speed of communications. Each of those is an empirically testable phenomenon, as a result, is that what organizations find or is that just hype?

- To what extent are organizations able to embed collaboration in their work processes and to what extent is it facilitated by ESN? Is collaboration used primarily for unstructured processes and do enterprises provide content for structured and frequently occurring problems?
- Although this paper has not focused on notions of "innovation" does ESN facilitate innovation? How would organizations ultimately measure such an effect?
- To what extent are security and privacy major concerns in ESN? To what extent do legal concerns influence what users say as part of their collaborative efforts?
- It has been suggested that ESN gains from so-called "network effects." If that is true what levels of participation need to be involved in order for ESN to provide full or even partial benefits.
- How can content and collaboration be better integrated?

These and other issues identified earlier in the paper provide a number of research opportunities.

3.11 Summary, Contributions and Extensions

Recently firms have recognized that their knowledge management strategies have not fully leveraged collaboration opportunities. New software capabilities, referred to as Enterprise Social Networking (ESN) software has captured social media approaches and brought those capabilities to enterprises. As a result, there appears to be a "tension" between classic knowledge management approaches based on content, as compared to approaches based on collaboration. This paper investigated some of these issues and examined some potential research opportunities.

This paper has a number of contributions. First, this paper examined the apparent bifurcation of knowledge management in enterprises as those organizations expand beyond content to increasing try to facilitate collaboration. Second, this paper analyzed both content and collaboration for their roles in knowledge management systems. Third, this paper reviewed enterprise social networking capabilities, and its role in collaboration. Fourth, this paper generated potential theories to help explain potential knowledge management system use. Fifth, this paper applied those theories to the supply and demand of personal knowledge to both content and collaboration settings. Sixth, this paper summarized a number of potential related research issues related to ESN. Finally, this paper developed a case study to illustrate some of the concepts generated in the paper.

There are a number of extensions to this research. First, the theories regarding knowledge management behavior summarized in this paper could be empirically tested or applied to other enterprise knowledge management settings. Second, additional case studies, beyond the PWC case could be developed to study the relationship between content and collaboration. For example, Grant Thornton reported recently adopted Jive. As a result, potentially they could provide the

opportunity for an important case study. Third, there seems to be limited research in turning collaboration messages into knowledge or facilitating reuse of those messages. Future research could generate alternative approaches beyond classic approaches such as who sent the message on what date. Fourth, the resulting ESN networks will generate substantial data that can form the basis of substantial future research.

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Chapter 4
Social Media and Employee Affiliation: Networks of Practice as New Supra-Organizational Entities

Mladen Čudanov and Kathrin Kirchner

Abstract Through social media, companies can apply new forms of communication, collaboration, and knowledge sharing. Employees rely more and more on web *communities of practice* that share the same experiences and interests, instead of getting input from colleagues. This paper discusses perceived changes in employee affiliation as caused by social media usage by company employees. An empirical evaluation surveyed 316 employees from 49 companies in southeastern Europe. Results indicate that employees who use social media regularly have greater perceived changes in affiliation, with this affiliation more related toward online communities of practice. Our findings can contribute towards developing a more elaborated model of the relationships between employee sense of affiliation and social media usage. This study is among the first to discuss organizational changes caused by social media in companies, namely their influence on changes in affiliation.

Keywords Employee affiliation · Employee loyalty · Networks of practice · Social media

4.1 Introduction

Web 2.0 or the "social web" is causing a transformational change resulting in new ways of speaking, working, and having fun [47]. It can be defined as set of Web applications that harness network effects improving themselves automatically as

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more people use them [60]. Parallel to the consumer social web, more and more companies are adopting the social web, both for internal and external collaboration with suppliers and customers [10, 11].

User generated content is one of the core characteristics of social web applications, and includes the various forms of content (e.g., text, pictures, and videos) that are publicly available and created by end-users [59].

Build on Web 2.0, social media has increased its presence in business, and changes business concepts and relations. Kaplan and Haenlein [37] define social media as a group of Internet-based applications build on the ideological and technological foundations of Web 2.0, allowing the creation and exchange of user generated content. They list blogs, social networking sites, virtual social worlds, collaborative projects, content communities and virtual game worlds as examples of social media. Social media makes knowledge sharing possible as a way to augment collective knowledge by connecting and summing the individual intelligences in a harmonious manner [62, 63].

The use of social media for knowledge sharing, one of the main professional and business-related uses of social media, is related to social interaction in a group that often exists outside of the company. A continuous upgrading of skills through reciprocal problem solving is a welcome opportunity to spend time on self-education and socializing with peers, at least virtually [24], with peers often working for other companies in the same industry.

In this chapter we will discuss some fundamental changes caused by social media, especially the sense of employee affiliation. We focus on the relationship between social media usage in companies and shifts in perceived employee affiliation, as well as the evolving distribution of professional affiliation between organizations and networks of practice. By exploring the socioeconomic implications of changes caused by social media, we will concentrate on networks of practice as centers of employee affiliation. Research implications may be valuable for managers focusing on the behavioral aspects of employee affiliation. A sense of affiliation is connected with loyalty, motivation, turnover, and forms of interaction and knowledge sharing among participants. This study may motivate companies to boost their efforts and apply motivational techniques to increase organizational affiliation in organizations where employees regularly use social media for job-related tasks.

4.2 Literature Review

4.2.1 The Impact of Social Media

Companies are improving their use of social media. In a McKinsey survey among 4200 global executives, respondents expect social media to modify many of their organizations' processes. Within 3–5 years, respondents expect that with fewer constraints on social media at their companies, boundaries between employees,

vendors and customers will blur (35 % of respondents), teams will more and more organize themselves (32 %) and individual performance will be evaluated rather by peers than by managers (14 %) [11].

Researchers also believe that these new Internet paradigms will result in radical economic, social, and political changes, with collaboration on a mass scale changing every social institution [72]. People are developing new ways to innovate and to be creative en masse; following the concept of "wisdom of the crowd" [71], p. XIV). Large groups of people are often better at solving problems, fostering innovation, coming to wise decisions, and even predicting the future [64]. Such groups can be established without a formal organization, combining ideas and skills without a hierarchy [45]. The debate is present across a wide range of industries, with many believing that it will transform the institution of the university and the different activities—teaching, learning, research, and publishing—that lie at its heart [69]. This analysis is in line with the paradigm asserting that the rise and increasing significance of knowledge, instead of capital, will be the main source of competitive economic advantage and power in the years to come.

Social media also influencing the way how knowledge is shared in companies. It supports group interaction toward establishing communities, undermining traditional firm boundaries. Knowledge can be created and shared in a decentralized way so that management influence is diminished. Furthermore, outside knowledge, e.g., from Wikipedia, can be used easily without additional cost. The question arises how to protect local knowledge from spilling over and how to protect companies' internal knowledge from outside influences [76].

A case study in chemical industry reports about companies using social media to share knowledge about technical problems in development and production with outside experts. Management expects to get a problem solution by an outside individual in return for a monetary reward paid by the company [67]. By importing such solutions, internal company's procedures may have to be adjusted and make the company more similar to other competitors. Moreover, firms may risk to reveal knowledge gaps.

Generally, the influence of new technologies on intellectual capital improvements is connected with organic organizational structures [61]. Learning enhanced with social media significantly changes knowledge-management processes in high-growth organizations [18]. Some researchers are skeptical; while advances in the impact of social media on business have been found, there is also a gap between what was expected and what has actually occurred [4].

4.2.2 Communities and Networks of Practice

The term community of practice has been first coined by Lave and Wenger [42], and further explained by Wenger [78] as "groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" [80]. Such communities

have gained popularity as a means of collective learning and knowledge creation, as well as knowledge sharing within organizations [5, 33].

Social media has enabled a growing community of peers to increasingly replace formal organizations in supplying knowledge to employees. It is not unusual for users of social media to feel a sense of unity and affiliation with their online contacts. Web 2.0 tools have been described as facilitators for communities of practice [36, 49]. Karakas [38, p. 10] describes global "online communities" or "virtual communities" as formations in which widely dispersed, like-minded users come together in cyberspace based on similar interests, regardless of geographical and social boundaries. If communication means in communities of practice rely primarily on ICT, Dubé et al. [21] distinguish virtual communities of practice (VCoP).

The networks of practice concept originated from the concept of communities of practice. Brown and Duguid [9] initiated research on this concept, envisioning networks of practice as social networks which facilitate information exchange, knowledge creation and distribution, but generally with less formal ties between participants. Wasko and Faraj [77, p. 37] define networks of practice as self-organizing, open-activity systems focused on shared practices and existing primarily through computer-mediated communication. Similarly to Dubé et al. [21], Wasko and Faraj [77] define electronic networks of practice as a "special case of the broader concept of networks of practice where the sharing of practice-related knowledge occurs primarily through computer based communication technologies". Although the original view of Brown and Duguid as the creators of the concept regard communities of practice as a subdivision of networks of practice, we propose a continuum distinguished by the strength of social relations between members of the network/community, and on another axis we distinguish means of communication from old-fashioned, face-to-face communication toward modern means represented by social media. The division between communities and networks of practice and its common representations is proposed in Fig. 4.1.

Cobb and McClain [16] discuss communities and networks of practice among school teachers within a school or district to exchange, e.g., about leadership and teachers' instructional practices. Teachers jointly address issues particular content of lectures and their understanding of the development of pupils.

Ho et al. [30] report about an electronic network of practice in the health care sector in British Columbia. Using a web-based system, heath care professionals can communicate synchronous and asynchronous about clinical topics. The authors derive guidelines for future projects, e.g., the voluntary involvement of the community members and the discussed content should be problem-centered. The mix of participants from different areas of expertise is also essential for a successful knowledge sharing.

Jo [34] reports about a case of a Korean high-tech company, where newly hired software developers from different geographical places had to conduct collaborative research on wireless communication technology. They did not met in person and build a virtual community of practice for collaboration.

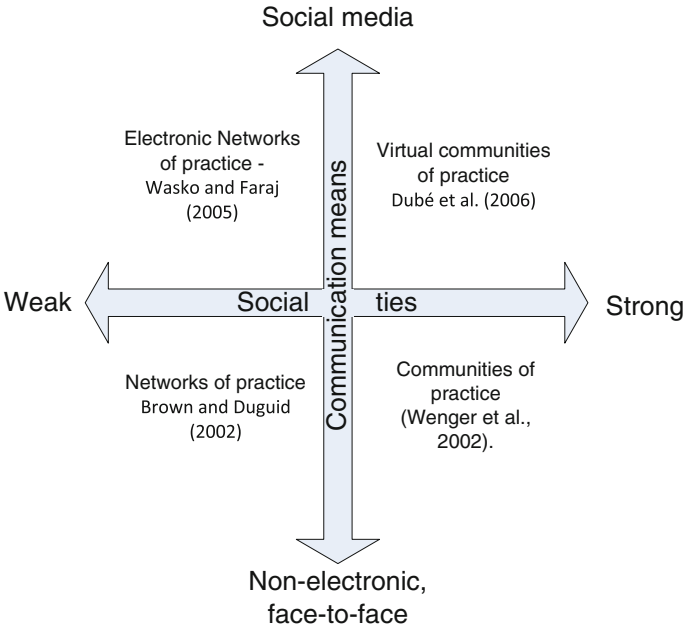

Fig. 4.1 Networks and communities of practice

4.2.3 Employee Affiliation

Employee Affiliation can be defined as an employee's sense of belonging to a group of other people in a larger social structure. It is closely connected with the general need for affiliation [51], establishing, maintaining, or restoring warm relationships with other people. People tend to have affiliations of different strengths toward numerous different organizational and social entities, such as the company they work for, informal groups of colleagues, a favorite sports team, and their extended family. Social interaction ties within groups are related to individual knowledge sharing [14]. The sense of affiliation and identification with a formal or informal group is an important motivational factor for performing work that is not directly compensated [70]. One's sense of affiliation can extend to commitment, including a strong emotional attachment to the group and its value systems, as well as a desire to remain within it [17].

Affiliation to common interest or cause sharing groups has been present since the upper Paleolithic Age, but these groups really became prominent beginning in the Neolithic era [3]. Between the thirteenth and eighteenth centuries guilds offered a superior organizational matrix for the acquisition and deployment of skills for most urban artisans working under the prevailing technological, commercial, and political circumstances [22]. After the industrial revolution, the mode of operation shifted to electoral and bureaucratic norms and procedures [3]. We can presume that

changing trends of affiliation will continue through networks of practice. Networks of practice can use the social web to increase their sense of identity. Such identity, defined by a shared domain of interest, has to be taken into account [1]. Networks of practice have different levels of strength, from clubs of friends and networks of personal connections to a significant social or professional group (e.g., software engineers specializing in Java).

Bock et al. [8] conducted an empirical on knowledge sharing and the influence on group building using a sample of 154 respondents from 27 different companies. This study explains subjective norm, intention and attitude related to knowledge sharing through empirical research. It infers causal relations between and among others, fairness, innovativeness and affiliation as descriptors of organizational climate and subjective norm and intention to share knowledge. In our context, the dimension of affiliation which Bock et al. [8] is expressed through how the members in organizational units keep close ties with each other, consider other members' standpoints, have a strong feeling of "one team" and cooperate well with each other is especially interesting. Through organizational climate it is positively connected to subjective norm and intention to share knowledge with others. However, the authors state in the limitations of their research that due to cross-sectional, not longitudinal nature of the data causality is only inferred by the data (though in line with existing theories) which report correlation between observed values.

Users of social media often feel a sense of unity and affiliation. The most vivid example can be found among contributors to Wikipedia who often express their affiliation with the Wikipedia community on mailing lists and user pages, indicating social identification [68]. Identification with the Wikipedia community, and the resulting engagement and satisfaction, can result in a positive feedback loop. The Italian motorcycle manufacturer Ducati offers a clear example of how to mobilize an informal group to share knowledge and initiate learning or design processes. A web-based collaborative innovation platform with more than 160,000 amateur motorcycle fans was the key to facilitate creativity and learning in developing new products [65], as well as in increasing unity in this collaborative group. Another example is China Software Developer Net, a vibrant Internet professional community that adds value to the work of software developers in terms of knowledge sharing and daily technical problem solving [81].

We can compare networks of practice influenced by social media with medieval guilds, drawing parallels in the definition of quality standards, and in the transmission of skills and innovation. Epstein [22] elaborated on the numerous functions of guilds in the pre-modern economy, including negotiation, financial support, quality assurance, member protection and—the main parallel with modern guilds—transmission of skills and technical innovation. Due to such support, guilds in the pre-modern economy enjoyed a strong sense of loyalty and affiliation from their members, even when guilds were often scorned as secret societies. We believe that contemporary employees enjoy a similar sense of support in terms of knowledge—currently the most valuable resource—through social-media propelled networks of practice. Employees who use social media to aid them in personal development

may experience a shift in affiliation, from a specific company to a specific network of practice. For example, software engineers may interact through forums, blogs, social networks, and wikis, exchanging information and transmitting skills and innovations. Technology-enhanced learning originated in the context of a network of practice, which is parallel to a guild as a provider of knowledge.

4.2.4 Influence of Information and Communication Technologies on Employees' Sense of Affiliation

The development of information and communication technologies has resulted in rapid advances in all aspects of the economy. This development demands increased acquisition and creation of knowledge, an increasingly important factor in job satisfaction. If a company fails to satisfy its employees' needs for professional development, a higher turnover rate is to be expected [54], indicating a diminished sense of employee affiliation and loyalty. Generally, labor markets are becoming more flexible, and employment with a particular company only constitutes one episode in the employee's professional biography, rarely resulting in lifetime tenure [27]. This theory partly explains the high turnover and frequent freelancing in knowledge-intensive industries. The professional ethos of open knowledge sharing, characteristic of industries such as software engineering might easily come into conflict with the vital interests of the firm, challenging the individual's loyalty to his or her employer [24]. However, when loyalty to one's employer is lost, it does not need to be directed toward another company, but rather, it may attach itself to other structures, such as networks of practice. If properly managed, this increased loyalty to networks of practice does not necessarily negatively impact the employee's company; rather, it may even provide benefits for the organization [79].

4.3 Research Design

4.3.1 Data Collection

To answer our research question regarding whether changes caused by social media result in perceived shifts in employee affiliation we collected data in three stages: an exploratory online discussion, a pilot survey, and a questionnaire based on information gathered during the first two stages (Fig. 4.2).

First, we started an online discussion using social media in order to directly solicit comments from users. Previously, elitesecurity forum (www.elitesecurity.org, with more than 275,000 registered users), has been analyzed as a Web 2.0 platform for collaboration among software developers and other knowledge-intensive professionals in southeastern Europe [40], which had already created networks of practice. Members of those networks express their sense of affiliation in interesting ways,

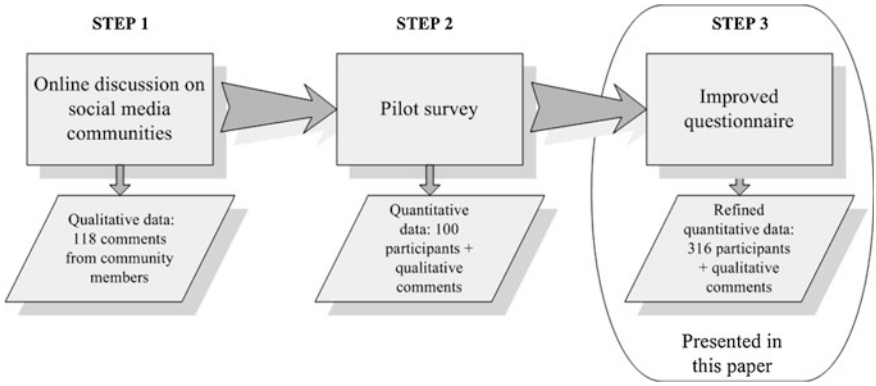

Fig. 4.2 Data collection process

organizing off-line social interactions, such as sports activities or cultural meetings, printing shirts with the forum logo, or mobilizing to provide solutions to local public problems. We received 118 comments from community members. For the IT and telecommunications sector, users agreed that software engineering engages in informal association with networks of professionals that were developed using social media. Comments from these discussions were valuable for giving ideas and illustrating findings obtained through prior research.

Based on the results of this online discussion, we set up a pilot survey that was administered to 100 participants who worked in knowledge-based industries that often use social media, such as software engineering, business analysis, consulting, higher education, and design. This pilot study indicated that social-media usage is related to organizational structure and culture, and as well as in changes in the knowledge-management process [19, 40]. Insights impacted how questions were asked and answers were scaled, making the assessment more understandable to participants and balancing subjective differences in responses. We then surveyed 316 employees from 49 different organizations from southeastern Europe using this improved questionnaire.

4.3.2 Methods

To examine whether changes caused by social media usage in organizations resulted in a perceived shift in employee affiliation, we put forward seven hypotheses (Fig. 4.3).

First, we wanted to know if social media usage had an effect on the perceived affiliation of company employees:

H1 Groups with different social media usage will differ with regard to perceived affiliation changes from their companies to their networks of practice

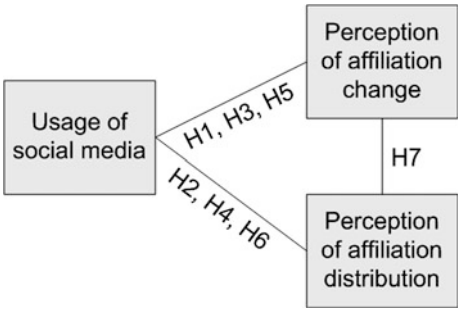

Fig. 4.3 Examined hypotheses

H2 Groups with different social media usage will differ with regard to perceived affiliation distribution between their organizations and their networks of practice

Second, we focused on the people with high (at least daily) social web usage:

H3 Group of employees with daily social media usage will have higher levels of perceived affiliation change, from their organizations to their networks of practice

H4 Group of employees with daily social media usage will perceive that they are more affiliated with their networks of practice than with their companies

Third, we examined correlations between the evaluated variables:

H5 There is a positive correlation between social media usage and perceived affiliation change

H6 There is a positive correlation between social media usage and perceived affiliation distribution

H7 There is a positive correlation between perceived affiliation change and perceived affiliation distribution

In order to test these hypotheses, non-parametric Wilcoxon-Mann-Whitney tests, a commonly used test for detecting differences in central tendency between two samples, were used to determine differences between the two groups [23] with high and low social media usage. Further, a t-test was conducted to confirm findings, under the assumption that qualitative data represented on a 0–10 or 1–5 numerical scale can be treated as intervals [41]. There is considerable debate as to whether using parametric tests in combination with Likert-type responses converted to interval scales is methodologically sound. Therefore, this method was only used to check results from the Wilcoxon-Mann-Whitney Test. We assume here that the Likert-type scale items have been converted in a meaningful way to an interval scale, giving the researcher the ability to use totals or to calculate numerical

averages [52] and consequently, to perform t-tests, a commonly used method (e.g. [15]. Spearman's correlation was employed to check the association between variables examined in Hypotheses 5–7 [41], and hypotheses were rechecked using Pearson's coefficient, based on assumptions regarding the interval nature of data. The dividing point for high and low social media usage for business purposes was set at five times per week, i.e. at least daily usage during the work week. This point was chosen based the assumption that high-use participants would need to use social media at least daily; previous research in usage of ICT tools in communication has also used this benchmark [39].

4.4 Data Analysis and Results

We surveyed a wide range of industries, from IT to construction (Table 4.1). Our survey started with an analysis of the companies, with each of the 49 organizations described in a business consultancy report, incorporating financial, organizational, technological, market, and human resource data.

Organizations in our sample varied in terms of financial success (ranging from being in a restructuring phase to being leaders in performance), number of employees (Table 4.2), and hardware and software infrastructure, with the number of computers per company ranging from between seven to approximately 8500. Following the completion of the business consultancy report, a questionnaire was handed out to three to five employees in each organization, asking the following questions:

1. How often (approximately) do you use social media during a working week? (A numeric answer should be provided.)
2. How much has social media changed your sense of affiliation from your current company to your networks of practice? Answers should be provided on a scale from 1 to 5, with 1 meaning "no change," and 5 meaning "essential change."

Table 4.1 Distribution of participants among industrial sectors

Industrial sector	No. of participants	Percentage
IT and telecommunication	71	22.5
Retail	56	17.7
Production	55	17.4
Service	50	15.8
Media	25	7.9
Science and education	24	7.6
Banking and finance	20	6.3
Public administration	5	1.6
Energy industry	5	1.6
Construction	5	1.6

Table 4.2 Distribution of participants according to different organizational headcounts

No. of employees	No. of companies	Percentage
<10	25	7.9
10–50	140	44.3
50–250	85	26.9
>250	66	20.9

3. Rate your current sense of affiliation between your company and your networks of practice. Zero means "total affiliation to company," 5, the mid-point, denotes "affiliation is evenly split between the company and the network of practice" and 10 means that employees have a "total affiliation to network of practice."
4. How does social media usage influence knowledge management in your company? Answers should be provided on a scale from scale from 1 to 5, with 1 meaning "no influence," and 5 meaning "a great deal of influence."

We used a 0–10 scale instead of a 1–5 scale for question three in order to provide more degrees of choice on each side of the mid-point, allowing the affiliation distribution to be graded on a five-step scale. By using a 1–5 scale, the mid-point is 3, leaving only two degrees of affiliation on both sides. While a scale from −5 to +5 with 0 as the middle point would provide more degrees of choice, it could also be misunderstood to denote that negative values were connected with negative sentiments. We did not find enough evidence based on participant responses to produce an elaborate model, but some measurements yielded statistically significant results. Descriptive statistics are given in Table 4.3.

To test H1 and H2, as to whether the use of social media has any effect on perceived employee affiliation, we used the Mann-Whitney-U and Wilcoxon-W tests, with both leading to the same conclusion (Table 4.4). Both for perceived change in affiliation and perceived distribution of affiliation, z-scores had very low values of significance, leading to the conclusion that there is a statistically significant difference ($p < 0.001$) between perceived changes in affiliation change in employees who used social media at least daily and those who used it less than daily. Therefore, we can confirm Hypotheses H1 and H2.

Table 4.3 Descriptive statistics for participant responses

Questions	Mean	Median	Mode	Std. deviation
1. How often social media are weekly used?	12.56	3.0	3.0	24.86
2. How much do social media influence affiliation of employees?	2.43	2.0	1.0	1.20
3. How is the affiliation of employees divided between enterprise and the network of practice?	4.71	5.0	5.0	2.36
4. How much do social media influence knowledge management?	2.97	3.0	4.0	1.276

Table 4.4 Mann-Whitney test (grouping variable: regular social media usage)

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
How much do social media change affiliation of employees?	7489.5	30,709.5	4.486	0.00
How is the affiliation of employees divided between enterprise and the network of practice?	7814.5	30,819.5	3.940	0.00

To determine H3 and H4, we examined participants with a high (at least daily) use of social media. Analyzing mean ranks (Table 4.5), we can conclude that for both variables, mean ranks are higher in groups with at least daily social media usage, supporting hypotheses H3 and H4. Employees who use social media at least daily think that their affiliation has changed more, and is more distributed toward their networks of practice than the organizations they work for, as compared to their peers who use social media less than daily.

Table 4.6 shows the results corresponding to hypotheses H5, H6, and H7. We used Spearman's Rho Test to check if the correlation can be represented by a monotonous mathematical function between variables and, if so, to assess how strong that connection is. Values shown in Table 4.6 suggest that a statistically significant ($p < 0.01$) correlation exists between all three variables.

Correlation between social media usage and perceived change in affiliation is positive, meaning that participants who use social media more frequently believe that their affiliation has changed more than their peers who use social media less frequently. The correlation between social media usage and perceived affiliation distribution shows that the professional affiliation of employees who use social media more frequently is more oriented toward their networks of practice, but that the existing association is weak in strength. Finally, the correlation between perceived change in affiliation and perceived distribution of affiliation indicates that those participants who indicated higher degrees of change in their affiliation also tended to be more oriented towards their networks of practice. Therefore, survey results confirm Hypotheses H5, H6, and H7. However, relatively low p-values

Table 4.5 Mann-Whitney test ranks

	Usage of social media at least daily	N	Mean rank	Sum of ranks
How much do social media change affiliation of employees?	No	215	142.83	30,709.50
	Yes	100	190.61	19,060.50
How is the affiliation of employees divided between enterprise and network of practice?	No	214	144.02	30,819.50
	Yes	99	185.07	18,321.50

Table 4.6 Spearman's rho correlations for selected variables

Spearman's rho correlation coefficient	How often does respondent use social media weekly?	How much do social media change affiliation of employees?	How is the affiliation of employees divided between enterprise and the network of practice?
How often does respondent use social media weekly?	1.000		
How much do social media concepts change affiliation of employees?	0.310(**)	1.000	
How is the affiliation of employees divided between enterprise and the network of practice?	0.236(**)	0.250(**)	1.000

**Correlation is significant at the 0.01 level (2-tailed)
**1e-006 (for 0.310)
**2,488064556815e-005 (for 0.236)
**7,144648748861e-006 (for 0.250)

indicate that, although correlation exists, it is not strong, and there are likely to be additional variables influencing these trends.

In accordance with the assumption that our measurements of change in affiliation and change in affiliation distribution can be treated as an interval scale, we again used a parametric test, Pearson's coefficient of correlation, to check our hypotheses. Results confirmed that a statistically significant ($p < 0.01$) linear correlation exists, with correlation coefficients of 0.147, 0.212 and 0.247 for H5, H6, and H7, respectively.

Additionally, we used a two-step cluster analysis [6] to find groups in the data according to social media usage, as well as in the influence that these tools have on affiliation and knowledge management. Using our data, we identified three clusters (Table 4.7). Participants in the first cluster used social media very often during a working week. Most of them work in the IT or telecommunication sectors. They believe that social media has changed knowledge-management considerably, but they see only incremental changes in employee company loyalty. The second cluster is comprised of people who use social media approximately twice a day. They reported incremental changes in both knowledge-management and loyalty. They also mostly work in the IT sector. The third cluster is comprised of people who use social media rarely or never. They see no changes in either knowledge management or loyalty. Most of them work in the service sector.

In all three clusters shown in Table 4.7, loyalty is equally divided between participants' companies and their networks of practice. This was also the case for Clusters 1 and 2, who used social media regularly and exchanged ideas with people outside of their companies.

Table 4.7 Cluster results

	Cluster 1 "social media community oriented"	Cluster 2 "social media medium users"	Cluster 3 "social media beginners"
Influence on knowledge management	Considerably (70 % of answers)	Incrementally (86 %)	Not at all (55 %)
Influence on loyalty of employees	Incrementally	Incrementally	Not at all
Frequency of weekly social media usage	25.29	8.75	2.46
Industry sector	IT and telecommunication (29 % of answers)	IT and telecomm. (22 %)	Service (28 %)
Loyalty division	Equally between company and profession (46 % of answers)	Equally between company and profession (48.5 %)	Equally between company and profession (44.1 %)

Going back to our expert discussion on the "elitesecurity" forum and discussing that topic with IT experts, responses included:

- "In my case, company loyalty is directly proportional to the money and privilege that I get… if my job is well paid, there is more loyalty toward the company, and loyalty changes proportional to the position that one has in the company."
- "Not only salary, but also working environment, management [and other factors impact company loyalty.]"
- "The IT sector is quite different. If someone develops a product only a little better than the competitors, the competitor can be ruined."
- "It is my opinion that guilds cannot appear in the IT field as long as there are serious obstacles for further technological development and progress in the area [of information technology]."

4.5 Discussion and Connections with Other Research

Our results are founded on the idea that knowledge transfer and learning influence individual employees, initiating further changes in perceived affiliation. Knowledge is increasingly important in the contemporary economy, and is becoming a more and more important factor for society, organizations, and individuals [14, 58, 61]. Our research also ties in with recent research introducing an extremely important career anchor in the rapidly changing e-era—motivation for learning. Our study provides clear evidence for the existence and importance of this new career anchor

[13], not only as an important determinant of employee turnover, but also as a determinant of affiliation and even loyalty. Motivation for learning does not only determine loyalty to companies; if a wider social structure of colleagues provides the employee with learning opportunities, this employee will express gratitude with a sense of affiliation, just as gratitude to the company is expressed with lower turnover. Companies providing free training and continuing education to their employees can expect lower turnover rates [74]. However, support from networks of knowledge is slowly shifting outside of the company, toward peer communities. We assume that employees' sense of affiliation and loyalty will also shift from their companies toward their peer communities, as repayment for that support. A voluntary organization can even compete for members with "company-type organization," such as a factory, if the two have members from identical segments of the community, and if they meet at the same time [53].

The study of Bock et al. [8] is in line with our findings that knowledge sharing practice (through usage of Web 2.0 tools) is correlated with a higher sense of affiliation in the organizational entity where knowledge sharing is performed. Interpreting results of their hypothesis in the light of our context resulted in the following table. As we can observe in Table 4.8, communities of practice supported by Web 2.0 tools in general have more favorable factors recognized as important for knowledge sharing in this study, where affiliation with the knowledge sharing organizational entity is the most important trait for our research, and in line with our findings.

Affiliation with certain groups can explain diligence in investing in knowledge sharing with colleagues, in this case using social media. Intrinsic motivation is an activity performed for its inherent satisfaction rather than for external benefits. When intrinsically motivated, a person is moved to act for the sake of the enjoyment or challenge, rather than for external reasons [20]. The experience of self-efficacy that can result from successfully using social media to share knowledge was also reported as a significant predictor in collaborative work in open-source projects [28]. Knowledge sharing and other uses of social media allow users to obtain the feeling of belonging to a group, gaining prestige, or fulfilling themselves [29], which are the top needs according to Maslow's theory [50]. The positive impact of trust in knowledge sharing has already been elaborated on [58]. Since it is evident that members of online communities share knowledge, we can presume that social capital among group members is related to knowledge sharing [14]. Although social capital plays an important role in creating successful communities, this aspect is still not well understood [32]. In a study about knowledge sharing among bloggers [12], knowledge sharing is positively correlated with the belief that other members of the community would not do harm, such as using personal information without the owner's permission or otherwise taking advantage of others, even if an opportunity arose. Simply put, we share knowledge with decent and benevolent peers.

Another explanation of this shift in sense of affiliation lies in the soft nature of control in knowledge-intensive organizations. Organizations leading in technology-enhanced learning are mostly knowledge-intensive organizations who rely on a corporate ideology—a set of guiding ideas, beliefs, emotions, and values—

Table 4.8 Comparison with results from [8]

Original hypothesis	Existence of factor in enterprise, singular organization	Existence of factor in Web 2.0 supported community of practice
The more favorable the attitude toward knowledge sharing is, the greater the intention to share knowledge will be (supported by results)	Attitude toward knowledge sharing depends on organizational culture and climate, ranging widely	Attitude toward knowledge sharing is generally positive
The greater the anticipated extrinsic rewards are, the more favorable the attitude toward knowledge sharing will be (not supported by results)	Depending on corporate reward policy	Generally, extrinsic rewards are not present
The greater the anticipated reciprocal relationships are, the more favorable the attitude toward knowledge sharing will be (supported by results)	Only one out of three possible organizational interdependences are described as reciprocal [75]	Reciprocal relationships important trait of communities of practice which gives advance in comparison to institutionalized cultures [66]
The greater the sense of self-worth through knowledge sharing behavior is, the more favorable the attitude toward knowledge sharing will be (not supported by results). The bigger the subjective norm to share knowledge will be. (supported by results)	Relationships between self-worth and knowledge sharing behavior depends on specific culture and climate of the organization	Sense of self-worth and knowledge sharing behavior are more directly connected in communities of practice
The greater the subjective norm to share knowledge is, the greater the intention to share knowledge will be, the more favorable the attitude toward knowledge sharing will be. (both supported by results)	Singular organizations often declaratively have subjective norm to share knowledge, communicated by hierarchical superiors, but those norms are not always respected in practice	One of the main purposes of communities of practice based on Web 2.0 tools is to share knowledge, making that subjective norm strong both declaratively and in practice
The greater the extent to which the organizational climate is perceived to be characterized by fairness, innovativeness and affiliation, the greater the subjective norm to share knowledge will be, and the greater the intention to share knowledge will be. (both supported by results)	In theory, organizational climate in singular organization should be characterized by fairness, innovativeness and affiliation, but often organizations have to seek help to improve problems in those dimensions	Communities of practice based on Web 2.0 tools as mostly open and voluntary organizational entities are characterized by fairness and affiliation

more than formal structures to control employees [2]. A result of this, the awareness of the formal corporate entity, usually represented by organizational structures and hierarchies, is often diminished; the formal chain of command, as well as mechanisms of reward and discipline, become less visible and explicit. Issues are settled through informal, "clan" procedures and an organization as an entity is perceived as an informal group of colleagues. When the formal organization loses visibility, employees look to different entities for affiliation. This can lead to a change in orientation, with employees feeling less affiliated or loyal to impersonal corporate entities, transferring their loyalty to groups of colleagues who represent a larger community and provide them with knowledge. This loyalty is rewarded by support from the informal group of colleagues, mainly in the form of protection, socialization, knowledge sharing, and professional and social contacts. Using social media allows groups of colleagues to organize outside corporate borders, creating new social systems. A similar trend has been observed in project-based organizations where projects, especially large ones, are often considered to be social systems distinct from the original umbrella organization [35].

Our research sees employee affiliation as closely related to loyalty, as other studies have shown that a deep sense of affiliation can lead to individuals making extraordinary efforts on the part of the community [26]. In a medical context, the sense of affiliation between patients and their practitioners, who refer to each other as "my doctor" and "my patient," is often expressed in terms of an implicit contract of loyalty [25]. We can therefore regard loyalty beyond the narrow, classical definition of active behaviors that demonstrate pride in and support for the organization, and rather, as a wider concept causing an employee to identify and affiliate with other entities [56]. The previous, narrow understanding of loyalty usually stems from competitiveness, especially in knowledge-intensive industries that base their competitiveness on motivated, loyal employees and who, necessarily, need to ensure low employee turnover. We do not assume that a perceived affiliation shift toward networks of practice will result in less loyalty to companies; these two trends are not a zero-sum game. If an organization uses employee affiliation toward networks of practice wisely, it can benefit, even from pre-Web 2.0 networks of practice [79].

Online communities tend to perceive themselves as democratic groups of equals, allowing leading users to distinguish themselves through a number of characteristics and behaviors [31]. Leading users are more motivated to innovate, and score higher in areas such as being an active member of the community, getting together with others online to provide opinions and solutions to problems, and suggesting innovative solutions to the community, gaining popularity in the community as a result [31]. Some sense of economic rationality also emerges in online communities, as evidenced by a study of blogger behavior [12]. If bloggers think that they can save time and costs, they share more knowledge and information on their blogs. By integrating services provided by different individuals, Web 2.0 communities can create value [43], which is also an important feature in organizations. Those findings direct us toward the conclusion that an informal professional community empowered by social media shows some basic features of organizations: a hierarchy among

members, however informal and insignificant, a basic sense of economic rationality, and the ability to create value.

One important issue in our research is the practical possibility for a shift in affiliation to occur. Employees can feel that they belong to a community of practice, however their working contracts are still mostly signed for their companies. A set of forces influences whether a change in their sense of affiliation, and how it can further change real affiliation, and that is best represented by force-field analysis [48]. Based on forces commonly observed in the literature and from our experience we proposed a force-field analysis given in Fig. 4.4.

Employees working on knowledge intensive activities will in general, at least according to our results, have more contact with a community of practice. That will consequently change their perception toward affiliation to that community. A set of jobs which require external collaboration, such as business consultants, web consultants or PR specialists often bring employees in an external community of specialists, which encircle a majority of job-related interactions. Also, problems with accepting organizational culture—defined by Morgan [55] as a set of beliefs, values, norms, rituals and symbols by an individual employee can drive toward change of affiliation outside organization with that culture. If organizational culture is unfit with individual's own beliefs, values or norms it will drive change faster on individual level, and general state of weak and fragmented culture is a force which

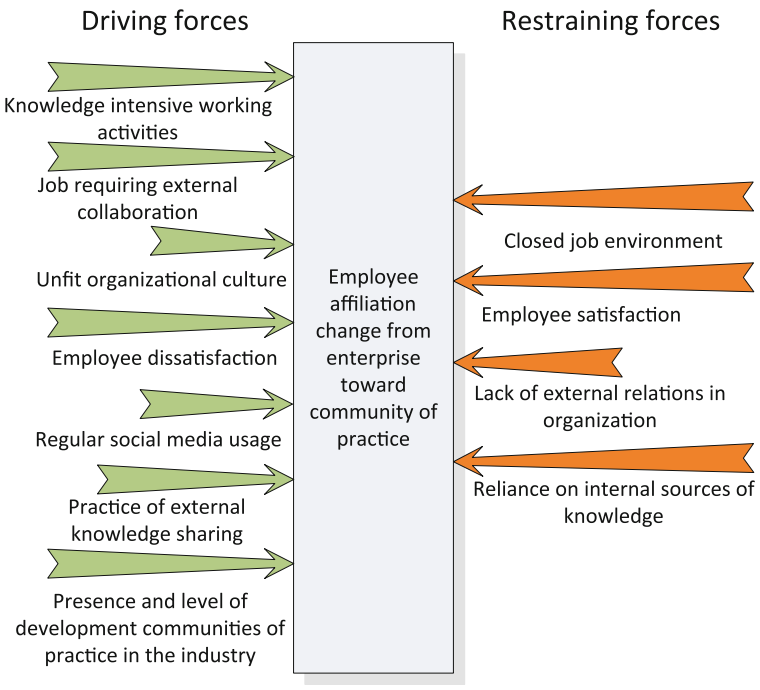

Fig. 4.4 Force-field analysis for employee affiliation change

can drive change of affiliation perception on a level of the company. Dissatisfied employee, just as any dissatisfied member of community will search for another community to identify with, and in some occasions that community could be community of practice instead of another organization. Regular social media usage, as well as practice of using it for sharing knowledge externally is a force aiding change—as it was shown by results in Tables 4.4, 4.5 and 4.6. Finally, presence of developed communities of practice is at the same time pro force and *condition sine qua non*, because communities of practice must exist, and be developed enough to be recognized in order for employees to feel affiliated with them.

On the opposite side, closed job environment on individual level, just as lack of external relations on organizational level restrain interactions with external communities—hindering the change of affiliation. Also, such conditions often create closed, even slightly xenophobic culture which does not promote sharing information and knowledge, let alone feeling affiliated with external entities. Employee satisfaction leads to higher organizational identification, as shown by Lee [46]. Strong reliance on internal source of knowledge, regardless of the cause—security, specific knowledge needs or lack of trust in external sources decreases level of interaction via social or other media, as well as trust and respect into external communities which can provide knowledge, thus also hindering the change.

4.6 Conclusion and Outlook

This chapter describes a small fraction of the organizational and social change that has been influenced by emerging social media. The influence of social media is embodied in technology-supported learning and in perceived changes in affiliation. Findings indicate that perceived changes in affiliation, from organizations to networks of practice, depend on the frequency of social media usage. Employees with daily use of social media had a stronger perceived change in affiliation from their organizations to their networks of practice. As networks of practice, boosted by social media, give more support to employees working for profit-based organizations, we can presume that such support will be repaid in some way. Communities empowered through social media gain some basic features of organizations, such as member hierarchies and economic rationales. In the future, networks of practice may increase their importance and influence in the business, organizational, and social milieus, becoming the new supra-organizational entities.

Based on the feedback to our study and its theoretic assumptions (especially from [79], we presume that employee affiliation toward networks of practice, if managed properly, does not necessarily decrease affiliation or loyalty toward their companies, nor negatively influence the company's goals. Further research should test this assumption, determining the actual distribution of loyalty and commitment in employees using networks of practice. Such research can draw parallels between commitments to labor union and commitment to informal professional groups, exploring patterns of employee commitment to unions, the construction of loyalty

to unions, beliefs in unionism, feelings of responsibility toward unions, and willingness to work for unions [73]. These parallels can be used to better conceptualize and understand commitment to informal professional groups of colleagues due to such factors as loyalty, belief in a professional community, responsibility toward a professional community, and willingness to work for a professional community. This study did not investigate a causality between the observed factors, which could also be a topic for a further research model of influences and factors in this area. Furthermore, our data did not include demographical data (e.g., age, position, education) of the respondents. In further research, it would be interesting to include this data in a survey, in order to investigate whether this plays a role in the employee's sense of affiliation.

In the future, further research can be aimed on the improvement available from the advent of Web 3.0, also called the Semantic Web. Web 3.0 was envisioned to assist the evolution of human knowledge as a whole [7]. Technical improvements such as Web Ontology Language (OWL) can enhance enterprise knowledge management [57]. Lai et al. [44] already found that applying the technology of Web 3.0 and linked data in the enterprise knowledge management can solve the problem of knowledge sharing, especially for tacit knowledge. Conceptually different from Web 2.0, which is based on user collaboration, Web 3.0 is from our perspective important for its basis on connecting knowledge more intelligently by using semantics. Such approach can generate completely different behavioral and perceptive consequences in a business environment than those presented in this chapter. Nevertheless, our chapter is useful for giving a clue on a research framework and potential nature of Web 3.0 influences on employee affiliation perception and other organizational issues.

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Part II
Managing Knowledge Using Social Media: Factors Influencing Adoption and Usage

Chapter 5
Studying Social Software Adoption by Management Consultants: Use and Application Categories for Knowledge Management

Malte Martensen, Stephanie Ryschka and Markus Bick

Abstract In knowledge management, Enterprise 2.0 applications are thought to have the potential to bridge the gap between technology- and human-oriented paradigms and approaches. Thus far, however, it remains unclear how social applications are ultimately used in knowledge-intensive organizational contexts such as management consultancy. Our study addresses this gap by answering how and to what extent innovative social software applications have been used for job-related purposes. We derive use and application categories which are validated by means of qualitative interviews with management consultants from large firms in the industry, in order to build a comprehensive classification system for the professional use of social software. Stakeholders of our research include scholars and practitioners. Understanding potential redundancies can help design more effective social software suites. Moreover, understanding drivers of user acceptance may provide insights into the optimal composition of social software suites and the purposes for which these applications can be applied.

Keywords Social software · Knowledge management · Management consulting · Enterprise 2.0

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5.1 Introduction

Few technologies have developed as rapidly in recent years as social software [1]. Since the first definition of Web 2.0 and Enterprise 2.0 by O'Reilly [2] and McAfee [3], many authors (e.g. [4, 5]) have highlighted the potential of social software and social media to support organizations.

Social media services have been popular with private users since the beginning of the twenty-first century, but now we can also observe an increasing adoption of social software applications by organizations [6]. By the end of 2013 it was expected that more than 90 % of Fortune 500 companies would have fully or at least partially implemented social software [7]. Developments have increased to the point that that there is even a unique Gartner Hype Cycle for social software (cf. [8]). In the literature, however, it has been noted that the organizational and professional use of social software has still not reached a significant level of private use, and that organizations have yet to realize the technology's full potential [9]. In addition, there are questions surrounding user acceptance in the organizational context, which lags behind expectations [10, 11]. Therefore, an understanding of possible applications of social software in the business context is highly relevant [12].

Despite a growing interest, the body of research on social software in the organizational context remains incomplete, with the majority of publications on the subject taking the form of qualitative case studies [13]. Although knowledge management has long been a topic of discussion for consultants (cf. [14], Wirtschaftsinformatik 05/2001), the question of how and for what knowledge management purposes social software is used has only been investigated within the framework of individual patterns of use, such as in the area of collaboration [15]. A systematic examination of knowledge workers [16] has yet to be carried out; similarly, there has not been an industry focus on knowledge intensive fields such as management consultancy [17].

In the present study, the collection of qualitative data was carried out by means of semi-structured, guideline-supported expert interviews conducted with eight consultants. The interviews were recorded and transcribed and a content analysis was performed to provide insights into the use of social software. In addition to types of use, different social software applications form the focus of the analysis, and thus the questions concentrate on which applications are available in consultancies, as well as which of them are actually used for professional purposes. Moreover, based on the qualitative data, definitions for the use and application categories are developed. These objectives are represented by our research questions:

- Research question 1: How can the different types of social software used in the field of knowledge management be classified?
- Research question 2: Which social software applications are used professionally for knowledge management?

5.2 Theoretical Background

5.2.1 Management Consultancy and Knowledge Management

Few sectors of industry have developed as dynamically in the last few decades as management consultancy. In Germany in 2002, total turnover in the sector was 12.3 billion euros, almost doubling to 22.3 billion ten years later [18].

Management consultancy is a sector within the knowledge-intensive business services field (KIBS), and is distinguished by the fact that it provides knowledge-intensive inputs for the processes of other organizations [19]. The concept of KIBS was introduced by Miles et al. [20] and is defined by the authors as follows:

> We understand KIBS to be services that rely heavily upon professional knowledge, […] either supply products which are themselves primarily sources of information and knowledge to their users (e.g. measurements, reports, training, consultancy); or use their knowledge to produce services which are intermediate inputs to their clients' own knowledge generating and information processing activities. [20]

KIBS are thus organizations whose core competences lie in the generation of knowledge and innovation, and the sale of their services to other organizations. Meanwhile, KIBS are themselves dependent on knowledge to sustain their business models [21].

In addition to their classification as KIBS, management consultancies can also be considered part of the group of *professional service firms* (PSF) [22]. PSFs are seen as a particularly complex form of service providers, since their services are characterized by a certain amount of uncertainty, given that they deal with unstructured, complex and highly demanding customer-specific problems [23]. Thus, PSFs provide particularly complex services, whose critical resources reside in knowledge, relationship-building competence and reputation (see Fig. 5.1). Industry and methodological knowledge on the part of PSFs leads to a knowledge advantage which is expressed by a special form of reputation. Customer specificity is achieved through strong relationship-building skills, which leads to interaction, integration, and ultimately to individual solutions [24]. This is especially true for the services of management consultants, since they are characterized by the fact that service delivery always takes place during interactions with the client [25].

The management of knowledge thus plays a crucial role in management consulting, with knowledge creation being particularly relevant given the characteristics and distinctiveness of KIBS and PSF. In this regard, Nonaka and Takeuchi [26] emphasize that the creation of knowledge is a dynamic process of interaction between tacit and explicit knowledge, which takes place on the individual, group and organizational levels. Hence, an important management task is to construct opportunities for interaction. According to Hansen et al. [14], who focused their

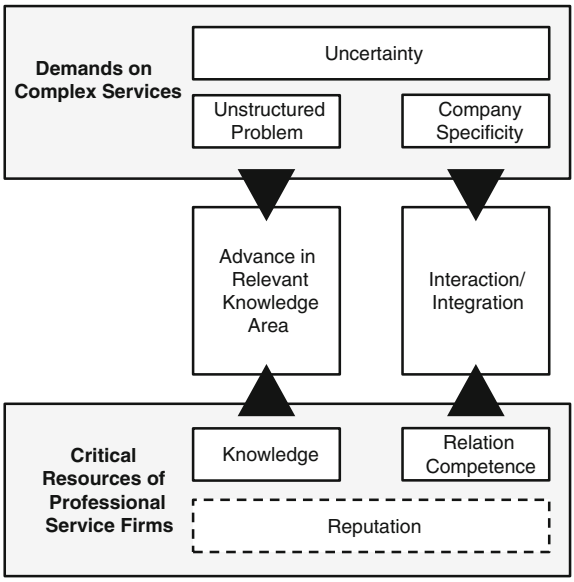

Fig. 5.1 Critical resources of professional service firms (*Source* [24, p. 4])

study on management consultants, these interactions are based on two different strategies: codification and personalization.

A codification strategy aims to generate and codify certain knowledge-related assets once, and to reuse them as often as possible. For this purpose, a relatively large investment in knowledge-supporting infrastructure is needed to allow people access to its contents. In contrast, a personalization strategy aims to establish a culture of knowledge sharing [27], which brings to the foreground the individual creativity and expertise of highly qualified employees. While a codification strategy focuses on explicit knowledge, the emphasis of a personalization strategy is placed on implicit knowledge. Table 5.1 provides an overview of the cornerstones of both strategies, and explains how these can be implemented in management consulting.

Alavi and Leidner [28] distinguish between the processes of *knowledge creation*, *knowledge storage/retrieval*, *knowledge transfer* and *knowledge application*. Personalization strategies tend to support knowledge generation, while knowledge transfer and codification strategies support the processes of knowledge storage and use. However, as a comprehensive knowledge management policy cannot neglect any of these processes, it is clear that a knowledge management strategy for management consulting must include both personalization as well as codification. While conventional knowledge management systems are more likely to support technology-oriented knowledge management, a new technology is presumed to provide the potential to close the gap with human-oriented management—social software. The theoretical foundations of social software research and the way they address the human–organization–technology triad [29] will be illuminated in the following section.

Table 5.1 Strategies for knowledge management in management consulting

	Codification	Personalization
Competitive strategy	Provide high-quality, reliable and fast implementation of information systems by reusing codified knowledge	Provide creative, analytically rigorous advice on high-level strategic problems by channeling individual expertise
Economic model	*Reuse economics* Invest once in a knowledge asset; reuse it many times. Use large teams with a high ratio of associates to partners. Focus on generating overall revenues	*Expert economics* Charge high fees for highly customized solutions to unique problems Use small teams with a low ratio of associates to partners Focus on maintaining high profit margins
	People-to-documents	*Person-to-person*
Knowledge management strategy	Develop an electronic document system that codifies, stores, disseminates and allows the reuse of knowledge	Develop networks for linking people so that tacit knowledge can be shared
Information technology	Invest heavily in IT: the goal is to connect people with reusable codified knowledge	Invest moderately in IT: the goal is to facilitate conversations and the exchange of tacit knowledge
Human resources	Hire new college graduates who are well suited to the reuse of knowledge and the implementation of solutions Train people in groups and through computer-based distance learning Reward people for using and contributing to document databases	Hire MBAs who like problem solving and can tolerate ambiguity Train people through one-to-one mentoring Reward people for directly sharing knowledge with others

Source [14] (Following [25, p. 424])

5.2.2 Social Software

Social software in this context is understood as software which supports cooperation and communication between individuals. These include technologies and applications in the field of *social networking sites (SNS)*, *wikis*, *weblogs*, *microblogs*, *online communities, forums* or *instant messaging* applications [30]. It is important to note here that it is not so much that the software is social, but it does open up opportunities to reach others through social channels [31]. According to Hippner [32], social software includes:

> Web-based applications which, for humans in a social context, support information exchange, relationship building and communication, and which are guided by specific principles. [32, p. 7]

The term Web 2.0 is now used much more generally, especially by practitioners, than was originally intended: it is now often used as a generic term to describe any kind of innovation or alleged innovation related to the Internet [33]. It has also

Table 5.2 Disambiguation

	Public internet	Enterprise context
Phenomenon	Web 2.0	Enterprise 2.0
Artefact	Internet social media	Intranet social software

Source [85, p. 90]

come to be used as something of a buzzword, even in scientific research, though many authors have been critical of this practice because it does not recognize its original focus and theoretical foundations [13]. Many researchers prefer to use the term "social software" to highlight the social structures and interactions involved (e.g. [33]). Thus, few clear-cut scientific distinctions exist, and phenomena (Web 2.0) and artefacts (social software and social media) are often merged. Table 5.2 attempts to make a conceptual distinction—although, both in research and in practice, such strict distinctions are rare.

According to McAfee [3], the shift in interaction channels and process chains that has emerged from the use of the principles and technologies of Web 2.0 within and between companies and external stakeholders has intensified. This has particularly affected collaboration between knowledge workers [34]. McAfee [35] defines Enterprise 2.0 as: "*[…] the use of emergent Social Software platforms within companies, or between companies and their partners or customers.*" However, it is not only the use of social software that is indicated by Enterprise 2.0, but also the creation of an open corporate culture and an informal change management policy. An overview of different application classes which can be distinguished in the field of social software and Enterprise 2.0 is provided in Table 5.3.

5.3 Literature Analysis

The literature review follows the methodology of Webster and Watson [36] and Levy and Ellis [37]. For the literature review on professional uses of social software, a full keyword search was carried out in databases relevant to business information systems. The scope of the search thus included EBSCO (Business Source Complete), Elsevier ScienceDirect, JSTOR and Emerald. In addition, the American Conference on Information Systems (AMCIS), the European Conference on Information Systems (ECIS), the Hawaii International Conference on System Sciences (HICSS), the International Conference on Information Systems (ICIS), the Bled Conference (BLED), the Wirtschaftsinformatik (WI) and the Multikonferenz Wirtschaftsinformatik (MKWI)—all from 2007 onwards—were also within the scope of the literature review. Search terms included "Web 2.0", "Enterprise 2.0", "social software", "social media", "social Web" and "social intranet". If any of these terms appeared, the abstract, introduction and conclusion of the respective articles were analyzed to determine whether any aspect of professional use played a role (see [38]).

Table 5.3 Social software applications

Application	Description
Social networking sites	Social networking sites (SNS) are web-based applications which allow users to create individual profiles in which to display their personal information, preferences and skills to other members. In addition, connections or friendships can be established with other users, and these can be made visible in the form of contact lists. It is often possible to send personal messages, post status messages, save and publish different file types (e.g. photos), establish groups, or set up appointments or events
Wikis	Wikis are websites whose content cannot only be read by users, but also edited in a web browser. One aim of a wiki is to collect and consolidate the knowledge of many users, who can maintain and even create pages themselves (collective intelligence). Wikis are thus suitable for collaborative work on texts, and many wikis are used as thematic or cross-thematic dictionaries and encyclopedias on a network
Blogs and microblogs	A blog, also known as a weblog, is a regularly updated news service whose entries are presented in chronological order, i.e. in the form of a diary on a website. Users can create an ongoing discussion of a particular topic or subject area within this structure. Most blogs offer a comment function for readers. Microblogs are a particular sub-type of blogs in which the length of entries is limited to a short message, mostly no more than 200 characters. The most well-known of these is Twitter (www.twitter.com)
Instant messengers	Instant messengers (IM) are Web-based applications that allow two or more users to send messages in real time. They therefore serve primarily for synchronous, i.e. direct, communication. IM applications allow the creation of contact lists which display when other users are online and whether they are available to contact. Many services include a voice or video function
Document exchanges	Document exchanges are cloud-based web services that allow the online backup of data in terms of document storage. In addition, they allow the synchronization of files between different people and devices. Documents can thus be created and edited collaboratively
Forums	(Internet) forums or bulletin boards are virtual noticeboards which allow the exchange and archiving of opinions, thoughts and experiences. The method of communication is asynchronous, since posts can be read and answered later by other users. A collection of successive responses to a post is known as a thread. Forums are mostly oriented towards a specific topic
Podcasts	Podcasts allow media content, such as audio and/or video files, to be saved to devices (fixed or mobile) and played later. They are usually offered on a subscription basis by way of news feeds, which allow podcasts to be automatically downloaded
Social knowledge environments	Building on enterprise knowledge infrastructure and knowledge management systems, Bick et al. [64] propose that a social knowledge environment is a comprehensive arrangement of information and communication technology applications that are contextualized and integrated. On the basis of a shared ontology, they foster awareness of others' activities, encourage contributions of user-generated content, and support networking for knowledge processes that seek to increase the performance of knowledge work

Source Following [43]

5.3.1 Social Software Research

The arrival and overwhelming success of social software, Web 2.0 and Enterprise 2.0 (see Sect. 5.2) have raised a variety of novel scientific questions. In the following, these issues and the current state of research are discussed from the perspective of the business information systems field. Based on the literature, existing studies can be classified into the following subject areas:

- Benefits and success factors
- Challenges and obstacles
- The influence of culture
- Motivations for use
- Use types

Table 5.4 provides an overview of the contents of these subject areas, as well as of the respective studies. It should be noted that this is only a selective representation of the area of business information systems, and that there may be a large number of other studies whose research focuses on issues of social software.

In addition to these subject areas, a variety of (economic) research and practical contributions on the use of social software deals with specific business functions. In contrast to studies that focus on subject areas, the function-specific literature is characterized by practical case studies rather than by empirical studies or theoretical research contributions. Furthermore, it should be noted that the aspects explored are particularly characterized by a high degree of interaction with partners outside of the organization. These include inter alia marketing and sales and customer services as well as the human resources function where social software is already intensely used in the areas of recruitment and HR marketing [6].

The state of research into various business functions and practical contributions can be found in Table 5.5. Here, it is again noted that the contributions shown represent only a selection of the literature on the subject of social software. In particular, in the business-related fields adjacent to business information systems which focus on specific business functions, there are a number of other research fields, and thus a large body of further literature.

5.3.2 Use of Social Software for Knowledge Management

The management of information and knowledge is regarded as one of the main potential uses of social software [39], while the use of Web 2.0 technologies has led to significant changes in knowledge management, both in research and practice [40].

In the context of knowledge generation, social software applications help, for example, in cross-linking information or linking different knowledge sources (combined from [26]). Closely linked to the generation of knowledge, collaboration is a further category of use [41]. As will be shown below, collaboration between

Table 5.4 Content-specific social software research

Subject area	Contents	Authors/studies
Benefits and success factors	• Value lever	e.g. [65–67]
	• Productivity	
	• Success measurement	
	• Advantages of use	
	• Success factors for deployment	
	• Acceptance	
Challenges and barriers	• Privacy	e.g. [68–70]
	• Data security	
	• Compliance and legal factors	
	• Information overload	
	• Risk of addiction • Media competition	
Cultural influences	• Influence on motivation and adoption	e.g. [71, 72]
	• Country-specific applications	
	• Role of organizational culture	
Motivation to use	• Hedonism	e.g. [43, 73–75]
	• Utility	
	• Social (relationship) motives	
	• Self-marketing	
	• Group pressure	
	• Functionalities	
	• Extrinsic and intrinsic factors	
Use types	• Information and knowledge management	See Sect. 5.3.3.
	• Communication	
	• Collaboration and coordination	
	• Identity and contact management	

individuals is enabled or improved by the use of social software, and collaboration is in turn the basis of the generation of knowledge (cf. [42]).

The suitability of social software for obtaining knowledge has been shown many times [43–45]. Here, in particular, the fact that social software applications store explicit knowledge, documents and information, and also makes them available and searchable for others, is highly important. For these purposes, wikis, forums, blogs and document exchanges are especially useful. The importance of knowledge retention is not valued highly enough in most industrialized nations, as we are living with an ageing population, alongside high staff turnover [46].

A starting point for knowledge retention can be provided by knowledge exchange. Nonaka and Takeuchi [26] distinguish four types of knowledge transformation: socialization, externalization, combination and internalization. Geißler et al. [47] link these with the SLATES concept of McAfee [3], which combines

Table 5.5 Function-specific social software research (selection)

Functions	Contents	Authors/studies
Marketing and sales; service	• Customer integration	e.g. [76–78]
	• Viral marketing	
	• Consumer behavior	
	• Social advertising	
Technology development	• Open innovation	e.g. [79, 80]
	• Crowdsourcing	
	• Customer integration	
Procurement, logistics and operations	• Supplier integration	e.g. [81]
	• Supply chain optimization	
Human resources	• Recruiting	e.g. [82–84]
	• Employer branding	
	• Work–life balance	
	• Learning and training	
Firm infrastructure	• Knowledge management	See Sects. 5.3.2 and 5.3.3
	• Internal communications	
	• Collaboration	
	• Enterprise 2.0	

features and principles of Enterprise 2.0. An overview of the use cases of knowledge management in Enterprise 2.0 is provided in Table 5.6.

In particular, informal information and knowledge transfer is supported by certain social software applications. According to Manouchehri Far [48], an open knowledge culture—and thus the transfer of knowledge and internal networking—can be promoted through the use of social software. Other authors also point out that the use of social software can have positive effects on knowledge sharing (e.g. [49, 50]). Possible use categories will be discussed in more detail in Sect. 5.3.3.

Table 5.6 Use cases of knowledge management in Enterprise 2.0

Enterprise 2.0	Knowledge management			
	Socialization	Externalization	Combination	Internalization
Search	Find experts			Information search
Links			Linking information	
Authoring		Content repository		
Tags		Give keywords	Combine sources	
Extensions			Alerts for similarities	
Signals				Alerts for content

Source [47, p. 39]

5.3.3 Deduction of Use Categories

Our category system on the use of social software for professional purposes (addressing the first research question) was deductively derived through an analysis of studies in the area of internal organizational social software usage. It was found that previous contributions were characterized by great heterogeneity, and that the authors discuss a wide variety of very different types of use. Some categories, however, were mentioned repeatedly or, despite differing labels, were discussed in terms of congruent or similar aspects (see Table 5.7).

Following this finding, all types of use were listed in tabular form and analyzed in order to be subsequently combined into groups with similar types of use. This procedure led to the following groups:

- *Communication, discussion, dialogue and interaction* (see e.g. [33, 51–53, 54])
- *Collaboration and cooperation* (see e.g. [33, 51, 52, 54])
- *Coordination of activities and tasks* (see e.g. [44, 54, 55])
- *Information and knowledge management* (see e.g. [33, 53, 56]).

Table 5.7 Literature review of organizational use categories (selection)

Study	Object	Use categories
[51]	Social software	Social networking; social communication; social tagging; social collaboration; social navigation
[52]	Social media	Broadcasting; dialogue; collaboration; knowledge maintenance; sociability
[33]	Social web	Collaboration; information; communication; maintain relationships
[53]	Social software	Information sharing; discussion; seeking support; self-marketing; meta-communication
[55]	Microblogs	Task coordination; time coordination; discussion; event reporting; input generation; informal communication; information storage; problem-solving
[54]	Enterprise 2.0 tools	Communication; cooperation/collaboration; coordination; content combination
[56]	Social software	Informal network building; weak tie building; social capital building; knowledge transfer
[44]	Wikis and blogs	Facilitate and accelerate work; improve knowledge transfer and collaboration; improve status and work; improve processes; find project opportunities
[43]	Social software	Information management; identity and network management; interaction and communication
[32]	Social software	Information exchange; relationship building; communication
[57]	Groupware	Communication support; coordination support; cooperation support
[34]	Social media	Collective knowledge management; personal knowledge management

Based on this distinction, the content-oriented group *information and knowledge management* is further divided into the categories of *knowledge sharing* (active) and *knowledge seeking* (passive consumption). This division is also made by Richter et al. [53].

The areas of communication, discussion and interaction, collaboration and coordination are viewed as categories of a functional dimension that brings the processes to the foreground. The category of communication includes aspects of discussion and interaction, as well as the sending of messages, and it represents, though it is not entirely clearly delineated by (i.e. it should ultimately include other categories of communicative action), one of the main categories of the use of social software (see e.g. [33, 51]).

In addition to communication, *collaboration* and *coordination* are also considered as separate categories within functional management. This division goes back to Teufel et al. [57], who define these three levels of interaction processes for group work. Among others, Williams and Schubert [54] use this categorization for social software.

Coordination represents the coordination of activities, tasks and processes. Riemer et al. [55] make a further division into *task coordination* and *time coordination*. The categories of *simplifying work*, *accelerating service provision* and *improving processes*, as identified by Stocker and Tochtermann [44], can also be viewed as aspects of coordination.

The category of collaboration ultimately describes the fact that individuals collaborate on documents and other work products with the aid of social software, and thus share a common goal. Collaboration is seen by Hu and Schlagwein [52] and Stocker and Tochtermann [44], among others, as a separate use category. Figure 5.2 provides an overview of the derived use categories. In Table 5.8, further descriptions of use categories are provided.

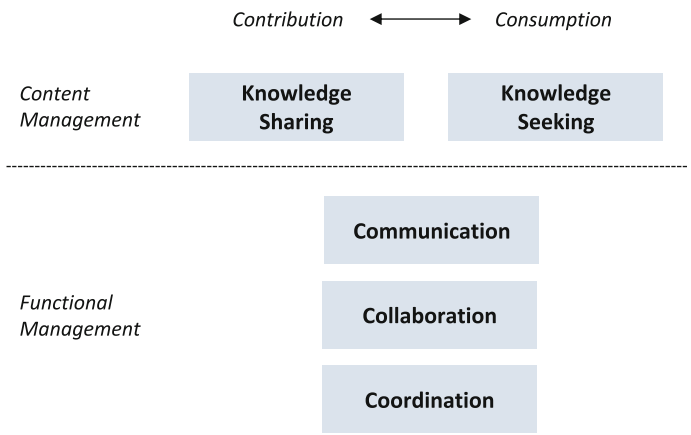

Fig. 5.2 Social software use categories

Table 5.8 Description of use categories

Use category	Description
Knowledge sharing	• Sharing know-how from work experience with colleagues
	• Contributing best practices, templates and lessons learnt
	• Providing advice to others
Knowledge seeking	• Searching for specific information and knowledge
	• Looking for best practices, templates and lessons learnt
	• Seeking help and advice
Communication	• Exchanging messages (one-on-one or in groups)
	• Discussing
Collaboration	• Working together at specific documents and tasks
Coordination	• Making joint decisions
	• Orchestrating processes, workflows, events and tasks

The present section has identified the various use types of social software from the existing literature, and consolidated them into a comprehensive category system. Its components *knowledge sharing* and *knowledge seeking*, *communication*, *collaboration* and *coordination* will be empirically investigated in the next section.

5.4 Qualitative Expert Study

In the present study, data collection was carried out using semi-structured expert interviews conducted with eight consultants. The interviews were recorded, transcribed and analyzed in order to provide information on the use of social software. In addition to the focus on the various use types and social software applications, the analysis included whether internal applications were available, and whether or not they were used.

Following Meuser and Nagel [58], *expert interviews* represent a special form of problem-focused interviews, since the subjects come from a certain target group and are thus questioned in their role as representatives of their companies or industry sectors; that is, as experts [59]. The interviews have a certain degree of pre-structuring and are supported by guidelines [60]. These interview guidelines are not strictly question and answer templates, but more a set of reminders and a framework for the researchers. This can help to ensure that all the aspects and categories of questions are dealt with during the course of an interview, so that the comparability of the interviews can be guaranteed [61].

The guideline on which the present study is based consisted of seven phases, whose order varied in part (see Fig. 5.3). The start of the conversation consisted—after a personal introduction and an outline of the topic—of open questions intended to determine general information about the use and application categories of social software. In the second part of the interview, the interviewee was given an overview of the use categories and their definitions, as well as an overview of the

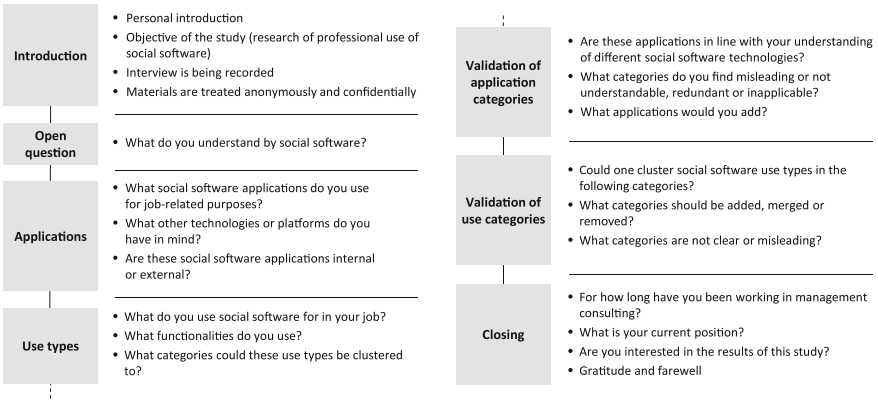

Fig. 5.3 Interview guideline

application categories. The aim of the second part of the interviews was for interviewees to express their subjective perceptions of the quality of the categories and their definitions. Here, the emphasis was on the comprehensibility, consistency, completeness and delineations of the categories. This section should also explore which applications were made available by each management consultancy, and which internal and external applications were or were not used.

For interviewee selection, the technique of minimal contrasting was applied; all interviewees were social software users and experts from large consultancies. After six expert interviews, a certain level of saturation emerged, and based on the interview notes, preliminary results and trends could be inferred. To ensure that theoretical saturation was achieved, two more interviews were held after a certain period of time. Overall, eight interviews were carried out. The respondents worked in six different consultancies, all of which are among the top 25 firms in Germany in terms of annual revenue [62]. As illustrated in Table 5.9, six respondents were male and two female, with an average age of 28.6 years and an average of 3.4 years' experience in the consultancy sector.

Table 5.9 Participants of expert interviews

Name	Gender	Age	Consulting experience (years)	Consultancy	Duration (min)
IP1	M	36	7	A	25
IP2	M	27	2	B	20
IP3	M	25	2	A	27
IP4	M	28	2	C	23
IP5	M	26	2	D	20
IP6	M	32	6	A	28
IP7	F	28	5	E	21
IP8	F	27	1	F	17
	25 % F	**Ø 28.6**	**Ø 3.4 years**	**6 diff.**	**Ø 23**

The coding of the interview transcripts was performed with the aid of MAXQDA 10. The first interview was coded independently by two researchers to validate the category system and to ensure inter-coder reliability. The codes were then compared and analyzed. The coding of the first interview showed that 97 % of the available codes were used by both researchers, and 68 % of the codes were consistent in terms of frequency. Based on the validated category system and coding guidelines, the remaining transcripts of the interviews (2–8) were also coded, in these cases by a single researcher. The corresponding results are presented below in Sect. 5.5.

5.5 Results and Discussion

In the following section, the results of the qualitative content analysis are presented and discussed. First, we address the validation of the identified use categories of social software for management consultants. In Sect. 5.5.2, the applications are then analyzed to support these use categories.

5.5.1 Use Categories

Proposals for extending or modifying the category system were put forward by only a few interviewees. It can be stated in general that the majority of the interviewees confirmed the derived categories (see Table 5.5). Only the category of coordination was not seen as warranting a separate category by six of the eight experts: "*Well, I have a bit of trouble with the last point, coordination, since it defines something materially and it's not quite clear to me why*" (IP5-102); "*I agree with all of them with the exception of coordination*" (IP7-118).

A further analysis of the transcripts shows that coordination is considered to be part of collaboration by the majority of interviewees, and therefore should be subsumed under this category: "*[…] why do there have to be two extra dimensions? […] when I collaborate, what do I then have to coordinate?*" (IP2-92); "*It's probably really just a purely scientific or theoretical discussion, whether or not it cannot also be seen as a part of collaboration*" (IP6-104).

This process brought about a new category system which consists of four use types (Table 5.10). In the following, revised definitions for these categories should be refined, and perhaps redeveloped, based on the statements of the interviewees.

5.5.1.1 Knowledge Sharing

Knowledge sharing was confirmed by the majority of interviewees as a use category of social software. In particular, IP2 emphasized the importance of these

Table 5.10 Affirmation of use categories by interview partners

Use category	IP1	IP2	IP3	IP4	IP5	IP6	IP7	IP8
Knowledge sharing	✓	✓	✓	✓	✓	✓	✓	✘
Knowledge seeking	✓	✓	✓	✓	✓	✓	✓	✘
Communication	✓	✓	✓	✓	✓	✓	✓	✓
Collaboration	✓	✘	✓	✓	✓	✓	✓	✘
Coordination	✓	✘	✓	✘	✘	✘	✘	✘

✓ Agreed with category; ✘ Refused category

categories, stating that one doesn't need "*to reinvent the wheel again and again*" (IP2-56-62). Only IP8 saw no separate categories in knowledge sharing and knowledge seeking, while IP5 wanted these condensed into knowledge management, since the difference was not clear to him (IP5-106-114). IP4 was also not entirely sure of the distinction between two of the categories: "*So from my point of view knowledge sharing and knowledge seeking […] are strongly connected with each other […]. It doesn't seem necessary to me to distinguish in this way. For me, one is dependent on the other*" (IP4-132-136).

IP1 agreed with the categories, but raised the issue that the concepts of information, document and knowledge should be clearly identified in the definition of the *knowledge sharing* category to distinguish them from communication and collaboration (IP1-50-52, 78). IP2 noted that the term "*exchange*" should be defined so that the exchange of messages should be one form of communication, while the exchange of information and documents should belong to the category of *knowledge sharing*. Perhaps a distinction between *knowledge exchange* and *knowledge sharing* would also be useful, depending on whether or not the participants know each other or not (IP2-12, IP2-146).

Knowledge sharing was found throughout the interviews to be considered an important factor: "*My main use, and I think the main use of most of my colleagues, is that the applications are used for the exchange of knowledge*" (IP2-34). This occurs, for example, in the codification of knowledge in case studies, as well as their subsequent storage: "*If you have successfully completed a project, [it makes sense to] build a case study from the project and then [to] upload this into the internal knowledge system*" (IP5-34).

5.5.1.2 Knowledge Seeking

Compared to *knowledge sharing* the *knowledge seeking* category was discussed less extensively by the interviewees. IP7 wondered whether "*the posting of questions can be seen as an aspect of knowledge seeking*" (IP7-96), and whether asking a colleague directly was part of *knowledge seeking* or of *collaboration* (IP7-120). IP5 pointed out that the category could perhaps be extended to research (IP5-46).

In the interviews, *knowledge seeking* was charted through a variety of knowledge transfer points: "*[…] Social software offers the possibility to find what you're*

looking for and to get results in a relatively targeted and controlled manner […] or to see what you need to get to that point" (IP3-24). Hence project preparation above all is supported by social software: "*[…] so, obviously in the context of preparing the project using the system to look at comparable projects*" (IP5-34). However, the selection of sources for each application is also important here: "*I haven't actually used social networks for analysis, as most of the content is not up to date*" (IP5-111-112). It is also worth noting that established knowledge management systems have been replaced by social software: "*So putting the topic as your status message, or also posting questions instead of what used to be 'Write an email to the mailing list' and ask 'Has anyone worked on this project or in this industry?' which has actually been replaced by […] live feeds in communities.*" (IP6-28)

5.5.1.3 Communication

In the discussion of the *communication* category, the interviewees displayed its differing characteristics. IP3 distinguished between active and passive communication on the one hand (IP3-22-24), and synchronous and asynchronous communication on the other (IP3-76-80). In addition, *communication* could take place either between two parties or between members of a larger group. IP1 noted that interaction, communication and the exchange of news should be separated (IP1-22). IP5 argued for the inclusion of commenting into the *communication* category (IP5-56).

Overall, *communication* was highlighted as a central component of use: "*To be able to exchange is for me the focal point of social software*" (IP1-18). The utilitarian component of the use of social software for communications purposes—which is supplemented by hedonistic elements—is explained in the following case: "*Another tool we currently use [that is] very successfully, and which is also fun for me, is Lync, the Microsoft Office solution for instant messaging, which makes it possible not only to get together with colleagues at relatively short notice, but especially to see who is available at the moment.*" (IP3-18)

5.5.1.4 Collaboration

As explained above, the *coordination* category was subsumed under *collaboration*. Additionally, IP2 saw *collaboration* as a subcategory of *communication*, and stressed that these kinds of use were taking place more through conventional technologies like telephone and email, rather than through social software (IP2-90-114): "*[it is not clear] whether they are on the same level, whether or not communication is an umbrella term, and whether collaboration and coordination are sub-concepts*" (IP2-114).

According to IP1, it should be clarified how far *collaboration* should also be seen to include the sending and receiving of documents, and to what extent these use categories should be distinguished from *knowledge sharing* (IP1-174-176). IP6

saw idea generation as part of *collaboration* (IP6-54-56). Outside of these questions, *collaboration* was confirmed as a use category by all interviewees.

The concrete function of knowledge management was described here as follows: "*It should also be possible through social software to work on a document simultaneously and so to speak create knowledge through interaction*" (IP3-66). Mobile applications were emphasized as a special aspect of this: "*What is especially important is that many of these software solutions are also available on mobile devices. That is, the user is not necessarily sitting in front of a laptop, but has the opportunity,* via *iPhones or Android phones, to participate, to work on solutions and to do some work on documents simultaneously*" (IP3-18).

5.5.1.5 Summary

As valuable as the comments of the interviewees were, it is difficult to construct a way to integrate them fully into a universal and, at the same time, concise definition. The definitions which were ultimately derived thus do not include all aspects of the opinions of the interviewees, and necessarily represent a simplification of these complex issues (cf. Fig. 5.4).

5.5.2 Application Categories

For the application categories, we first examined which internal applications were available in each consultancy. This approach follows a suggestion of IP2, who argued for separating individual adoptions from the question of which applications were available (IP2-144).

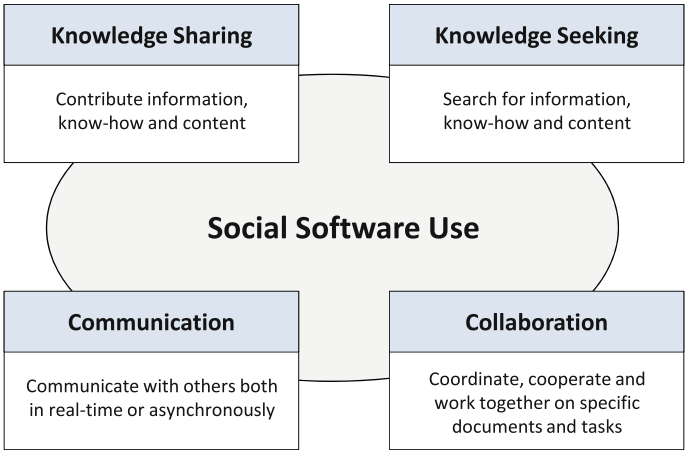

Fig. 5.4 Use categories after consolidation

Table 5.11 shows that six of the nine social software categories were available as internal applications in most of the consultancies. These included social networking sites, instant messengers and document exchanges (each identified in seven interviews as available), as well as blogs, wikis and forums (each identified in six interviews as available).

Internal organizational podcasts and microblogs were reported by only four and three interviewees respectively, while social decision tools—a category discussed by IP1 as a tool for scheduling, such as Doodle (www.doodle.com)—were not available internally at any of the consultancies, and moreover were not considered by many interviewees as a separate category: "*I find it hard to give [social decision tools] their own category*" (IP6-52) or "*I've also not seen voting platforms*" (IP2-130). Moreover, external social decision tools were only used by two interviewees, and even then more in private than for professional purposes (IP3-46): "*We actually haven't used [social decision tools], I have to be honest*" (IP4-110).

Where document exchanges and social networking sites were internally available, these were actively used by the interviewees (see Table 5.7). Furthermore, the adoption of internal instant messaging tools and forums was relatively high. Microblogs, however, were rarely used for professional purposes: "*Most of my acquaintances don't use things like […] microblogs*" (IP2-134); "*I have a Twitter account […] but I've never actually used it*" (IP8-82-84). IP4 confirmed this: "*We don't use Twitter-like sites or even blogs at all*" (IP4-88).

Wikis, too, though available as an internal application according to most interviewees, were rarely used, and when they were, they were consumed rather passively: "*In principle, wikis are used most heavily by broadcasters and content providers such as newsletter authors, for example*" (IP6-44); "*[…] We have more and more wikis, and I think we even have an external one, but I don't use them*" (IP7-50-54); "*I know we have internal wikis, but I myself honestly use them very rarely*" (IP3-38).

The case is similar for blogs and podcasts, which are used exclusively for consumption. Only IP6 himself writes a blog (IP6-26). The important point here,

Table 5.11 Availability and use of applications

Internal application	IP1	IP2	IP3	IP4	IP5	IP6	IP7	IP8
Blog	✓	✓	✓	✘	✓	☑	✓	
Document exchange	☑	☑	☑	☑	☑	☑	☑	✘
Forum	☑	✘	☑	✘	✓	☑	☑	☑
Instant messenger	☑	✓	☑	☑	✘	☑	☑	☑
Microblog		✘	☑	✘	✘	☑	✓	
Podcast		✘	✓	✓	✓			✓
Social decision tools		✘	✘	✘	✘	✘		
SNS	☑	☑	☑	☑	✘	☑	☑	☑
Wiki	☑	☑	✓	☑		✓	✓	

☑ Application deployed and used; ✓ Application deployed but not used
✘ Application not deployed; *blank* not mentioned in interview

however, is that the function of blogs and podcasts for internal communication by upper management is: "*[…] so that firstly our CEO […] can record video messages in his office and then send them to all employees […]*" (IP4-96); "*Actually, one of the leadership team members of our business unit writes in a weekly blog*" (IP7-34); "*[…] the leaders at our company do that more and more often, writing a blog entry*" (IP3-22); "*[…] it is partially applied in the context of this blog. So the CEO has already uploaded videos a couple of times*" (IP5-68).

According to IP1, an important area regarding the use of Internet-based applications for professional purposes lies in interactions with customers (IP1-50). IP7 also explicitly mentioned that she would like to keep in contact not only with colleagues, but also with customers through social software (IP7-4): "*Dropbox for example is there to share […] with customers as well as with colleagues larger amounts of data that can be somewhat difficult to share by email*" (IP1-36).

The above analysis of the availability and use of different applications also shows that there are some application categories that were either rarely available internally, or were not used by the experts for professional purposes, as was the case with microblogs, social decision tools and podcasts. Particularly where microblogs are concerned, this finding contradicts earlier studies, since microblogs were assumed to have great potential (cf. [55, 63]).

It is also clear that in some consultancies, *social software suites* have been implemented on *social intranets* that span several different application categories. This was stated by IP1 with regards to an internal portal based on Microsoft SharePoint, which serves as a *wiki*, community (with newsfeed function) and as a *document exchange*. This could be used as a "*community of practice*" for newsgroups and announcement pages (IP1-44). According to IP3, Microsoft SharePoint is used like a *social networking site* (IP3-18). In addition, one can post questions such that SharePoint behaves like a forum (IP3-44). Moreover, the internal SNS serves as a *blog*, document folder and knowledge management system (IP1-28-30). Some interviewees also discussed specific social software suites. IP3, for example, named Jive and Salesforce Chatter as social software platforms (IP3-26, 58), while IP4 explicitly named databases used for knowledge storage (and thus also for sharing and searching for knowledge). These knowledge bases and knowledge management systems are comparable with wikis (IP4-16). IP5 also pointed out that there was an internal knowledge management system at his consultancy that stored personal data, and which was used intensively (IP5-12, IP5-34, IP5-42).

A detailed analysis of the coding with respect to applications indicates a growing integration of different types of applications into more complex, comprehensive social software suites. Regardless of this trend, definitions for each of the six application categories can be derived on the basis of the expert interviews. In particular, the definition of *instant messengers* was made more comprehensive than originally intended on the basis of the interviewees' comments. IP1 considered online Web-sharing and telephone conferencing as a part of *instant messaging* (IP1-20-22), while IP3 identified screen-sharing as a feature of the Lync instant messenger (IP3-18). IP6 also mentioned instant messengers in connection with screen-sharing (IP6-18). The suggestion to integrate news feed(s) into an existing

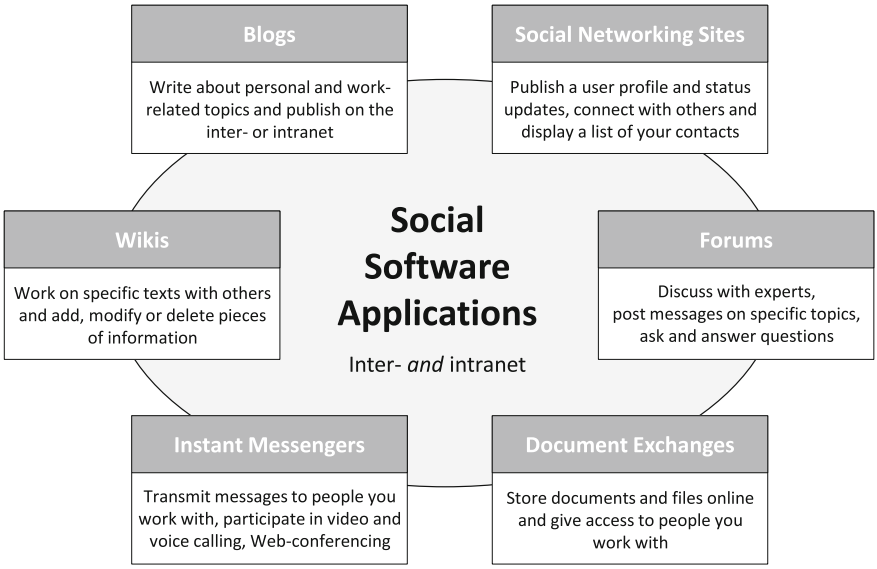

Fig. 5.5 Application categories

category, e.g. into *social networking sites* or *forums*, as argued by IP5 and IP6, was not acted upon for reasons of comprehensibility (IP5-72-78, IP6-18). Figure 5.5 shows the final application categories and their definitions.

5.6 Conclusion and Outlook

Within the context of the present study, the adoption of social software in the management consulting industry was explored. Focusing on the question of how social software is used for knowledge management, qualitative expert interviews were conducted. By means of a deductive–inductive approach, our study provided a comprehensive overview of the fragmented landscape of social software research in the area of knowledge management (Sect. 5.3). By integrating existing findings (Table 5.7), we proposed a system of use categories (Table 5.8). This system was in turn validated through a qualitative interview study, leading to the merger of two categories, namely collaboration and coordination, and to the affirmation of the other three categories. Our system of professional social software use thus contains four categories: knowledge sharing, knowledge seeking, communication and collaboration.

Subsequently, various social software applications were analyzed to determine whether certain applications were deployed and available within consultancies, and whether these applications had been adopted at an individual level. Our expert interviews revealed that blogs, wikis, instant messengers, document exchanges,

forums and SNS were most frequently applied for knowledge management purposes.

Stakeholders of our research include scholars and practitioners. Although we pursued our research with end-users of social software in an organizational context, they do not represent the major stakeholder group for our results. In fact, organizations in knowledge-intensive industries—as well as suppliers and developers of social applications—will benefit most from our findings. For example, our results allow to focus on one or several of the specific use categories and thus incorporate specific requirements that can be already implemented in their development processes. This in turn allows the provision of much more targeted social software solutions according to knowledge management specifications. Additionally, understanding potential redundancies across the use categories can help design more effective social software suites. Moreover, management consultancies can benefit by deploying our framework to analyze the current strengths and weaknesses of an existing social software suite, and to develop a targeted social software strategy.

The results of our study, however, should be considered with regard to some limitations. First, as our research focuses on a specific sector—namely, management consultancy—the results might differ for other sectors. Industries with less knowledge-intensive operations might benefit differently from the deployment of social software in their work routines. Additionally, the experts with whom we conducted our qualitative interviews were consultants working at large international consultancies; their larger workforces and office distances might favor the adoption of social software for knowledge management. Furthermore, as the interviews took place with German participants, potential cultural differences in the adoption of social software have not been considered for this study.

Based on these limitations, future research should aim at expanding our current findings to various industries, as well as to small and medium-sized companies. Moreover, a cross-cultural study could reveal cultural influences on the use of social software for knowledge management. Our study concludes with the deduction of social software use categories and the current state of social software adoption. Subsequent quantitative studies should aim at connecting these results by addressing the question of which applications are used for which kinds of use. Furthermore, antecedents of social software use for knowledge management should be further explored.

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Chapter 6
Social Media Within German Companies—An Interview-Based Analysis

Kathrin Kirchner and Daniel Stegmann

Abstract Social media like social networks, blogs or wikis provide new possibilities for knowledge sharing in companies. In several studies the usage of social media in companies is already discussed, but it is concentrated on knowledge exchanges with customers and business partners or on quantitative analysis. Instead, in our chapter we employ qualitative analysis to investigate how social media is used for internal knowledge sharing in companies, especially in Germany. The study found that social media is used intensively if employees can benefit from the provided content. Although an open corporate culture and management support can facilitate a wider usage of social media, having a benefit is the main driver for knowledge sharing via social media, regardless of industry, company size, employees' age, or incentives given to employees.

Keywords Social media · Internal knowledge sharing · Qualitative interview

6.1 Introduction

In recent years, social media (e.g., social networks, blogs or wikis) changed the way of managing, sharing and presenting knowledge, boosting business communication and collaboration. In this context, the term Enterprise 2.0 was coined by McAfee [28] which refers to the use of social media to improve knowledge sharing and collaboration between companies, employees, customers and business partners. Several studies already discuss the usage of social media in companies. According to a report conducted by McKinsey [4] based on the answers of 4200 global executives, 72 % of these companies use social media. In accordance to our

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knowledge, only a small number of companies use social media for internal purposes [21]. While most studies concentrate on external communication and collaboration with business partners and customers only, some case studies focus on companies that use social media for internal knowledge sharing (e.g., Čudanov and Kirchner [9]; Razmerita and Kirchner [41]) as well as networking and communication within their own company.

Therefore, in this chapter, we focus on the internal usage of social media in companies. Our research comprises a literature review and a qualitative interview study. Based on our literature review, we developed an interview guideline and conducted qualitative semi-structured interviews in 10 German companies of different sizes and industries. The interviews aimed at reflecting the usage as well as benefits and challenges for the company-internal usage of social media. We questioned whether social media arrived in companies and achieved a relevant influence on internal knowledge sharing. The results of the interviews are analyzed using qualitative content analysis and are compared with other research.

6.2 Methodology

Our methodological approach is three-fold: we use a literature review, semi-structured qualitative interviews and a comparative analysis. First, we did an in-depth literature review about social media and its usage in companies. From the literature, we derived an interview guideline for questioning experts in German companies. The guideline contained 20 open questions covering the following topics:

1. What is the influence of social media on internal knowledge sharing in a company?
2. How do the employees participate in social media knowledge sharing? How do they accept social media?
3. What is the motivation of employees to use social media within the company?

For the interviews, German companies were selected. We contacted more than 70 local companies as well as companies that were mentioned in the social media case studies that we found in our literature review. From the feedback of the companies to our emails, we found that some of the companies do not use social media at all, use social media only for external communication purposes or had no time for an interview. At the end, we could include 10 companies from different sizes and industries in our study. From every company, we selected an expert for the interview who was involved in the usage or introduction of social media in that company.

We used a semi-structured interviewing approach which is the most widely used method of data collection in qualitative research [53]. The advantage is that the open nature of questions leads to a further discussion with the interviewees. We conducted the interviews according to our developed interview guideline. Local companies gave a personal interview; with other companies a telephone interview was undertaken. Every interview lasted around 1 h.

After the interviews, we transcribed the content. We evaluated the results for every question within the three topics by using a qualitative content analysis [27]. This allows a systematic examination of our collected interview material. Finally, we compared our findings with other results from literature.

6.3 Related Work

Web 2.0 was popularized by O'Reilly [37] and defines the web as a public space, where users may interact and collaborate as creators of user-generated content. Social media can be defined as "…a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of user generated content" [18]. Instead of using personal static web sites, static encyclopedias or content management systems, blogs or wiki systems are used. Social media has nowadays been adopted in organizations to support both the personal and collective process of managing knowledge [42]. Table 6.1 provides a short overview of social media that are often used.

Table 6.1 Overview of social media

Tool	Definition	Purpose
Blog	Organized in a form of personal diary, other users can comment [18]	To inform others about own activities, to publish own opinion (Razmerita et al. 40)
Microblog	Blog with short messages less than 200 characters [19]	Short updates about activities of a user, spread news, create attention [48]
Wiki	Websites that allow users to add, change and delete content [18]	Documentation of work, support of projects and team work, hierarchical structuring of information [48]
Social networking sites	Connect with other users by personal profiles, inviting others to have access to this profile and exchange messages [18]	Management of relationships, identity management, informal learning (Razmerita et al. 40)
Forum/discussion board	Online discussion site where users can have conversations in the form of posted messages [33]	Exchange an collect ideas, opinions, experiences in an asynchronous way [55]
Social bookmarking	Bookmark interesting web sites and exchange with others [29]	Enables users to add, annotate, edit, and share bookmarks of web documents [36]
RSS-feed	Standard web feed forward to publish and spread frequently updated information	User can subscribe to categories and get updated information via push method; is rather a technique than social media, but allows to spread information originally published in social media, e.g., in blogs [24]

6.3.1 *Influence of Social Media on Knowledge Sharing*

Companies are undergoing a permanent change because of an economy shift from industrial age to knowledge era. Therefore, in recent years, the systematic management of knowledge has become more and more important in companies. Many companies have already implemented social media like blogs, wikis or social networks. They bring a new wave for knowledge management [24].

Several case studies as well as empirical research already show that the usage of social media can have a positive impact on knowledge management in a company. A study reported by Bughin et al. [4] found among 4200 global executives that 74 % of interviewees think that they have a quicker access to knowledge. New, cost-effective and small tools can bring back knowledge management where traditional and big knowledge management systems fail [46]. People, who are on the same organizational level, can learn quicker from one another than from a higher level person, because they have a common context [25].

Stocker et al. [49] discuss that blogs can help to document working steps, so that knowledge management is fostered. Blogs can be better integrated in daily working routines than traditional knowledge management systems [12].

Although social media is considered useful for knowledge management, not every tool can be used for every purpose. Figure 6.1 shows the usage of various social tools for several purposes.

Organizations have to be careful because success is not coming through adaptation of tools alone. A central guidance is necessary, and a critical mass of users is needed [24].

Capability	Social Software Tools									
	Microblog	Discussion Board	Wiki	Idea Voting Platform	Blog	Social Network	Prediction Market	Social Bookmark	Podcast	RSS
Total	H	H/M	M	M	M	M/L	M/L	M/L	L	L
Identify expertise	H	H/M	M	M	H/M	H	M/L	M	M	N/A
Facilitate cross-boundary communication & conversation	H	H/M	M	M/L	M/L	M/L	L	M/L	L	L
Preserve institutional memory	H/M	H	H	M	M	L	L	L	L	N/A
Harness distributed knowledge	H/M	H/M	M	H	L	N/A	H	N/A	N/A	N/A
Discover emerging opportunities	M/L	L	L	L	L	L	L	L	N/A	N/A

Relevance Legend

H High H/M High / Medium M Medium M/L Medium / Low L Low N/A Not Applicable

Fig. 6.1 Capabilities of various social media tools [30]

6.3.2 Employees' Acceptance and Participation

With the introduction of new social media tools, new working processes are created. Thus, employees need to get used to these new processes. Cervellieri et al. [7] found in a case study that employees rejected the introduced wiki and continued preferring the use of office-documents because of their long-standing habits. But after a certain period of time, by seeing advantages and benefits, the acceptance rate increased.

Bukvova and Kalb [6] identified reasons why employees rejected social media tools. They do not want to publish because they fear to be misjudged and to be responsible for mistakes. Therefore, employees only want to publish final results. As a solution, which is contrary to the openness of social media, the access can be limited to certain people.

Levy [24] argues especially in relation to knowledge management in SMEs, that usually 20 % of the users, which can be seen as content experts in a specific threat, are responsible for 80 % of the shared knowledge. But precisely the remaining 80 % of the less active individuals, which can be referred as "long tail", should not be ignored because they are a big group.

According to Nielsen's [34] 90-9-1 rule, user participation in large communities and online social networks is not distributed equally. 90 % of users are only observers who only read or observe, but do not create any posts. They are free riders. 9 % of the users provide content from time to time and only 1 % are heavy contributors. These users are the most active in the community and are 90 % responsible for most of the published articles. E.g., with the American online retailer Amazon, 67,113 user-reviews of books can be traced back to only a few top 100 reviewers, alone 13.5 % (12,423) of them originate from the most active author.

A lot of case studies show that a certain critical mass of users has to be generated so that employees participate and benefit from the system. Social media systems should be pre-filled with information from legacy systems and employee profiles from the existing systems. This way, barriers are kept as low as possible by keeping it comparable to editing in Word or writing an e-mail. Miller et al. [30] describe the adoption of social media in 3 phases. First, users will check the system for usability, reliability and use, with the prerequisites that few barriers exist. In the second phase the use is increased because more content is available, which in turn motivates others. In the third phase learning and performance effects are achieved by better networking and by achieving the critical mass.

Case studies provided by Koch and Thönnißen [23] point out that participation in social media is higher than in traditional intranet. Steinhüser and Gerz [47] found that employees, who do not participate in meetings, are more active in social media systems. Mörl et al. [31] argue for Siemens TechnoWeb that it is enough if 10 % of all users care about the maintenance of the network, create 20 % of posts, comment and participate in certain communities, so that the remaining 70 % of users can have a profit from that.

6.3.3 Employees' Motivation to Share Knowledge

Individuals are not always willing to share all forms of knowledge [8]. Knowledge can be seen as a private good, which is normally influenced by market mechanisms or is micro-politically determined. Individuals exchange knowledge, e.g., because they get an incentive as employee for good performance.

Majchrzak et al. [26] distinguish between two user groups with different motivation factors in companies. On the one hand, "synthesizer" are primarily interested in their own reputation. On the other hand, "adders" are more interested to complete content and are less interested in their own reputation.

Wasko and Faraj [52] argue that according to the agency theory [17] no incentives for contributing to social media exist due to the self-interest of individuals to maximize their own benefits. Participation would thus become irrational because of the participation fees incurred without compensation. Arguments against this statement are altruistic, moral and pro-social behavior. Other arguments are the intrinsic desire to increase the welfare of third parties by own publications, or the hazards arising from the individual desire to share content [28]. The overall organizational knowledge depends on the willingness of individuals to share. Ryan and Deci [45] identified four types of motivation:

1. *Intrinsic motivation*: Individuals participate because of self-satisfaction.
2. *Identified regulation*: The activity is beneficial in the long term and under some circumstances connected with subsidization. But users have the choice whether they want to participate.
3. *External regulation*: Individuals are rewarded or paid for participation.
4. *Amotivation*: Human behavior cannot be described as fully extrinsically or intrinsically. People act intuitively without intention, controlled by emotions.

As the involvement in social media is usually based on a voluntary basis the points (1), (2) and (4) are of special interest. Wasko and Faraj [52] already discussed that the intrinsic motivators for participation can be found in several points. One factor for motivation can be a reward, e.g. the access to current information or experts who are available in the community, or to obtain rapid and specific assistance. Other employees are motivated by self-satisfaction and the desire to maintain their own content fresh, to learn about their own activities based on "fun" at the stake. Participation can also be motivated by a personal interest, to improve own learning, to share with others, or as a manifestation of own expertise as mentor, as well as competing for a certain status with others. A rich interaction with a community can be reached, where different opinions, perspectives, or problem solutions can be discussed. A strong motivation can also be seen in an altruistic desire to help others [35]. Social media can be used for locally distributed collaborations with colleagues who are otherwise unattainable and for a faster integration into the work by providing access to new knowledge.

On the other hand, barriers and reasons for non-participation are numerous [52]. As they point out, employees might not want to help others with a lack of

knowledge to solve their "homework". In case too many inquiries from others arise, because answers were not accurate enough due to the limited time budget or working time, participants can be demotivated easily. Others have fears that they cannot provide adequate help to others due to a lack of knowledge. Additionally, published content is not considered relevant enough or important enough for others to be published in a company wide network. It might not be clear whether content has to be shared or sharing is accepted in the company, or employees do not know what is allowed to upload. Employees do not like to ask questions which might be already answered.

Companies can be in a security and confidentiality dilemma, therefore information sharing about closed networks such as telephone or e-mail is preferred, or information is not exchanged at all (for example, if confidential shared content is visible for managers). If knowledge transfer is done in face-to-face groups, people do not like to participate in online platforms, because redundancies for employees who are long in the company can arise.

In case the employees who write content are not the ones who benefit from it, they lose their interest in participating in online platforms. Also cultural inhibitions might play a role as a barrier: Especially in wikis, people do not want to edit contributions of a third party. Furthermore they lose control and responsibility of own contributions. If several people contribute, decision making in large groups is a tricky task [11].

Employees might be reserved in sharing incomplete content, but they are more open to share if only a few others are reading. This problem especially arises in the continuous changing process in wikis. Furthermore, people might not be motivated to learn new tools [15].

Another source to motivate participation is the extrinsic incentive compensation [13]. Nielsen [34] points out that motivation can be increased especially by a reward function as well as by highlighting most active users visible for all others. It can be presumed that employees have to be motivated permanently to participate [32, 56]. This is also supported by King and Marks [20]: The agency problem, as well as the frequency of the posts in knowledge management systems, can be positively influenced by the use of supervision and control. Osterloh and Frey [39] argue that intrinsic factors stronger affect knowledge sharing than extrinsic factors, which is especially important for the exchange of tacit knowledge that is in the head of employees [25].

Mannsperger [25] found that an important determinant is the confidence in the system. Employees will only share knowledge if they also get something back in return. Transparent culture, the behavior in the organization, as well as overcoming language and cultural differences can be seen as prerequisite [3]. DiMicco et al. [10] argue that employees will only share content if they gain personal advantage. They identify three factors why employees are motivated to use the system in their daily work:

1. *Caring*: The desire of the individual to connect with others on a personal level, especially with colleagues they do not know or do not work together; According to DiMicco et al. [10], networking is the main reason of motivation.

2. *Climbing*: The use of tools to enhance the career of the employee through the promotion of her/his own personality and strategic networking in certain communities of practice. For example, by commenting posts of the manager or supervisor with the objective to make itself known, or the development of future useful contacts.
3. *Campaigning*: The use of tools to attract support for projects or ideas by users on its own project pages which can be seen by the management. Also the collection of feedback from other staff as support for projects is possible.

Some employees are motivated by all these three factors. These points can be seen as a professional difference to the private use of social media.

6.4 Interview Results

According to the study of Bughin (2011), the adoption of social media in a company does not depend on the type of industry, although the highest adoption rate can be found in high tech industry. Therefore, we conducted interviews with 10 German companies of different sizes and branches regarding their usage of social media. We only selected companies that already use social media for internal purposes. The interviewed persons either used, developed or introduced social media in their company, or have background information about usage patterns, success and challenges of these systems. The information we gathered was anonymized. An overview about the questioned companies is given in Table 6.2.

In the following, we report about some special results from the interviews that we found interesting. In Sect. 6.5, we will generalize our findings and compare them with our literature review results.

Company 1 is an international company with headquarter in Germany. In 2005, the company developed their own social media platform as well as an internal wiki system. The aim was to make communication more transparent, and reach a better information quality. 80 % of employees consider social media as useful for their work. Employees share project experiences and best practices that can be reused in new projects. This way, time and cost could be saved, and new customers could be found. The management encourages the system usage, but still, employees can freely decide whether they want to use it.

More than 50 % of users in company 1 only read content, but do not contribute. Employees "*need to be motivated to make own contributions*". Every member of the internal social media system has an own member site where contact data can be found. All contributions of this employee are connected with his contact information, so that she or he can be visible as an expert. During the start-up phase of the system competitions took place. Thus, the most active authors were able to win prizes and a certificate signed directly by the respective supervisor. The most active users are also visible in the software system and published in staff magazines. During the competitions, the average number of contributions was increased.

Table 6.2 Overview about interviewed companies

No.	Industry	No. of employees	Position of contact person in company	Used social media tools
1	Automation, Energy, Building technologies	42,000	Senior Manager Knowledge Management	Own developed system comprises: Social Network, Discussion Board, Microblog, RSS, Database for knowledge management; separate company wiki
2	ICT (consulting service provider)	1039	Head of Knowledge and Application Management	SharePoint, Blog, Wiki, Instant Messenger, Microblog
3	Mobility and logistics service provider	295,000	PR & Internal Communications	Wiki, Blog
4	ICT	3000	Internal Communications	Wiki, Blog, Discussion Board, Instant Messenger
5	Automotive industry	270,000	Coordination of Knowledge Management	Wiki, Instant Messenger
6	Automotive industry	300,000	Internal Communications	Wiki, Blog, Discussion Board, Social Network, SharePoint, own Enterprise 2.0 Platform
7	ICT and media	100	Consultant	Wiki, Blog, Social Bookmarking, SharePoint
8	E-Commerce	480	Business Development	Blog, Microblog, Wiki, Skype, Newsgroup
9	IT	4	Managing Director	Social Network
10	Management Consulting & Teaching	13	Managing Director	Wikis, Blog, RSS, Microblogs, File Management System, Instant Messenger, Social Network

Motivation was also increased by the use of a "community manager". Permanent incentives for sporadic users by newsletters, reminder trigger, RSS feeds and personal prompts were given.

In company 2, the top manager requested blogs and video posts for the internal company's communication. Employees are not forced (but encouraged) to use social media. Everyone is self-responsible for his posts, and the quality of contributions is not checked. 50 % of employees are using social media, but 60 % of them only read and do not write. Usually, the media that is available inside the company is used for communication. But two years ago, "*...a yammer group among employees was established, because no similar tool was available inside company. The IT department has therefore to react quickly*".

In company 3, which is a rather huge company, social media is not used company-wide, because this would be connected with high cost for the

introduction. Furthermore, a new department would be necessary that only deals with the social media management. Therefore, social media is only used within projects, especially if different departments are involved. The quality of information in these systems is high, "*...because only a small number of employees are involved. In case every employee would use social media, a huge amount of information with different quality would be collected and important information would be tricky to find*". Furthermore, only one third of all employees have a computer available at their working place, so they could not use social media. A lot of elder employees are working in the company who have little experiences with internet. Therefore, internal journals or newsletters are used to spread information.

Company 4 has used social media since 2011. Especially blogs are used intensively. The blog of the management board where management writes about experiences, meetings or current company's topics is read 1200 times a day. Besides, every employee can run his/her own blog. Usually, employees are responsible for content, but the communication department has the right to delete entries. Not all employees read the content that is provided in the social media tools, and only 17 % have a login to write something. The reason is that employees have no time, consider the registration for a login as complicated and complain about the many isolated social media applications.

A self-made wiki system and a forum are used in company 5 in two different departments. The contribution to the systems is encouraged by the management. A team of experts has regular meetings to check the content and assures high quality and currency of the content.

Formation of communities, expert search, knowledge sharing and communication are supported by social media in company 6. Employees use the systems in case they have a concrete benefit from it. This depends on the discussed topic. Due to data security regulations in the company, collected knowledge has to be deleted automatically after a certain amount of time. This is done for knowledge collected in wikis, but also opinions from employees or blog entries. The advantage is that outdated knowledge is deleted. Especially in the technological development, a lot of changes occur over time. So a deletion is necessary because employees would otherwise read outdated knowledge.

Company 7 uses social media e.g. for working together. But employees are not motivated enough to use the systems, because they do not get enough support by the management. Furthermore, the usage of social media is not embedded in business processes.

From the start of the company, newsgroups were established to collect knowledge in company 8. Now, additionally, a central blog as well as department-specific blogs and wikis are used. The discussed topics are company-specific, but additionally, a private marketplace exists, where employees can sell, e.g., their bicycle. Elder employees or employees, who have worked for the company before social media was introduced, still prefer using newsgroups instead of blogs. Therefore, the same information can be found in newsgroups as well as in social media.

Company 9 is very small, but works heavily together with other small companies on projects. They use a closed Facebook group together with employees from other

small companies with which they work together. It is used for knowledge sharing, team building and finding experts. The problem is to organize the knowledge in the Facebook group, so learning from the collected knowledge is difficult.

Although company 10 is also very small, employees are often not present in the office because they are busy in consulting projects all over the world. Therefore they use an internal twitter service on their smartphones to stay in contact instead of being in face-to-face contact. Furthermore, blogs and wikis are used to collect knowledge. E.g., the employee responsible for finance collected knowledge about financial regulations (business trips, customer contracts). This way, consultants that are not in-house can read that whenever they want and do not need to call for asking questions.

6.5 Discussion

In this section, we generalize our findings from our qualitative interviews with German companies and compare them with the findings obtained by other researchers. We especially focus on the influence that social media use has on internal knowledge sharing and on the motivation of employees to participate and share knowledge.

6.5.1 Influence of Social Media on Internal Knowledge Sharing

Our interviewed companies all introduced social media due to several reasons. Frequent usage reasons were better collaboration and communication (10/10), better project management (10/10), improved knowledge management (9/10) and improved productivity (9/10). Furthermore, the search for experts and a simplified communication between departments regardless of hierarchical boundaries were named.

Only company 9 reported that knowledge management was not improved by social media. The reason was that they only use a Facebook group that does not provide a search for knowledge and therefore makes it difficult to manage knowledge efficiently. In all other cases, company members could better collaborate, especially in spatially distributed companies. Four companies reported that they have less information overload compared with traditional email communication. One company argued that social media is only used in parallel to traditional knowledge management tools, and an improvement of knowledge management is therefore difficult to define.

Compared to the literature, we arrived at the same results with our interviews. Knowledge management can be improved by using social media. Sometimes, the

usage of tools has to be adapted to the company-specific regulations. So companies use social media partially with restricted access to employees in projects, or outdated knowledge is deleted regularly. In order to be used successfully in companies, social media need to be accepted and adopted by employees who use the systems.

6.5.2 *Employees' Acceptance and Participation*

Nine of the interviewed companies said that generally social media is accepted by the employees. A fundamental ambition of the staff to use the systems exists although these systems are not actively used by all. Several employees read only passively or are "*active listeners*".

90-9-1 rule of participation. Four respondents in our interviews explicitly stated that the described 90-9-1 rule [34] applies approximately across different departments and "*the usual suspects*" exist. Only some employees create content. Reported problems in the literature were, that there is no deep integration into business processes and older employees do not use the systems. However, there is an exception in our own survey, where all employees use the systems. This is due to the need to use the tools for daily work as an integral part of cooperation in the corporate culture. This results in a nearly full participation which makes the rule inapplicable.

Compared to the literature, our results can be approved with minor deviations [6, 31]. In a case study of a large company for internal use of Yammer it was determined that 10 % of users are responsible for 80 % of content, and even 25 % of the posts remain unanswered [43].

Social media in small companies. During our interviews we found that user involvement can also be successful in small businesses or in smaller project groups if the systems are everyday required or necessary, or if these tools offer sufficient, benefit-creating information for the employees. This also corresponds with a previous case study [41]. Zeiller [56] argues that the higher the amount of actual content is, the more frequently employees will access the systems, and the more users are willing to share their own content. Another possible reason can be seen in the dwindling anonymity in small communities, where employees can only difficultly escape from usage. Both our interviewed SMEs said that users are actively involved. Similar results based on the size of the company or the number of employees can be found in literature. There is a tendency that particularly large companies with many employees are affected by the lack of acceptance [6, 12, 31, 44] and smaller companies are effected less [7, 23, 50, 56, 57]. This was also found in our interviews with companies 3 and 5 in relation to the use of the tools in single departments or in projects.

Participation and age. In order to examine why employees only partly accept social media, we previously identified reasons. Derived from the fact that younger people primarily use social media tools (e.g., [16]), we could also find that those who write posts in the systems are rather young. It can therefore be assumed that the

use of the tools depends on the age. In our own survey we also stated that a fundamental purpose of the tool usage is the luring effect for young candidates. The opinions about this issue in our cases are different, 5 companies stated that the age has no effect, 4 have a neutral attitude, and one firm confirmed that employees with a higher age do not accept social media but prefer traditional systems. In one of the questioned companies the medium age of employees is high. These elder employees do not use the systems, which is also due to the fact that not every one of them uses computers at the working place. For the other interviewed companies, the age structure is mixed between 18 and 60. They argue that the use of social media "*is not significantly dependent on age*" and depends more on the specific personality of the employee. One interviewee said that the most active participant is the eldest one; another interviewee even said that "*many older people are right at the forefront*".

Furthermore, there are different social media tools preferred by employees of different ages. Younger employees are more likely to be found on blogs or micro-blogs, older employees are rather to be found in systems, which have long existed like familiar newsgroups for communication. Basically it can be stated that it tends to be that the usage of the tools is not significantly dependent on the age.

Usage of external tools. Another potential factor is that the rejection of the systems is due to the fact that employees do not use the internal systems but prefer to use external platforms. This might be caused by the fact that contributions in external platforms are more anonymous than in internal platforms and are not supervised by managers. The majority of our respondents negate this question for the reason that access to external services which are outside the firm's firewall or the secure area of the company is either not permitted or blocked, or is not possible because of data protection. One company reported about the establishment of an external Yammer group because of the lack of internal systems in the company. Thus, if all the required services are internally available, then no incentive for external engagement exists. The IT department has to, as well as DiMicco et al. [10] note, react quickly. If no equivalent is given internally, employees will try to find a needed service in the well privately known environment. "*Consequently, confidential and secure content will be outside the firewall*." Another expert has stated in the interview that external platforms are used (and cannot be prohibited) for "*general social media-related topics*", while the internal systems are used for business-related matters only.

Private use of social media. We asked whether employees use the systems too much for personal use. 90 % of the respondents believe that this is not the case, since some tools or information may be used "*solely for business purposes and have no personal reference*". For this reason it "*can be assumed that employees act responsibly and use the systems for work purposes*". Furthermore, it is stated that in the present time, "*the area between private and professional life is flowing*". In two of the surveyed companies, a separate area for employees is offered, where employees can implement private matters. An emerging issue is, whether the employee should ever settle personal matters during working hours. Wu et al. [54] argue that differences in personal and business use are observed due to the

professional context, which is based not only on "stay in touch" but rather includes a professional identity in the working environment.

Content quality. Another question is whether employees do not use the systems because the quality of the provided content is low. Therefore no benefit for individuals might be derived from the systems. It can be argued on the one hand that the quality can be controlled via an internal control committee. On the other hand, it can be stated that due to the personal registration in the company's systems by using real names always meaningful answers are given. These answers are mostly given at a very high technical and high level of quality "*because nobody wants to embarrass*". One respondent said that "*employees entering contents perform sometimes more or less sloppy*" and the quality depends on the person who entered the content. In other companies the tools such as wikis are currently used only in small-scale departmental or project level, so that the quality can be evaluated. The interviewed expert believed that the more people use the system, the more the quality would be reduced, and thus the quality will be higher when only a few users contribute. However, this assumption could not be substantiated by further own or external case studies.

Our findings in the literature show that there must be timeliness and content in appropriate quality, so that employees are motivated to use the system and benefit from it. This way, a positive correlation between high quality and frequency of terms is observed [24, 56]. Stobbe [48] explains that the quality of content in wikis or blogs might go down if there are too few users in the system. It is therefore counterproductive for the motivation to participate in social media, if the content is not updated frequently enough by the users, or if insufficient content is available.

In conclusion it can be said that it will be difficult to overcome the unbalanced distribution of readers and writers according to the 90-9-1 rule. But even if there are only few participants involved, the system has to provide a value. The problem occurs that individual knowledge of non-participants is not considered. A way out of this dilemma is making it easier for the users to share specific content, e.g. by providing an evaluation function to vote for good contributions. Hill et al. [14] introduced that the "read wear" effect can be used, which states that reading or using a tool leaves some signs of wear, which are similar to those resulting from reading or scrolling through a book. Hence an automatic rating can be derived. It is also suggested to create and edit content only in pre-defined templates. Thus, the barriers for creating completely new content are kept as low as possible [1].

6.5.3 Employees' Motivation to Share Knowledge

Additionally to the participation of employees, we surveyed what is their motivation to participate and share knowledge with others. One interviewee argued, that with social media tools, the people are in the focus and "*this is how it should be*". Our interviews showed that the usage of social media in a company can lead to a better performance of employees in dealing with customers and by providing them

with ad hoc information from other employees. Furthermore, a better allocation of projects to employees is possible. Based on our survey, no clear statement can be derived from our interviewed companies, because it is difficult to evaluate whether employees can realize personal benefits by using social media, although there is a positive trend (also found by DiMicco et al. [10]). Ardichvili et al. [2] argue on an economical basis that knowledge management systems can obtain similar information as other sources may include, but the possibility to access them is much faster and thus the efficiency of the employee can be increased.

Due to the fact that up to 90 % of employees are less motivated to contribute and mostly read only content, the level of involvement is below average. Nevertheless, it can be derived from most of the obtained responses that employees are willing to participate. Eight of the respondents indicate that employees are motivated to contribute (as also discussed in Miller et al. [30], McAffee [28, 47, 51]) while 2 companies provided a neutral response. Reasons for insufficient motivation were that many employees are intrinsically motivated according to their individual personality. Others probably put nothing in the systems because they are not familiar with the systems without any relation to motivation aspects. It can therefore be assumed that there will be a learning effect over time and even creating posts "*and noting that it is not so bad*" contributes to knowledge sharing. Another interviewee pointed out that participation is still highly dependent on the content discussed in the systems. Therefore certain persons or departments with appropriate knowledge, regardless of the technology, become more active. Furthermore, it can be said that the motivation of the employees should be intrinsically so that individuals benefit from the good quality of contributions. Thus, motivation results as a "*filled with life*" value. Other intrinsic factors, which are discussed in the literature, are: helping colleagues, experiencing fun during use, profiling own expertise, getting feedback from other coworkers, perceiving new opportunities and reducing working hours. Other types of motivation arise by perceiving the views of the employee, therefore he/she feels included, important and integrated. If management support is not given, the motivation to use the system is seen as neutral. Furthermore, the management should be active to provide a good example for motivating employees. The importance of management support for the successful knowledge sharing with social media was also discussed in [35].

Furthermore, we can conclude that employees are motivated to use social media depending on their individual personality and willingness to share knowledge (as also stated, e.g., in Kirchner et al. [22]).

Willingness to share. Furthermore, respondents were asked if employees are willing to share their own knowledge and insights, whereby 4 companies agree, 1 company does not agree and 5 did not provide a response. This fact was also reported by Kirchner et al. [22]. Our survey comes to the conclusion that this is not a phenomenon limited to a special technology like social media. It is rather a question of character whereby some who are active in the system, are willing to share and others are not. Interviewees argued that the reason why others are not willing to share "*cannot be levied*". It is usually possible to find several contacts in the company who have expertise in the requested topic and who are willing to share

their knowledge. So no deficits arise when sufficient participation as well as a critical mass exists. Finally it can be said, that in principle willingness and motivation to disclose knowledge can be found, but this does not apply to all employees according to the explanatory approach of the 90-9-1 rule. Basically, the literature findings can be confirmed and an essential factor is to provide great benefit from the system as a very important motivating factor.

6.6 Conclusion and Future Work

In our chapter we investigated the usage of social media in 10 German companies with different sizes and from different industries. In order to introduce and use social media successfully, companies should consider several factors, which we can derive from our interviews: For a successful adoption of social media, an open corporate culture with a focus on user community is necessary. Furthermore, the provided tools have to be easy to use for all employees, and multiple communication channels should be offered within the tools. Social media has to be connected with other frequently used software in the company, so that no extra effort is necessary. Additionally, the top management should provide a good example for employees. As an important factor, the content saved in the social media systems should offer immediate benefit for all. Thus, a critical mass and regular users are necessary to ensure an active exchange.

Another factor is of great interest for an enterprise: Because most of the tools are free and must be adapted only slightly, no high launch and license fees exists, and tools are easy to set up. Costs incurred have to be applied for incentive or release measures or change management. This can be understood as a familiarization of employees by promotion.

For the implementation of social media, it is still important to determine in advance for which purposes it should be used in the company. Having the purpose in mind, a specific social media tool can be selected. Hence determinants need to be identified, how the selected tool will match existing processes. It further requires a discussion about which employees should be involved, what motivates them to participate, what benefits they can get from the systems and how to integrate the systems effectively into work routines.

As a limitation of our study it can be seen on the one hand, that the observed results do not correspond to all German companies due to only 10 observed case studies. On the other hand, it can be stated that the interviews may tend to be subjective. We can positively rate that not only companies from the IT world have been questioned, but also employees from different areas such as consulting, e-commerce, ICT, automotive and manufacturing companies were interviewed. Due to the effect that companies of different sizes are involved, one can speak of a better reliability of the results.

Our interviews show that social media tools can be used in any industry, and can also be advantageous for small companies. Because of the various foreign offices of

the surveyed companies, social media is important in an international context, as it was shown in the interviews with interviewed companies having subsidiaries in other countries.

As a result of our work and a further action recommendation we can conclude that social media tools have found their way into the companies and are already used in a more or less intensive manner. It can be further learned that, consistent with the cited literature sources, particular aspects of knowledge management, the location-independent collaboration, learning in the organization and better networking and communication can be supported by employees. They share their knowledge with the help of the systems and have even the possibility to share tacit knowledge through existing dialogues. Thus, the reflection of mostly privately used social media platforms in the business world is possible and useful. At the level of the economic benefits it can be partly confirmed that competition and performance parameters, as well as the innovation of a company can be improved. This can be explained because working time per employee can be saved, the responsiveness of the company is accelerated and the quality of the solution in large groups is improved.

Our chapter shows, additionally to the identified commercial use of social media, why and how employees use the tools and which motivational factors are relevant. It was found that variables such as age, too high private use or too high level of requirements toward entered expert knowledge have no relevant influence.

It was also noted that according to the 90-9-1 rule, only a small part of the users is actively involved as an author. But many employees read along passively which is to be assessed positively as passive learning. In the field of motivational factors it was found that employees use the systems thoroughly in order to realize personal benefits. Some have difficulties with sharing their knowledge, but there is a fundamental motivation to participate. It should be emphasized that a minimum level of confidence and motivation incentive must be available. A benefit derived from the systems by means of an open corporate culture is important so that employees disclose their knowledge. Employees will share their knowledge, but only if an exchange can be expected in return.

Finally, it must be said that in contrast to the use of social media for private purposes, the crucial difference in the business world can be determined as " […] the purpose of connecting people is to get work done, not to make friends" [5].

As our chapter shows, social media has a significant impact on companies. In the future, the so called Web 3.0 will be established, which means the transformation of the internet from unstructured content into a structured and semantic world, with the possibility to connect data from different sources [24, 38]. The impact of Web 3.0 on the business world is seen as a preview of future work. Other future work is required to determine the effect of empirical data on the actual and measurable degree of success factors listed above. Especially interesting are the questions about how social media can increase market positions, which monetary improvements are expectable, or which concrete effect refers to operating profit by improving networking, knowledge management and communication.

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Chapter 7
Social Media Applications for Knowledge Exchange in Organizations

Requirements, Application, and User Acceptance in Industrial and Scientific Settings

André Calero Valdez, Anne Kathrin Schaar, Jens Bender, Susanne Aghassi, Günther Schuh and Martina Ziefle

Abstract With the broad success of Web 2.0, organizations have become interested in using social media for professional applications. To date related research has mainly focused on the social impact of social media. However, little is known about the circumstances under which employees will invest time in using social media, especially the perceived benefits and its barriers within enterprises need further research. Different aspects of organizational knowledge management bring along different requirements for social-media-based solutions. This chapter focusses on providing both a theoretical background on social media acceptance and concepts, as well as empirical findings from practice and research investigating acceptance-relevant needs and demands of social media users in different contexts. Findings from practice corroborate that the complexity of the plethora of communication paths can be supported by social media. Findings from research reveal that regarding the users' (emotive) needs is critical when dealing with sensitive communication/data. Combining both practice and research tries to bridge the knowledge gap existing in fast paced developments like social media.

Keywords Social media · Knowledge management · Technology acceptance · Personality · User centred design · Talent onboarding · Technology platforms

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7.1 Introduction—The Knowledge Society 2.0

Three societal changes concur that will have a huge impact on how well a society will develop—demographic change [1], tertiarization, and technological progress. All of them will impact how societies deal with knowledge exchange in an effort to attain sustainable knowledge of experts.

Demographic change. Almost all big economies face the problem of demographic change. A large part of the workforce of an aging population is retiring, with a shrinking workforce supplying for the elderly part of the population [1]. Not only does this increase the burden on the younger part of the population to maintain a high tax volume to pay for pensions, the new generation will also have to acquire all business critical knowledge from the baby boomers before the cohort retires. Otherwise valuable intellectual capital will be lost with immeasurable repercussions on the revenue of enterprises.

Tertiarization. In a time where the biggest part of revenue of first world economies is generated by service providers and the tools of trade all deal with knowledge, loss of knowledge is a dangerous threat to an economy [2]. Without the knowledge of experts, existing systems can not be maintained and will deteriorate. Furthermore knowledge is required during the process of innovation [3]. Innovations emerge when people combine their knowledge in novel ways. So knowledge becomes a critical factor for a region as a whole. Granovetter [4] proposed that the weak ties in a social network are the sources of information, innovation and, opportunity—a proposal applied and tested by Rogers in his theory of diffusion of innovation [5]. Knowledge in contrast to information is always in the head of some knowing person. Knowledge can not be copied, stored or retrieved. It must be exchanged, learnt, and communicated [6]. Thus tertiarization shift the nature of knowledge to a social one.

Technological Progress. The development of Web 2.0, cloud computing, and modern Information and Communication Technologies (ICT) e.g. Smartphones have triggered new forms of communication and information interchange to emerge. Web 2.0 as a form of activating the end-user as a content generator has lead to a network of users, services and organizations. Processing power is always available because of ubiquitous computing. The users are always online and connected [7]. Beyond the user being constantly online, internet-capable devices and services are also constantly generating data. Big data is the emerging trend trying to facilitate these large amounts of data. Making all this knowledge and information available from largely unstructured incomplete data is a key driver of businesses. Social media can be used as a centralized means that builds upon all these technological advances.

7.1.1 Relevance of This Article

In a world, where the success of enterprises relies on their innovative capability and thus knowledge management, integration of communication into new forms of technology like social media is critical for the competitive advantage [8]. In this article three partners from relevant domains share their insights and research on how to successfully create a social media solution for knowledge exchange within organizational contexts.

IntraWorlds GmbH[1] is a provider of talent relationship management solutions, which include candidate engagement, talent onboarding, and active recruiting. The developed talent communities are being used by HR specialists to form ties with and acquire top talent from around the world. IntraWorlds are experienced with development and management of business related communities and bring in their practical expertise from industry projects. Offering hosted services gives IntraWorlds a unique insight into what makes community solutions successful.

The Fraunhofer IPT[2] combines knowledge and experience in all fields of production technology, such as process technology, production machines, mechatronics, production metrology and quality as well as technology management. The Fraunhofer IPT as a representative of RnD-services in applied sciences offers services for technology transfer connecting cutting-edge research and industry. In the context of this article they provide insights and research from how to use social media to foster knowledge exchange regarding technology.

The Human-Computer Interaction Center (HCIC)[3] is a research center of the RWTH Aachen University investigating the interface between humans and technology focusing on acceptance research and usability. An interdisciplinary team—encompassing fields from the social sciences, engineering and natural sciences—addresses questions of how cognitive, affective, and user diversity factors influence motives and barriers to use technology. In two research projects the HCIC deals with user-centered development of communities for knowledge exchange.

Emerging topics like social media are both currently industrially relevant and broadly scientifically unexplored. Therefore combining the knowledge from science, applied sciences, and industry ensures that results are both scientifically valid as well as industrially applicable and valuable.

7.1.2 Structure of This Article

This article is divided into four main sections. After the introduction the second section focuses on the special character of social media and its applicability for

[1] http://www.intraworlds.com.

[2] http://www.ipt.fraunhofer.de/en.html.

[3] http://www.comm.rwth-aachen.de.

knowledge exchange in professional settings. Section three presents research results on how to apply social media for knowledge exchange in both industry and scientific settings. The last section provides a conclusion and highlights how insights from both industry and science can benefit from each other, thus giving translational efforts a vital and pivotal role.

Scenarios of Social Media Usage for Knowledge Exchange. Since social media is a user-driven development usage motives might not carry over from the private to a work related settings unchanged. Work related settings are characterized by a diverse set of users, which can not just be employees, but also customers, colleagues, partners and possible new-hires. Each user group and usage scenario might have individual requirements for a successful application of social media.

Social media is used in organizations in different scenarios, which applies to both corporate as well as scientific settings (see Sect. 7.2).

Using social media in work contexts can have various characteristics, goals and challenges [9]. Basically two main alignments of social media integration into communication flows exist—the integration into *external* and *internal* communication matters. Albeit some solutions try to merge both internal and external alignments.

Social media platform solutions can have different foci (see Fig. 7.1) that are addressed in this article. It can focus on *company-to-(potential-)employee* communication (e.g. Talent onboarding see Sect. 7.2.3), *employee-to-employee* as well as *company-to-employee* (Intranet-communities see Sects. 7.3.2 and 7.3.3) and third

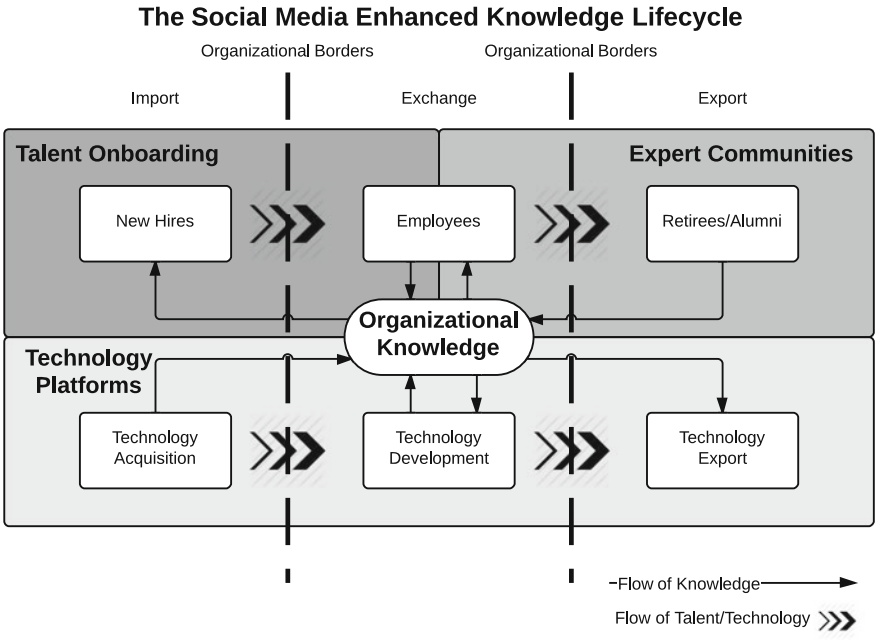

Fig. 7.1 Three roles of knowledge management in social media solutions. *Source* Own figure

company-to-company (e.g. Technology Platforms see Sect. 7.2.4). All of them address different communication facets. Lastly *company-to-consumer* and vice versa solutions exist (e.g. Participatory Design, Open Innovation, Product Platforms, etc.) but are not addressed in this article, as they are instruments of marketing rather than of knowledge exchange. A case for these platforms as a means of knowledge exchange can be made, but is not a focus of this article.

To illustrate how social media can be integrated two exemplary cases were chosen for demonstrative purposes. The first scenario (see Sect. 7.3.2) is a corporate platform for business internal communication with a special focus on business internal onboarding, knowledge management, and innovation support (i.e. a community for experts). For this example research results regarding requirements for such a solution are presented with a focus on etiquette needs and data disclosure dependent on user diversity factors. The second example (see Sect. 7.3.3) presents a platform design for a scientific context. In large-scale interdisciplinary research projects similar needs for knowledge exchange exist, as such endeavors are comparable to businesses with business units. There we try to transfer the findings from the first example, by addressing users needs preemptively. In particular carrying over findings on data disclosure to the different context of scientific data (e.g. publications, patents, etc.) must be addressed as well as implications of interdisciplinary communication. In order to establish interdisciplinary knowledge exchange groundwork features must be lain out (e.g. project management, terminology management, technology transfer) to enable successful interdisciplinary cooperation.

7.2 Social Media Based Knowledge Exchange in Organizations

Based on newly available ICT, innovative approaches for strategic knowledge exchange are appearing in professional usage contexts. In the following sections this phenomenon is taken up by working out the general characteristics of social media as a possible medium for knowledge exchange (see Sect. 7.2.1). This section unites findings from practice with theory to establish the need for further research presented in Sect. 7.3. Section 7.2.2 addresses the question whether social media can be a success factor for knowledge exchange. In this context both settings, which are relevant for this article (corporate and scientific), are portrayed according to the usage of social media. Following that, Sects. 7.2.3 and 7.2.4 are presenting two examples for social media usage in organizations from a practical point of view. Section 7.2.3 presents insights into the process of onboarding via social media. Section 7.2.4 deals with technology platforms, which constitute a social media enhanced approach towards technology transfer. Human factors that can determine success of ICT are elaborated in Sect. 7.2.5. Theory background on technology acceptance is presented and related and extended to the specific “social” aspects of social media.

7.2.1 Social Media as a Medium for Knowledge Exchange

Social media incorporates many of the technologies that were previously already available as singular services. A typical Social Networking Site (SNS) incorporates services like a messaging system (e.g. email or chat), a publishing system (e.g. message wall or Blog), a portrayal system (e.g. profile pages), and networking capabilities (e.g. friending-system).

The networking component allows users to connect their profiles, query the online status of connected users and easily send messages to single or multiple users. By differentiating between a publishing system and a messaging system users can pick a communication channel according to the urgency, privacy, and importance of a message. How these criteria are mapped to the individual communication channels may vary between users [10].

Communication channels integrated into social media can be partitioned according to the aspects of synchronicity and cardinality (see Table 7.1). The functions supplied by these channels can be attributed to support participation, collaboration or communication. *Participation* describes the process were multiple external users can submit or discuss ideas that are put online for discussion. Participation explicitly invites members of the weak-tie network to help out by creating content for an internal group of some organization. In *collaboration* scenarios members from within a group are assisted by communication media that allow improved flow of information within groups both synchronously and asynchronously. Collaborative scenarios are characterized by a highly many-to-many flow of communication. *Communication* scenarios include all forms of cardinality and focus on transfer of information between individuals.

7.2.2 Social Media as a Success Factor for Knowledge Exchange?

The benefits of social media could play a beneficial role in establishing sustainable knowledge management systems in organizational contexts. Based on the "Wikipedia-Trend" Wiki-systems emerged and have successfully penetrated the professional sector and were found to enhance reputation, make work easier, and help organizations to improve their processes [11]. But Wiki-Systems only provide a small proportion of "social" features that are available in public social networking

Table 7.1 Synchronicity and cardinality of communication channels

	Synchronous	Asynchronous
One-to-one	Private chat	Messaging-system
One-to-many	Micro-blogging, social stream	Blog, profile page
Many-to-many	Group chat	Message board

sites (SNS) for example. As mentioned in Sect. 7.2.1 there are many more functions that might be beneficial for organizational contexts. In the following two sections examples from corporate as well as scientific settings are presented, to work out at which points social media could be applied as a success factor for knowledge exchange.

7.2.2.1 Corporate Setting

While the impact of public social media on knowledge exchange has been investigated by Hemsley [12] (who also derives the need of firms to become more "social"), corporate social media platforms and their requirements from a user's perspective have not been investigated thoroughly yet. To analyze the success story of social media in the working context two central questions must be discussed: *What makes these social media applications attractive for business executives today?* And *what are the prospected benefits of an integration?* In regard to these questions we can assume that the extreme (economic) success of social media applications (e.g. facebook, Twitter, Flickr) within the private usage context [13–15] promises success of business implementations of social media. Another reason is the shift from predominantly physical work to knowledge-based work, which made knowledge the central resource of economy within the western countries [16–18]. In this context, a systematic management of a company's knowledge became increasingly important and a necessary field of action in enterprises. Social media integration into the knowledge management process of enterprises is also recommended by the recent knowledge management literature, which welcomes the integration of human aspects into knowledge management affairs [8, 19]. Richter and Koch in this context also address the fact that the goals and ideas behind social media are highly in line with the goals of knowledge management [20–22], which makes a combination of both even more suitable and attractive for enterprises.

Prospected benfits of social media in a professional usage setting are the strategic support of knowledge management, knowledge exchange, and knowledge support within enterprises [19]. Especially the "social" aspects promise a shift to a user-driven generation of content.

Two examples for social media/network solutions available for business applications are Yammer[4] and Liferay.[5] Both solutions offer a broad range of social media features, which can be utilized to support knowledge management in corporate settings. Besides functions like document management and the option to create groups, especially groupware components like Wikis, forums, instant messaging, calendars, and the opportunity to make centralized announcements allow diverse forms of communication and interaction as well as the interlinking of

[4] http://www.yammer.com.

[5] http://www.liferay.com.

content with users. This broad portfolio of different features offers the opportunity to create specifically tailored solutions with a focus on the respective user group. Thus social media promises to fuel the intrinsic motivation of people to participate and to overcome the known barriers of knowledge sharing and thus strategic knowledge management [23].

7.2.2.2 Science Setting

As valid scientific knowledge about success criteria for social media usage in corporate settings is rare, the situation for social network use in science is even worse. Although social media solutions are quite prominent in research there is only little knowledge about scientific use and impact of user-diversity factors in this context. In 2011 Elena Gilia presented an overview of available academic Social Networks [24]. In this context the quite prominent examples ResearchGate, Acedemia.edu and Mendeley are presented.

ReserchGate[6] focuses on sharing information abut ones research interest and activities with other researchers. Therefore, it allows users to list the titles of one's publications, upload full texts, name research interests as well as search within the available material and other databases like PubMed, CiteSeer, arXiv. Additionally it allows to sign-in into virtual groups with special research interest or discuss topics in a forum. Beside the interpersonal knowledge exchange there are also opportunities that distribute information about events like workshops or conferences as well as a jobs section, where one can find information about open positions in research. Another project presented in Gilia (2011) is *Academia.edu*,[7] which is comparable to ResearchGate, focussed on sharing and presenting one's research, as well as following other researchers within the same field. A third Social Network approach mentioned in Gilia (2011) is *Mendeley.*[8] Mendeley is a quite prominent online service for the management of references combined with a social network for academics. The Social Network integrated into Mendeley supports a upload of one's CV as well as presenting a personal profile with information about one's research interests, as well as current and future research activities, which can be searched by others. Comparable to ResearchGate, it contains a section for uploading papers. Additionally Mendeley offers community-forming facilities, which allow forming both private and public groups. This group section offers task assignment options for project planning, included in a personalized Mendeley Dashboard. In addition to the mentioned range of services, Mendeley also focuses on offering real-time insights into research trends. Therefore a matching of scholarly papers with your reported research interests, as well as statistics about the most prominent papers, topics, outlets, as well as authors within your field is given.

[6] http://www.researchgate.net.

[7] http://www.academia.edu.

[8] http://www.mendeley.com.

Mendeley is also active in the field of webometrics/scientometrics by generating individual research impact data, which portrays information about how many people have read your article or downloaded it. This also provides the authors with information about their audiences' scientific background and country of origin. Summarizing we can say that there are different scientific oriented social networks available, which offer different facets of social media based services.

According to the focus of this article we can say that there is a trend to use social media in corporate as well as scientific settings. Nevertheless in both settings only little knowledge about criteria for successful implementation exists. To bridge and fill this knowledge gap Sect. 7.2.3 on *Talent-Onboarding* and Sect. 7.2.4 on *Technology Platforms* will present two aspects of social media integration from a practical point of view. In contrast Sect. 7.3 will present a scientific investigation of social media integration in organizational contexts in two research projects.

7.2.3 Talent Onboarding

An application area of social media for knowledge exchange that has become more popular with corporations in recent years is onboarding of new employees. First of all, companies have realized that in a world of scarce talent supply valuing and retaining talent and employees has become an important capability for long-term success. Additionally, technologies make it possible to shape the onboarding process in a way that makes it easy to handle and also financially very beneficial.

The onboarding process refers to the mechanism through which new employees acquire the necessary knowledge, skills, and behaviors to become effective organizational members and insiders [25]. Whilst today an increasing number of organizations is thinking about a more formalized onboarding process, this movement is still quite new. A recent study of the Aberdeen Group states that "only 37 % have invested in a formal onboarding program for more than two years" [26]. Besides the two global aspects of talent scarcity and technological progress that support taking action there are four key drivers that push companies towards introducing systematic onboarding:

1. *Increased Productivity*: Structuring the onboarding process and handling it online reduces cycle times for documents and feedback loops from days to minutes. It additionally reduces costs and failure rates and brings new employees up to speed faster.
2. *Higher Employee Engagement*: In times of talent scarcity, providing employee engagement aspects is a main part of the onboarding process. Onboarding is a chance for making a good first impression and for welcoming a new employee as part of the corporate "family".
3. *Higher Employee Retention*: Analyses have shown that "86 % of new hires decide to stay or leave a company within their first six months and new

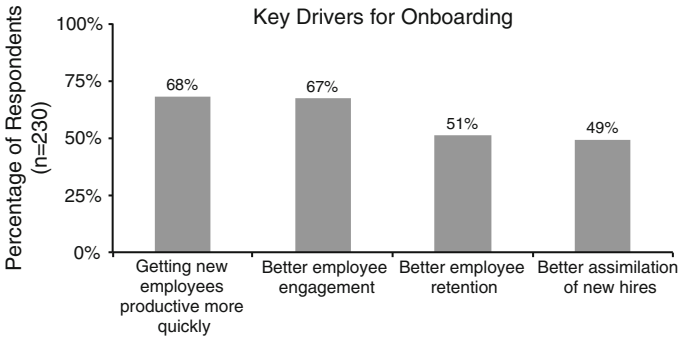

Fig. 7.2 Key drivers for onboarding according to the Aberdeen Group [26]

employees are 69 % more likely to stay longer than three years if they experience well-structured onboarding." [27]

4. *Better Assimiliation*: Providing new hires not only with structured formal processes but also with information about their new social environment and workplace can be complemented with learning information. With systematic onboarding new employees can access learning materials even before actually joining and also in the first months of work.

Whilst main drivers for onboarding are quite consistent amongst corporations (see Fig. 7.2), the definition of the timeframe for onboarding can vary quite a bit between organizations. From a conceptual view the onboarding even starts before the new hires signature, namely when the new employee still is a candidate. Although the main process defined as onboarding starts with the new employee's signature and end some weeks or months after his first working day (usually 1–3 months, see also [26]).

Social media and social software can assist this process best when workflows connect not only two people but involve several employees. In these scenarios an "onboarding portal" or "private online community" is accessible to new hires but also selected employees that have worked with the company for quite some time. In this onboarding community new hires can connect, share information, and build relationships with valuable hints from recent hires before even showing up for their first day of work.

This type of community addresses the first of the three roles of knowledge management (i.e. *import*) in social media solutions (see Fig. 7.1).

7.2.4 Technology Platforms

In this section technology platforms are introduced, which cover the second and third role of knowledge management in social media solutions (*exchange and export*, see Fig. 7.1).

Increasing technology complexity and rising efforts for technology development combined with shorter amortization periods of the developed technologies, intra- as well as inter-organizational technology transfer is once again gaining importance [28].

The intra-organizational perspective mainly deals with the question on how to get the developed technologies to an efficient use within the enterprise. The slogan "Technologies belong to the enterprise and products to the business units" shows the intent of companies, to reuse technologies in as many products as possible in order to maximize the technologies' exploitation potential [29]. This again leads to the next question, which is how technological knowledge can be made available throughout the (oftentimes regionally distributed) company? Modern ICT, particularly the intranet or web-based solutions can take a crucial role in supporting these activities [28]. The inter-organizational perspective of technology transfer mainly addresses the question on how to bridge the gap between research and industry. In order to stay globally competitive enterprises face an increasing pressure to be innovative [30]. The rising complexity of new technologies forces enterprises into RnD-cooperations with third parties as technology development can often not be handled by one organization on its own. At the same time lots of excellent research results from academia remain unexploited. The reason for this often lies in a lacking industrial partner for commercialization of developed technologies, which again is often caused by lack of visibility [31].

In the past decade, the spreading of the Internet, faster Internet connections and more and more powerful web technologies paved a novel way for supporting technology transfer. Web-based portals (technology transfer portals) have proven to be suitable support instruments, particularly in the preliminary phases of technology transfer (e.g. in the identification and search phase) [32]. Especially social media approaches allowing the user and its network relations to take center stage might play an important role for the support of technology transfer in the future. Web-based technology transfer portals—i.e. social knowledge management systems dedicated to the support of technology transfer—offer great potential by bringing together technology demand and offer. Although the potential of social media for the field of technology transfer has been recognized, its application to this context has been very limited in the past [28, 33].

Analyses have shown that most of the existing technology transfer portals are run by a university or university network and comprise of functions, allowing technologies or technological knowledge to be displayed, described and offered to interested consumers and potential transfer partners. Prominent examples are the "iBridge Network"[9] by the US-Kaufmann Foundation, the "Research to Business Technology-market"[10] of the Karlsruhe Institute of Technology or the "EasyAccessIP"[11] Portal in the UK. The investigated portals provide the contact to

[9] www.ibridgenetwork.org.

[10] techtransfer.ima.kit.edu.

[11] www.easyaccessip.org.uk.

inventors, technology owners and involved transfer mediators. Some even go further and support the actual transfer via predefined licensing forms and workflows. The way in which technologies are presented on the platforms varies from very structured approaches, including a short description, the technology readiness level and possible fields of application to more flexible forms, leaving more freedom to the technology provider. Furthermore, the considered portals show a differing range of application. Whereas some merely focus on technology transfer, others have a wider spectrum, such as the brokering of project partners or funding programs.

One research project where a technology platform is united with a organization internal knowledge management solution is the Scientific Cooperation Portal within the Aachen Cluster of Excellence (CoE) "Integrative Production Technology for High-Wage Countries" (see Sect. 7.3.3).

7.2.5 *The Human Factor in Knowledge Exchange via Social Media in Professional Contexts*

Understanding which factors are central for people in the context of using technology, is essential for any form of successful technology implementation within any given setting. Especially motives behind professional use of technology are of interest. In contrast to the private field, professional usage may not always be voluntarily but instead in most cases obligatory. This section portrays central theories and findings of technology acceptance research and works out the need to integrate the user's point of view into the design and realization process of technology in the professional context. Technology acceptance models have proven highly successful in predicting behavior in ICT settings, which occurred in the business world in the early eighties. But do these models fit to social media solutions?

The research field of technology acceptance originated from research in social psychology, when researchers tried to understand what factors influenced voting behavior and other forms of social behavior [34]. An early model for predicting social behavior is the Theory of Reasoned Action (TRA), which predicts an outcome behavior as a function of ones beliefs about the outcome of a behavior and its normative value.

In the technology acceptance model (TAM) behavioral intention to use an information system is predicted from two factors—compatibility and relative advantage (i.e. perceived ease of use and perceived usefulness). This led to the development of the TAM.

The TAM developed by Davis [35] and Bagozzi et al. [36] has been called the most influential model in this research area [37]. It has been applied multiple times in different contexts and extended by Davis and others [38–40]. Venkatesh et al. [41] reformed the model into the Unified Theory of Acceptance and Use of Technology (UTAUT).

The UTAUT predicts behavior using four perceptions (see Fig. 7.3) about a system—the expected performance (i.e. perceived usefulness), expected effort (i.e. perceived ease of use), social influence (i.e. perception of a system in the peer group), and facilitating conditions (i.e. availability of support). These factors are moderated in regard to their importance by gender, age, experience, and voluntariness of use.

The question remains how these models can be applied to social media applications. Much of the explained variance in behavioral intention in these models relies on the usefulness of the proposed solution. In a social media application a lot of the benefit stems from content generated by other users, whose usage behavior again depends on the usefulness of the system—a cyclical dependency. Based on TRA models and regarding the use of information systems Hartwick found the influence of user participation and involvement to be substantial for their success [42]. Lurking users do not actively contribute to a system but do so out of a variety of reasons [43]. Besides good usability, the feeling of being a part of a community is a necessity to convert lurkers to participators, thus a well defined community of active users is needed. A critical mass of users must actively use a system before it "takes off" and becomes a value on its own.

In order to get this critical mass to use a social media system it is necessary to integrate findings of public social media acceptance with the requirements of its professional use. Aspects of user diversity (e.g. personality, computer self-efficacy,

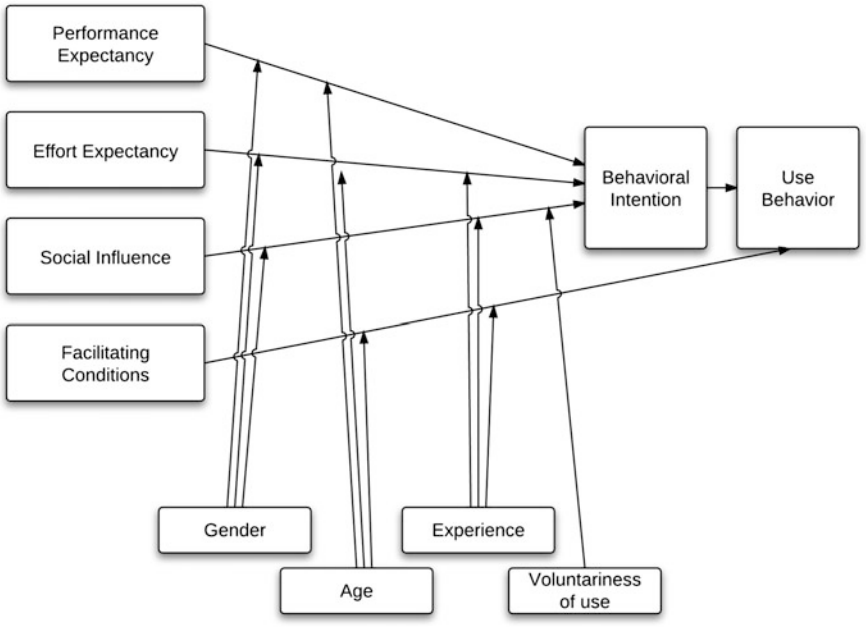

Fig. 7.3 Unified theory of acceptance and use of technology [41]

age, gender) and in particular integrating the uniqueness of a company's culture into the system must be considered when devising such a solution.

Summarizing we can say, that when trying to design a social media solution for knowledge exchange one must keep the requirements of the users in mind. Firstly a user-centered requirements analysis must be performed in order to understand what makes a solution *useful* in regard to the user's everyday tasks. User-centered design and usability studies help to ensure the systems *ease of use*. Furthermore contextual constraints like aspects of *data security* or *customization* options should also be investigated to ensure that users feel safe and as part of a community, which in turn constitutes a big part of the *social influence* to use a system. A factor not studied for ICT is the influence and strictness of normative rules (e.g. what to share, how to behave) on the behavioral intention to use a system. In order to minimize barriers due to the communicative nature of social media we study the effect of some of these rules like *etiquette* and *data disclosure* and how their perception is influenced by user diversity factors.

7.3 Applied Social Media for Knowledge Exchange

As presented in Sect. 7.2, social media applications can have different target user groups and purposes. In the following sections the results of two ongoing research projects are outlined particularly in regard to their impact on knowledge exchange within a corporate knowledge-intensive setting. Both projects are approached user-centered, so a focus is put on requirements for usage motivation and acceptance. In both settings an internal communication is addressed.

In the first research project called *iNec*[12] an expert community is developed with a user-centered approach (see Sect. 7.3.2). The purpose of this community is to secure knowledge for knowledge-intensive companies in order to tackle the upcoming consequences of the demographic change (see Sect. 7.1).

The second research project is a sub-project of the research cluster "Integrative Production Technology for High-Wage Countries"[13] called *Cross-Sectional-Processes*. This sub-project investigates the usefulness of knowledge tools in a research cluster setting, dealing with high staff volatility, speed of knowledge development and the need for high connectedness (see Sect. 7.3.3). For this purpose a *Scientific Cooperation Portal* is devised integrating user profiles and knowledge output (i.e. scientific publications) visually. Furthermore the portal will be integrated with a technology platform (see Sect. 7.2.4), a technology centered means of knowledge exchange, completing the social media enhanced Knowledge Lifecycle introduced in Fig. 7.1.

[12]"Innovation through Expert-Communities in the time of demographic change" http://www.projekt-inec.de.

[13]http://www.production-research.de.

7.3.1 Methodology

The research presented in the following two sections uses both qualitative and quantitative methods. Both approaches are used repeatedly to triangulate the topic. As qualitative methods semi-structured double-interviews (two interviewees, one interviewer, N = 7, 14 participants) and semi-structured focus groups (total of N = 13 participants) were used. Participants were interviewed in a neutral setting, recorded, their recordings transcribed, categorized and then analyzed for frequency of categories. Participants were acquired through direct approach in the respective organizations. Controls were acquired through the individual networks of the partaking researchers addressing mostly people that fit the criteria of being an employed knowledge worker.

As a quantitative approach questionnaire studies were conducted (N = 151, N = 127, N = 99, N = 62). In most cases standardized item sets (e.g. Big-Five personality, achievement motivation, etc.) were used to ensure reliability and validity of measures. Where no standardized items were available, items were generated from qualitative data and assessed using six-point Likert scales.

Constructs where then generated using principal component analysis with varimax-rotation (verifying the applicability constraints: KMO-criteria for total and individual variable >0.8, Bartlett's test of Sphericity $p < .05$). Components were extracted when Eigenvalues were larger than 1 and when factor loadings were larger than 0.4. After testing additivity (Tukey) additive scales were generated. Scale reliability is then reported as Cronbach's α.

As measures of interaction, bivariate correlations (Pearson's r or Spearman ρ) and multiple linear regression analyses were performed. The normalized slope (β) as well as the increase in explained variance (adj. r^2) are reported. As measures of difference T-Tests, univariate ANOVA and Mann-Whitney-U tests were conducted. When normality could not be assumed it was tested for using Shapiro-Wilk's test of normality. When normality or level of measurement were insufficient non-parametric tests were used. A level of significance was chosen at $\alpha = .05$.

7.3.2 Research Project: iNec

The aim of the project "iNec—Innovation through expert-communities in the time of demographic change" is to build a new personal development concept via the social interaction in "virtual communities". It is a joint research project at the RWTH Aachen University with two industry partners.

One industry partner from Germany in this research project belongs into the category of companies that have a wide range of specialized products tailored for varying type of customers. Customers vary in size, requirements, and product setup. In particular it is necessary to maintain machinery in distant areas of the world that have been developed by staff members that might go into retirement within the next decade. These circumstances make the industry partner a prototypic

benefactor of the research aims given here. The other industry partner is a software company specialized in developing corporate social platforms.[14]

Since demography in Germany is a limiting factor on hiring new employees, knowledge transfer from the older generation to the considerably smaller younger generation must be optimized. Knowledge in this field is highly specialized and operation critical. In order to support this knowledge transfer the approach of the iNec-community was conceived. The purpose of the community was to channel communication through a social platform, in order to secure tacit knowledge, normally mostly forwarded through various *non-integrated* means (e.g. phone calls, video messages, issue-tracking systems, knowledge bases). These isolated solutions often lead to development of isolated knowledge. Having an integrated solution allows all actors to participate in the knowledge exchange, who might learn from this exchange or even add to it.

In order to ensure usage of the community one sub-project focussed on the user-centered design approach of the solution. The research focuses primarily on determining user requirements, motives and barriers, and motivational features of social media as a knowledge exchange environment. In interviews and focus groups important categories for later quantification were elicited, which were then operationalized. A specific focus was put on *age-related user diversity* to accommodate the generational gap between the learning younger generation and the "teaching" older generation of employees.

7.3.2.1 Requirement Analysis

The qualitative analysis of requirements were performed by the consortial partner Textlinguistics and Technical Communication at the RWTH Aachen University. The interviews and focus groups revealed five main categories of requirements [44]. A strong need for *integration* into existing software solutions was most frequently mentioned, followed by adequate *training and support*. This means that users do not want to change existing usage behavior if it is not fully supported by the infrastructure of the company. In particular guidelines for usage were requested. Furthermore an elaborate system of *roles and rights* was needed to map visibility of data within and between business units, as well as fast *access and good usability*. The system should not cause delays and be intuitive to use. Content should also be *consistent* and integrate multi-media capabilities. Communication through the platform should be *individualized* and a *search* function is necessary [44].

To ensure that all requirements are covered by the community approach, two scenario-based questionnaire studies were conducted (N = 127 and N = 62). Questions were generated around fears and expectations users have regarding a community based solution for knowledge management. Four key requirements

[14] i.e. http://www.intraworlds.com.

Table 7.2 Key requirements of community based knowledge management [44]

Requirement	Description
Ease of use	Central requirement. Only products that are usable will be accepted independently of age
Data-security	Two aspects of data security are perceived by the user. First data that is entered into the system must accessible at later times. Data-loss is unacceptable for the users. Additionally users demand that their personal data can not be compromised and expect a strategic approach to ensuring data safety from their company
Etiquette	Finding the right words to express a concern across hierarchies is complicated on its own. Finding the right words in new media is even more difficult if no established norms exist
Customization	The solution should cater to the specific needs of the company and make the users feel at home

Table 7.3 Exemplary items of social media usage barriers on a six-point Likert scale (1 = total agreement to 6 = total rejection) order by level of agreement descending, taken from [45]

I am skeptical about social media, because …	M	SD
… there is no established etiquette	2.75	1.37
… it is an impersonal way of communication	3.15	1.34
… it induces the impoverishment of interpersonal relationships	3.15	1.45
… it facilitates voyeurism	3.52	1.45
… social media is also involved in criminal and abuse contexts	3.67	1.52
… it supports stalking	4.04	1.43
etc.		

were found in the data (see Table 7.2). These requirements also line up with the perceived motives and barriers of the users (see Table 7.3).

When looking at user diversity, especially factors of data security [45] and etiquette [10] are important. In general requirements regard both the software solution directly as well as the implementation within the company and the applied social norms. Both willingness to disclose personal information and etiquette requirements were analyzed in separate questionnaire surveys additionally.

7.3.2.2 Willingness to Disclose Personal Information

In another questionnaire study we assessed the willingness to disclose personal information in private and business contexts (N = 151). Furthermore we looked into motives and barriers for sharing personal information in social media. Differences between the two contexts are stereotypical (see Fig. 7.4) as willingness to disclose business relevant information is higher in business contexts and vice versa. Especially disclosing personal private information (e.g. home address, political

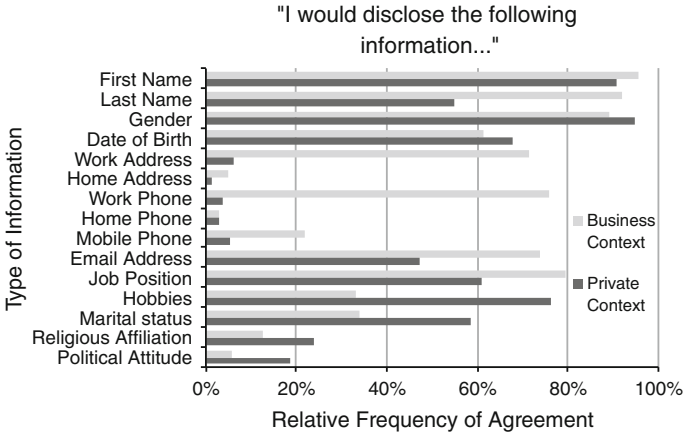

Fig. 7.4 Willingness to disclose personal information in both business and private context (N = 151) [45]

affiliation) is seen more critical than non personal private information (e.g. first name, last name).

In contradiction to the low willingness to disclose more sensitive information in private contexts (e.g. private cell phone number), willingness increases when used within a business context, where this information maybe useful for business conduct. Usefulness outweighs privacy needs in this case.

User diversity factors showed a particular large impact on the willingness to disclose information even in a professional setting [45]. In general the user's age has a negative effect on the willingness to disclose information. In some aspects though older users were more willing to disclose information. Disclosing the address of ones work was seen less problematic by older users than by younger users. This could have been caused by differing views on what constitutes sensitive data across generations. Gender also shows effects on the willingness to disclose certain personal information. Female users refrain to a larger extent to disclose their gender and phone numbers, which might be related to gender-related socialization (e.g. sexual harassment).

Differences in personality [46] were shown to influence social media usage in a private usage context [47–49], so investigating the influence of personality on willingness to disclose information poses a relevant question. Users that score high on the openness and extraversion scale are in general more willing to disclose their information in both settings. Conscientiousness and neuroticism show negative effects on the willingness to disclose information (with the exceptions of religious affiliation and hobbies). An overview of the influenced types of information and user diversity factors that were found to play a role can be seen in Fig. 7.5.

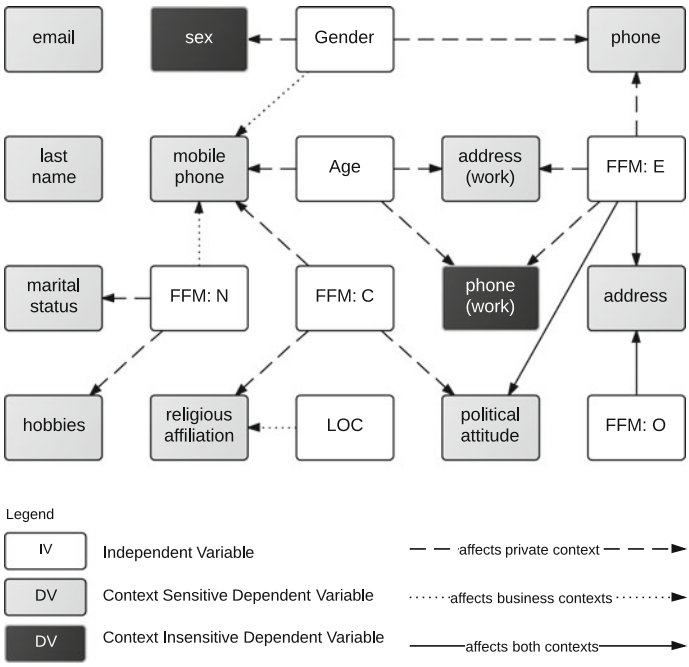

Fig. 7.5 Visual representation of influences of user diversity onto willingness to disclose different type of information [45]. User diversity factors presented in *white*. *FFM* Five Factor Model, *E* Extraversion, *N* Neuroticism, *C* Conscientiousness, *O* Openness, *LOC* Locus of Control

7.3.2.3 Social Media Etiquette

Since social media enables various forms of communication (see Sect. 7.2.1) and communication underlies a plethora of rules on different levels [50], etiquette is an important factor in social media communication (see also Table 7.3). Etiquette regards the rules that are in place to enable communication of relationship and belonging. It implies a diplomatic protocol [51]. A mismatch between unestablished etiquette for new forms of media and the high regard for etiquette in business communication burden the lighthearted use of social media in knowledge exchange.

In order to determine the influence of communication type on etiquette requirements we conducted a questionnaire study with knowledge workers (N = 99) to elaborate on the influence of user diversity. Three forms of social media applications were picked to represent underlying differing forms of communication. Email was chosen as an asynchronous means of communication, chat as a synchronous means of communication, and blog as a publishing medium. As measures of etiquette we operationalized six aspects of etiquette (see Table 7.4).

We found that media differed in regard to their etiquette requirements in general. Users demand a higher degree of correctness in both addressing and orthography from email communication than from chat and blog communication. Rejection of

Table 7.4 Operationalization of etiquette and reliability of scales (Cronbach's α) [10]

Scale	α	Description
Formal addressing	.918	The degree to which a person demands to be addresses properly, including title, address, and capitalization
Formal correctness	.820	The degree to which a person demands writing in a medium to be orthographically correct
Abbreviation rejection	.831	The degree to which a person rejects the usage of abbreviations (e.g. brb for "be right back")
Emoticon rejection	.775	The degree to which a person rejects the usage of emoticons (e.g. ":-)")
Perceived urgency	.789	The degree to which a person perceives communication in a medium as urgent
Work disruption	.789	The degree to which a person perceives communication in a medium as disruptive to his flow of work

both abbreviations and emoticons is generally low and lowest in chat. Chat is also perceived as most urgent and most disruptive to a person's workflow (see Fig. 7.6).

Looking at the influences of user diversity on these categories it became clear that the need for formal correct etiquette and the rejection of abbreviations and emoticons was strongly determined by a user's conscientiousness and age (see Fig. 7.7). Interestingly the desire for formal correct writing was not influenced by our measured user diversity factors, but much rather seemed to be a user characteristic on its own. The degree to which a user likes to use social media only showed a positive influence on the degree to which communication was perceived as disruptive to ones workflow (i.e. the more someone likes social media, the less he perceives it as disruptive). One must be careful to transfer these findings across cultural boundaries. Cultural influences on etiquette are immense and the findings presented reflect a German view on etiquette.

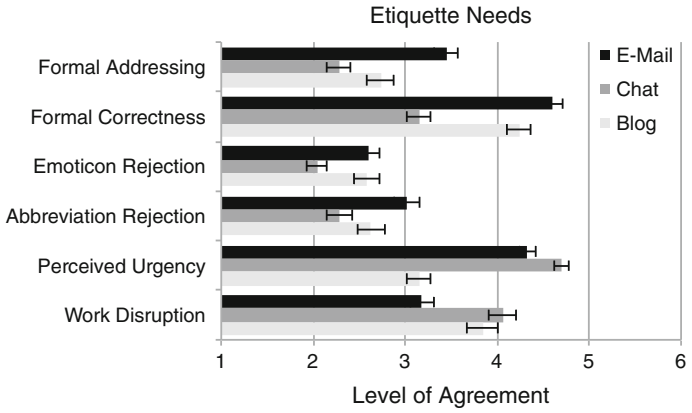

Fig. 7.6 Comparison of means of etiquette requirements [10]

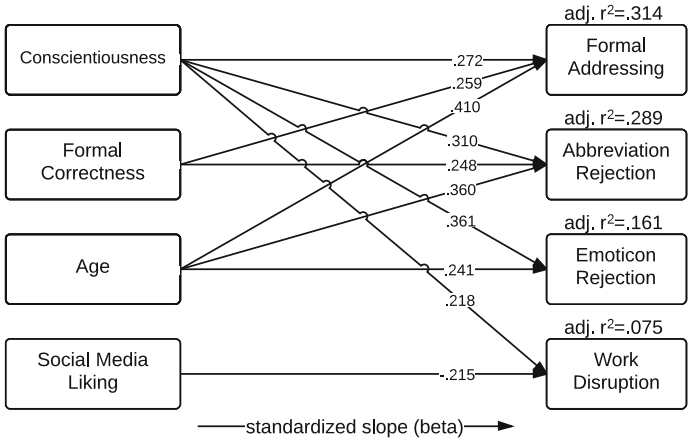

Fig. 7.7 Multiple linear regression analysis. Influences of user diversity factors on etiquette [10]

7.3.2.4 Summary Corporate Setting

The results from the "iNec" research project have shown that integrating the user early in the development of a social media based knowledge exchange system is essential for the success of the solution. Users demand a usable system, which protects the data, and enables friendly interaction. Fitting the solution to the individual requirements determines a system's usefulness. Furthermore usefulness depends heavily on usability, quality of content, and user participation. User diversity factors play a similar role in regard to data disclosure and etiquette needs. Incorporating the user's needs in regard to personal information disclosure is important, because it allows users to feel safe when entering data into a social media based knowledge exchange system. Age differences in user groups can bring along requirements regarding etiquette, which need to be understood, acknowledged and regulated by the company setting up the platform. Establishing a process model for communication based on such a system is highly recommended. Beyond the need to integrate the needs of current employees, one should consider the extended target group of potential employees when developing a knowledge exchange solution. Predictable development of demography forces knowledge exchange systems to be sustainable even in regard to hiring new employees, which offer another beneficial application of social media based knowledge exchange. Creating guidelines to elicit user requirements in specific situations of social media based knowledge exchange promises to aid in creation of viable solutions that can be successfully integrated into the infrastructure of companies.

7.3.3 Extension of Context: From an Industry to a Science Setting

The previous examples focussed on industry related social media for knowledge exchange. In a scientific setting similar needs for knowledge exchange exist. Strategic exchange of knowledge and knowledge management across disciplinary borders is necessary in both industry and science settings because of the structural similarity of the scenarios. Additionally disseminating technology from science to industry is a critical target of knowledge exchange.

The Cluster of Excellence "Integrative Production Technology in High Wage Countries" is a joint research effort at the RWTH Aachen University funded by the Excellence Initiative of the German federal and state governments [52]. The highly interdisciplinary research cluster is now in its second funding phase (of five years) and was evaluated positively for the first funding phase. In four cluster domains different topics of production research are engaged from researchers of 40 different institutes at the RWTH Aachen University. The similarity to a corporate setting and complexity of such an endeavor requires an effective knowledge management.

In order to cope with the huge demand of integrating the knowledge of the researchers across the cluster domains the so-called Cross Sectional Processes (CSPs) were instated. The purpose of three different CSPs is to ensure sustainability of the research cluster regarding people, scientific theory, and technology [53, 54].

During the first funding phase key *requirements* of the members of the research cluster were measured and tracked in order to support the workflow of the researchers. Among others, the following key tools were identified for knowledge organization and communication in a research cluster [52]:

- Knowledge organization
  - Balanced-scorecard-based performance tracking [55]
  - Doctoral coaching
  - Gender and diversity strategy development
  - *Knowledge management systems*
  - *Expert maps*
- Communication
  - Cluster conferences
  - *Knowledge platforms*
  - Scientific colloquia
  - Student conferences
  - Diversity teams
  - Inclusion of pupils
  - Customer-researcher workshops

The tools given in *italics* can be addressed using social media based knowledge exchange, because they focus on social aspects of knowledge. Campbell [56] stated

that "scientific knowledge is social". It exists in the shared knowledge of individual researchers and must be accessed socially. In order to enable both knowledge exchange and improved networking between the researchers of the cluster, the concept of the *Scientific Cooperation Portal* was devised—a social network for knowledge exchange in scientific cooperations.

Similar social software solutions in science settings exist. Many of the tools that are used are extensions developed from the field of CSCW [57]. Zheng et al. [58] created a social software for science support called TSEP to support collaboration between scientists. Similarly Li et al. [59] and Müller-Tomfelde et al. [60] highlight the need for shared workspaces and the need for audio-visual support in a health scenario setting. They also state, that the individual solution must be tailored to the requirements of the workgroup. Alves et al. [61] suggested the use of a system for finding possible collaborators that share a research interest to foster collaboration across institutional borders. Romano et al. [62] address the need for support in communication by using wikis and ontology based learning systems in the field of bioinformatics. In general tailoring the solutions to the needs of a potential user and his communicative [63] and motivational needs [64, 65] should also be regarded in a scientific setting.

The portal that we develop is a web-based service that addresses the requirements established from the first funding phase and includes the aforementioned functionalities. The underlying software architecture is a social networking site with added collaboration tools specifically suited for interdisciplinary scientific research. Beyond this software-based approach, additional measures like colloquia, seminars, and trainings are also offered. A strong orientation along users requirements has also been shown to be important in a scientific setting.

7.3.3.1 A Social Network for Scientific Cooperation

As features of the *Scientific Cooperation Portal* different applications are provided. One application addresses the problems of differing scientific terminologies, offering an interdisciplinary view on shared terminology between cluster domains, without losing the rigor of disciplinary definitions. Creating a concept of differing understandings of terminology is a key aim of the terminologies application [66].

In order to simplify project planning and communication of research plans the application "FlowChart" is created. The main focus of this application is to visualize the dependency of work-packages and results of a research process, as well as tracking of progress. This enables both researchers as well as industry partners to communicate more effectively about their research projects [67].

Another feature deals with the specificity of a platform within a production technology setting. Technology transfer and in particular knowledge about available technology within a cluster can be assisted through a *technology platform*. One goal is to create transparency of the technologies developed within the interdisciplinary research cluster as well as the technology experts behind them. In a first step, the technology transfer portal will be part of the Scientific Cooperation Portal

and will only be accessible to members of the cluster. Later on, public access will be granted to dedicated information in order to open up the cluster technologies to external interest groups such as potential industrial partners or external research institutions. To ensure usage of the portal findings from related research projects carry over to the development of the Scientific Cooperation Portal. The benefit of this platforms is, that without too much additional effort communication of technology to external stakeholders or business partners can be integrated into the workflow from within the cluster (see Sect. 7.2.4 for further information). Thus technology platforms connect the process of internal and external technology communication.

Improvement of networking of members is addressed, by providing yellow pages of all cluster members. The yellow pages contain information about the hiring institute, contact data and research focus. A visual representation of collaboration is achieved by a tool that employs *Publication Relationship Analysis*, which focuses on the scientific output of the cluster.

7.3.3.2 Sharing Non-personal Sensitive Data in Social Networks?

One feature of the *Scientific Cooperation Portal* presented here in detail is the *Publication Relationship Analysis* application. Scientific publications are one important output of scientific work that provide information on collaboration, external reception, and scientific content. Publications contain the actual research results. They can therefore be used to indirectly measure the social network of participating researchers, the growth of knowledge, but are also often used as a key performance indicator.

If integrated into a social portal the presentation of publication data in regard to knowledge exchange could allow showing core competencies of research groups by analyzing keywords, terminology, and additional user given input. Extracting referenced literature and mapping the "reference base" of research groups could allow new members of the cluster to identify key publications to read. This could help compensate for the fast staff turn-over in scientific settings. Additionally it allows finding key knowledge agents that have a better overview over cluster-relevant scientific output in form of publications, patents, and technology profiles. Making this knowledge available for external stakeholders is considered highly beneficial for the research cluster, as it provides a core means of disseminating innovations into industry.

In an interview study [68] with interdisciplinary active researchers (N = 5) we investigated properties of this approach. In particular we looked at applicability of information presentation for analyzing interdisciplinarity and the chances of a visualization being a support in the research process settings. As key benefits of this approach *positive impact on work performance*, advantages in the *planning* process, and the possibility of *retrospective analysis* were identified.

This very positive feedback was nonetheless contrasted with key barriers. Participants mentioned in particular that forms of visualizations could be *missing*

information besides publications that are also indicative of interdisciplinary cooperation. Additionally a visualization does not give feedback about the *quality* of the publications, and might have a negative influence on the workflow (i.e. increase of social pressure).

The interview study led to the conclusion that different types of data presentation are needed to be employed and to tackle the different goals of the platform. In order to enable *self-measurement of success factors* for the individual scientists an ego-centric view of the data (i.e. showing only the user's own publications [69, 70]) should be provided. This allows individualized feedback and enables the user to understand his own publishing behavior. By adding additional meta-data from a full-fledged social portal (like a Scientific Cooperation Portal) some of the missing data could be added to this view. This allows to give the researcher a profile-based view on all his research activities. Furthermore this egocentric view prevents negative impacts like social pressure, because individuals cannot compare their results directly. Adequate evaluation (in particular comparison) of two researchers in an interdisciplinary setting requires a certain amount of training to apply corrective factors according to the researchers diversity factors (e.g. length of scientific career, discipline, career goals, etc.).

Summarizing we can say that even publicly available information (i.e. publication data) can become a sensitive topic, when presented in a centralized manner. Employees as well as researchers are both aware of possible risks of disclosing personal or work related information. Not knowing who might look into ones profile can bring along a feeling of uncertainty, which hinders the willingness to disclose information in the first place. Therefore it is essential to engage potential users early in the development process and regard possible barriers early on.

In this context it is interesting to see whether the need to hide or disclose performance data may vary with personal factors (e.g. personality, age), or with contextual factors viewable within the platform (e.g. discipline, etc.), or rather social factors (e.g. relationships of friends, close collaborators, persons in a close spatial work environment). Furthermore, it could be studied how the willingness to disclose personal information might change over time, as barriers might change due to usage.

7.4 Conclusion

The spectrum of social media for knowledge exchange encompasses both industry and scientific applications. Both settings are highly knowledge dependent and struggle with staff-turnover and the resulting need to improve knowledge exchange and secure knowledge sustainably. In one case this is triggered by demographic change in the other by short-lived academic contracting.

The specificities of these scenarios bring along specialized needs that need be tackled by individualized solutions. The spectrum of social media for knowledge exchange applications can range from talent onboarding (see Sect. 7.2.3), over

scientific social knowledge exchange (see Sect. 7.3.3), over generational knowledge exchange (see Sect. 7.3.2), to technology transfer applications (see Sect. 7.2.4).

The differences in user diversity in these scenarios play a important role in establishing suitable requirements for a social media knowledge exchange system. The benefits of these systems can only be reaped when users actually integrate the system into their daily workflow. Integration can only be reached when the users see benefits in using the system for their work. Usefulness and ease of use have traditionally been shown to influence acceptance of ICT but provide only a limited view on systems that depend immensely on user participation. In addition to the basal necessity of usefulness and ease of use, quality of content and social interaction are both necessary and sufficient and thus central conditions for success.

A systematically user-centered approach when designing a social media based knowledge exchange system is highly recommended in order to synchronize the goals of the system with the goals of the future users. Our results have shown that respecting user diversity in regard to willingness to disclose personal information lower the entry barriers for using such a system, while explicitly defining social norms for communication improves the perception of daily use by establishing a consistent and matching etiquette. Most critically, the success will depend on the fragile acceptance of social media etiquette. Even though it is a factual need, companies should not just urge the members to use it. Employees will use it if they have the chance to individually tailor the way of using the system. This includes different needs of privacy, a different sensitivity to social pressure and the human wish to control systems [71, 72].

A tailored concept of features aligning with the specificity of the usage scenario paves the way for triggering motivation to communicate, participate, and collaborate in a social media based knowledge exchange system. Connecting all considerations about user requirements promises to offer an improved fit of user and technology, which enables a system to become a “social” network. These networks can contain two different kinds of connections—strong and weak ties. While the strong ties of a social network are important for daily work, weak ties are a source of innovation. The strong ties of a social network can benefit from social media applications that enhance the necessary daily knowledge exchange by adding further means of communication to the repertoire of employees. Even work-based strong ties can be achieved and fostered when employees are globally distributed across various time zones or are take part in location-independent flexible work models (e.g. home-office, parental leaves, sabbatical). Leveraging the strength of the weak ties in ones social network by making them readily available is crucial for any innovation processes. Social media based knowledge exchange activates this network by making the connections visible, accessible and navigable. Weak ties can exist intra-organizational in larger companies but also across borders of organizations with potential employees or business partners. In a connected globalized world it is essential to ensure integration of new generations of employees and the complete network of possible customers/partners early on. Weaving both strong and weak ties into a tighter social network via social media can attain sustainability of knowledge for both industry and academia. Integrating the findings from both

worlds has lead to a deeper understanding of how to improve modern approaches of knowledge exchange and management through social media. It is essential for both industry and academia to allow knowledge to permeate through organizational borders (in a controlled manner) to retain sustainability in a globally connected world.

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Part III
New Approaches and Technologies for Knowledge Acquisition

Chapter 8
Context-Aware and Process-Centric Knowledge Provisioning: An Example from the Software Development Domain

Gregor Grambow, Roy Oberhauser and Manfred Reichert

Abstract With the increasing availability of information and knowledge, effective knowledge utilization is becoming a growing and key competency within organizations in various knowledge-intensive fields. One current challenge in process-oriented work, such as that exhibited in new product development projects, is the provisioning of contextually-relevant knowledge to the knowledge workers at the appropriate point in their process. This chapter provides background on technical challenges, referring to the software engineering domain to exemplify these. Thereafter, a practical solution approach based on the Context-aware Software Engineering Environment Event-driven framework (CoSEEEK) is presented. Subsequently, it is shown how automated knowledge provisioning within processes, contextual adaptation of processes, and collaborative process support can be realized.

Keywords Context awareness · Process awareness · Automatic knowledge provisioning · Knowledge management · Semantic processing

8.1 Introduction

In various domains, process-orientation and explicit process management are beneficial [1–3], fostering both project efficiency [4] and product quality [5–7]. However, the quality of process-oriented work in various knowledge-intensive

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domains depends on the proper utilization of available knowledge[1] by knowledge workers [8–10]. Respective domains include healthcare, software, and automotive; especially new product development is a knowledge-intensive task [11, 12]. From a knowledge perspective, organizations develop their own local organization-specific knowledge systems [13]. In turn, these may overlap with other knowledge systems (e.g., discipline-specific, product-specific, market-specific, etc.). To a limited degree, such human-based knowledge systems may be represented within IT-based knowledge management systems (KMS) [14].

Drucker [15] has argued that knowledge-worker productivity will be the biggest managerial challenge of the 21st century. When considering current IT-based KMS solutions, knowledge utilization and effectiveness remains an issue [16]. While a KMS can store and retrieve knowledge, it does not really solve the real problem: providing the required knowledge to the right person at the right time for dealing with the right situation. For instance, retrieval and dissemination of the stored knowledge can become problematic when knowledge is highly dependent on the process and context of the participating persons. Typically, knowledge workers are responsible and tasked to retrieve and utilize knowledge on their own (active, free-access retrieval). However, this can be problematic and inefficient in certain situations. For example, not all workers may be aware of the knowledge they should attempt to retrieve (e.g., new knowledge or changes to the knowledge store) at different points in time or while working with new processes. Additionally, humans are prone to forgetfulness, especially in stressful situations, and therefore, even manual retrieval can become problematic.

Thus, the automatic contextual filtering and provisioning of structured knowledge, as well as the automated realignment of processes to changing knowledge, will become increasingly important KMS capabilities, especially in light of the increasing proliferation of information and knowledge. In order to cope with these issues, systems must be aware of context, processes, and knowledge to have the following capabilities:

- Provision knowledge to workers that is aligned with the task at hand.
  Knowledge is typically relevant only to specific situations. Knowledge redundancy (e.g., providing knowledge the human is already well aware of) or overload (e.g., too much knowledge at once) may be detrimental, in that the KMS may be ignored or rejected.
- Adapt users' processes to knowledge and context changes.
  Processes in knowledge-intensive fields may need to adapt the sequencing of activities to align themselves to the knowledge or contextual situation.
- Use knowledge to support collaborative processes.
  This includes automatically inferring impacts of any process activity and notifying or including appropriate collaborators in the processes.

[1]Since knowledge can be transformed into information when articulated, and information can be turned by a mind into knowledge, this chapter uses these terms interchangeably.

This chapter provides insights into how an automated information system can support the above capabilities. In particular, it addresses the following questions:

- How should information be stored to enable automatic information processing and dissemination?
- How can information be automatically distributed to those need it?
- How can the relevant information be injected at the right point into the users' operational process?
- How can a process be automatically realigned based on changes to knowledge?
- How can collaborative work be supported with knowledge?

Our knowledge management approach is illustrated with examples from the software development domain. Within the field of software engineering (SE), software development projects are collaborative, knowledge-intensive, and process-centric [17]. They exhibit the aforementioned issues and represent a knowledge management (KM) environment in which the three capabilities enumerated above can be exemplified. Developers and testers may participate collaboratively in multiple projects dealing with different products simultaneously and on teams that may be globally distributed. Due to resource and schedule constraints, developers should be able to enter and leave projects quickly and efficiently, which can be daunting considering that complex tasks require specific knowledge. Processes that should govern such tasks are usually manually implemented without automated guidance—presenting a further challenge for process-awareness, and these knowledge-intensive processes need to adapt to the dynamic knowledge situation. With regard to context, since the involved artifacts, tool chain, and actors are solution-oriented, the environment can be heterogeneous with dynamic contexts playing a significant role. Effective KM remains a crucial factor for successful software projects [17]. This chapter gives a comprehensive overview about the different knowledge management capabilities of our approach and system. Further reading to the discussed features can be found in our prior publications and the upcoming doctoral thesis of Grambow [18–25].

This chapter is organized as follows: the next section provides an overview of current approaches. Section 8.3 describes issues in knowledge-intensive projects, including problems and general requirements. Section 8.4 presents a solution approach, including a concept and an implementation framework for the SE domain. Then, Sect. 8.5 illustrates automated knowledge provisioning within processes, while Sect. 8.6 focuses on the knowledge-based contextual adaptation of processes, and Sect. 8.7 shows how knowledge-based collaborative processes are supported. Finally, Sect. 8.8 summarizes the chapter and designates future challenges. A glossary and references are provided at the end followed by a section with additional resources for the reader.

8.2 Overview of Approaches in the Software Engineering Domain

This section discusses various approaches, focusing on the example domain of SE. KM in complex and knowledge-intensive projects requires more than only storing and retrieving knowledge. A tool or system that aims to comprehensively support knowledge workers must provide holistic support for the entire project and for the collaborating knowledge workers. Therefore, approaches beyond the classical KM category are discussed that provide project and collaboration support for SE knowledge workers. Another factor especially important in SE is knowledge about the produced product and its quality. Therefore, approaches supporting software quality management (QM) are mentioned.

SE Knowledge Management Bjørnson and Dingsøyr [26] provides a systematic review of studies on the application of KM in SE, categorizing the studies according to the various KM schools: systems, cartographic, engineering, commercial, organizational, spatial, and strategic. Kurniawati and Jeffery [27] presents a study about the usage of a process-oriented KM tool in a small-to-medium-sized software development company. In particular, this tool allows for web-based documentation and support for the SE process model. The study showed good acceptance of the tool and that it really does support the developers. The approach presented in [28] focuses on KM, considering various risks in SE projects. The approach incorporates the modeling of risk archetypes and scenarios to model risk impact and resolution strategies as well as to provide reusable project management knowledge. Basili et al. [29] presents the knowledge dust and pearls approach, which aims to facilitate the application of an experience base containing information that has been analyzed and organized into experience packages. Looking beyond the SE domain, [30] presents a study of various KMS classified in different areas: knowledge-based systems, data mining systems, information and communication technology, database technology, modeling, and expert systems providing decision support. The presented approaches narrowly focus on management, storage and retrieval of information.

SE Quality Management Support The quality of the produced product and related knowledge involved are crucial success factors for a project. In order to be able to provide automated support for QM, continuous awareness about the quality state is crucial. Source code metrics are one means in SE of assessing quality. In [31], a report is provided about the application of such a metric program at Motorola. It describes a set of different views on metrics to support their successful application and reports success in several areas by using software metrics. Offen and Jeffery [32] describes a formal meta-model enabling measurement in SE. It puts strong focus on storing, interpreting and analyzing gathered data. Further, a practical framework is also developed supporting the creation of models for software measurement, connection of these to measurement tools, and storage of the results.

A comprehensive industry survey about the success of metric programs is presented in [33].

However, these approaches only deal only with the use of metrics, but not with tool-supported automated QM quality management. In the following, therefore, a selection of approaches concerning automated measurement tools is discussed. PR-Miner [34] enables automated analysis of source code and efficient and automated extraction of implicit, undocumented programming rules from it. Further, it automatically detects violations to these rules. Another tool is the Empirical Project Monitor (EPM) [35], which aims to support effective software process management by providing quantitative data. It collects and measures data from different repositories within software development support systems and presents that data graphically to the users in order to generate an awareness of the project progress. The collection and aggregation of data about users' programming behavior is offered by the modular framework ElectroCodeoGram (ECG) [36]. It comprises a set of sensors as well as modules for integrating the data gathered by the sensors. ElectroCodeoGram provides micro-process data to support researchers in understanding how programming is carried out on a fine-grained level. A similar approach shown in [37] is called SUMS (Standard User Monitoring Suite). SUMS features acquisition facilities for different programming languages, applying neural networks and Bayesian analysis to achieve automated learning features. While the mentioned tools offer advanced data acquisition, aggregation, and interpretation facilities for different kinds of data in SE projects, they address a relatively narrow quality area.

SE Collaboration Support Knowledge-intensive projects typically require communication and collaboration among knowledge workers in order to work on complex tasks. Existing approaches support such collaboration with related knowledge. For example, CASDE [38] and CoolDev [39] make use of activity theory. CASDE supports mutual awareness between different actors and their activities via a role-based awareness module. In turn, CoolDev manages activities performed by a single person in the context of global cooperative activities. It is realized as an integrated development environment (IDE) plugin capable of monitoring activities carried out with other plugins. Another approach is taken by CAISE [40], a framework that enables the integration of other SE tools and supports the development of new SE tools based on collaboration patterns. Other frameworks like Syde [41], SPACE [42], and ADAMS [43], take an artifact-centric approach. Syde is based on an extended view on source control management. It can automatically inform every developer about any changes another developer makes, even if the changes have not yet been synchronized to the common code repository. It enables synchronous development. SPACE (Semantic Process- and Artifact-oriented Collaboration Environment) takes another approach by managing two types of interconnected models for processes and artifacts. That way it enables a set of supportive features, e.g., personalized user views or comprehensive artifact traceability. ADAMS (ADvanced Artefact Management System) is even more

artifact-centric: it models the whole project in terms of its artifacts. Thus it features sophisticated versioning and locking approaches, fine-grained traceability of the artifacts, and an event module capable of informing users about any relevant event. The above mentioned tools focus on the collaboration perspective of humans and activities and neglect other aspects of comprehensive KM.

SE Project Support Numerous approaches exist that aim at providing some kind of SE project support based on knowledge. Respective approaches mostly target a distinct area. For example, [44] describes knowledge support approaches during process execution, consisting of the domain-oriented software development environments (DOSDE) as well as the enterprise-oriented software development environments (EOSDE). Another category of approaches for SE project support puts it focus on a model-driven approach. Representatives of this category include the Transforms Environment [45] and the model-driven approach described in [46]. Being situated on the M2 level of the OMG model layers, the Transforms Environment uses parts of the SPEM process meta-model and tailors it for MDA processes. The model-driven approach suggested in [46] also applies a model-driven procedure, in this case in order to support deployment and variability of software processes. While all these approaches provide a certain amount of project and knowledge assistance, they lack a comprehensive approach to optimally support project participants in their context, knowledge, and with their workflows.

8.3 Current Issues

This section describes problem areas and requirements that a solution must address for knowledge provisioning in process-oriented and knowledge-intensive projects.

8.3.1 Problem Areas

Concerning holistic knowledge support for contemporary projects in various domains, the problem areas can be classified in two categories: direct knowledge-related problems about processed artifacts, human collaboration, or used tools; and process-oriented problems. Because these areas are intertwined, if these two problem areas are not addressed properly, effective IT-based KM is impeded. Figure 8.1 illustrates these problems in the context of the SE domain. The project is separated into three process domains illustrating the relation of concrete KM problems and related process problems. Domains such as these have been mentioned several times in the literature (e.g., [47] or [48]). Both of these are conceptually analogous, and we herewith use Dowson's. It distinguishes three domains.

- *Process modeling*: processes are modeled and process models, including actors, tools, or artifacts, are situated.

- *Process enactment*: the modeled processes are implemented by means of workflow management technology [49].
- *Process performance*: the real-world-process takes place, including humans, the concrete artifacts, or concrete software tools used by the humans.

Knowledge Management (Fig. 8.1 (1)). The first problem area concerns classical KM. This comprises, for example, knowledge about the correct use of tools and technologies in an organization, its organizational structure, or other concrete approaches like how to apply source control management for the artifacts produced.

Quality Management (Fig. 8.1 (2)). The second area deals with the assets produced in the organization: artifacts in the SE domain. In particular, knowledge about the quality of these artifacts, occurring problems, reported bugs, or approaches to bug fixing are of primary importance. Organizations are often not aware about the state of their products' artifacts. Problems often remain undiscovered and reveal themselves either near the end of a project or later during use by the customer. Proactive QM is often not implemented. When software quality measures are applied under high time pressure, they often disrupt the development process or do not match the applying person's situation or abilities, and are thus less effective and efficient.

Information Coordination (Fig. 8.1 (3)). Knowledge workers collaborate, and thus efficient and effective coordination is crucial. For knowledge workers, information about the tasks and artifacts processed by co-workers is vital.

As mentioned, these problem areas directly relate to various kinds of knowledge and are not the only ones for contemporary projects. The problem areas are all situated in the *process performance domain*, where users interact with real tools and with each other. Because such projects are often complex, their processes have to be planned, modeled, and explicitly managed. In particular, their implementation and use is crucial for effective KM. Therefore, in the following, three more generic problem areas relating to processes are discussed (as also illustrated in Fig. 8.1).

Process Automation (Fig. 8.1 (A)). Processes are modeled in the *process modeling domain* using specific process modeling tools and notations. In many organizations, explicit support for processes remains at that modeling domain level. Process implementation is considered as the activity of releasing a process model document to all process participants. When no PAIS are in place to govern or support the actual *process enactment*, the real-world process can often and easily deviate from the modeled process as it is executed in the process performance domain.

Context Integration (Fig. 8.1 (B)). While Process-Aware Information Systems (PAIS) can provide organizations with IT-based process support and help govern process execution, only a limited amount of the work actually done in knowledge-intensive projects is even captured in process models. The PAIS are often unaware about the tools used, the variety of (partly unexpected) events that happen in everyday work, or the great number of potentially interrelated artifacts.

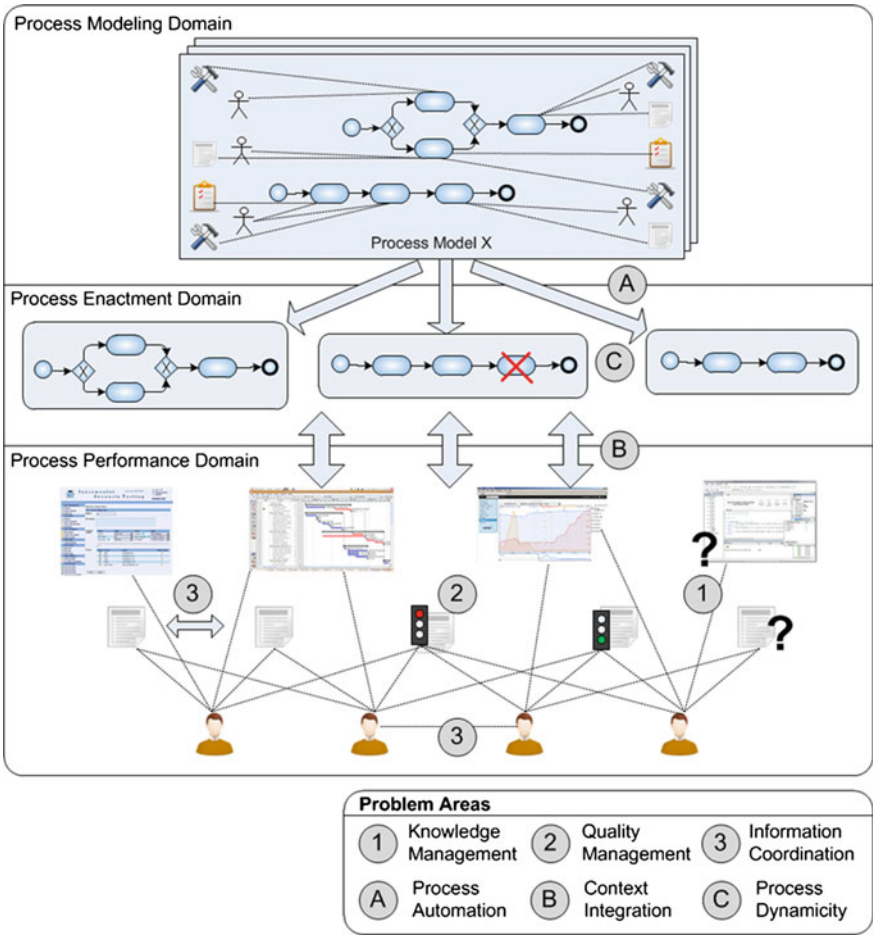

Fig. 8.1 Problem areas mapped to process domains

Thus the process, as it is really executed, differs from the one executed in a PAIS, and the latter becomes (at least partly) irrelevant.

Process Dynamicity (Fig. 8.1 (C)). Another problem with process implementation relates to the dynamicity of the executed process. If an organization has a system in place that governs and supports the process, the support provided by that tool can be beneficial in keeping the real world process aligned. But this mostly only applies as long as nothing requires a change in the operationally running process [50]. For example in SE, this can be a received bug report from an important customer that requires one or more developers to deviate from their standard development schedule.

8.3.2 Basic Requirements

For a system to cope with the above problem areas, it must fulfill certain requirements. These requirements are organized around the basic problem areas (RA relates to a requirement concerning problem area A from Fig. 8.1). The more advanced problems will be covered in dedicated sections: KM will be covered in Sect. 8.5, QM in Sect. 8.6, and information coordination in Sect. 8.7. Please note that fundamental system abilities such as distributing tasks to its users or correctness of process execution are presumed. Although the requirements are tailored toward the SE example domain to make them concrete, they can easily be adapted for other domains.

A system aiming for holistic process and knowledge support should incorporate the following features:

- *Additional Process Information* (RA.1): incorporate various types of supplementary information contained in process models (e.g., artifact hierarchies or supportive information like checklists). These should be integrated into the execution semantics of the executing PAIS to facilitate consistency between modeled and enacted processes;
- *Abstract and Operational Processes* (RA.2): model abstract processes (like the lifecycle of a whole project) and also operational concrete processes (like concrete development tasks). Both types of process areas (abstract and concrete) should be seamlessly integrated;
- *Seamless Integration* (RA.3): integrate seamlessly into everyday work. Usage should not be cumbersome and specific process or knowledge support should not distract users from their work;
- *Context-data Acquisition* (RB.1): automatically acquire context data from its environment, classifying the current situation;
- *Context-data Processing* (RB.2): automatically process acquired context data to react to changing contextual conditions;
- *Context /Process Integration* (RB.3): integrate acquired context data with its process model and the associated data to be able to align the enacted process with the actually performed process;
- *Dynamic Workflow Changes* (RC.1): enable changes to running process instances; and
- *Automated Workflow Changes* (RC.2): automate instance changes of running workflows to be able to autonomically react to changing situations.

8.4 Automated Knowledge Provisioning Approach

This section gives details on the basic solution approach comprising the abstract concepts as well as the implementation architecture of a system that enables comprehensive and holistic knowledge support for contemporary projects.

8.4.1 Abstract Knowledge Provisioning Concept

This section gives insights on the basic principles of the system we have developed that amalgamates a knowledge-based system (KBS) with an adaptable process-aware information system (PAIS) and a contextually-aware system. Figure 8.2 shows the major components in this concept.

Contemporary PAIS only offer a limited number of concepts like activities, workflows, data elements, users, and roles. To be able to execute processes in line with the actual project work, a system should have additional modeling capabilities. Our concept enables the integration of various interconnected entities that enable the explicit modeling of complex artifact hierarchies with diverse properties for each artifact (*Context Management* and *Knowledge Management* in Fig. 8.2). Further, it enables the relation of such artifacts to a similarly complex and flexible hierarchy of interconnected activities of different types (*Adaptable Process Management* in Fig. 8.2). Besides these, various other concepts are also implemented to enable a comprehensive modeling of complete process models for execution [20, 25].

Another limitation of contemporary PAIS is the fact that they mostly apply rigid and pre-defined workflows. In our opinion, rigid workflows applied in automated systems are an important cause for their dissonance in practice. Therefore, our concept not only comprises facilities to provide dynamic adaptation of running workflows for users (*Adaptable Process Management* in Fig. 8.2), but also to let the system perform automated process adaptations in alignment with context data representing the current project situation (*Context Management* in Fig. 8.2).

Context data is also crucial for a system that seeks to provide holistic project and process support. Therefore, our system integrates facilities to automatically gather context data from various sources (*Environment Sensors* and *Event Extraction* in Fig. 8.2). Further, aggregation and processing of the data is automated (*Event Processing* in Fig. 8.2), i.e., data can be delivered to the components that use it in a reasonable granularity and with more semantic value.

Providing automation in knowledge-intensive projects is challenging. A system aiming at comprehensive project support must be able to automate a large number of different types of tasks while still being flexible and transparent to the user. To enable this, our system combines different technologies for supporting different tasks: semantic web technology enables automatic classification capabilities, rule engine technology automates simple recurring tasks (*Rule Processing* in Fig. 8.2), and an agent system adds more autonomic capabilities (*Agent System* in Fig. 8.2).

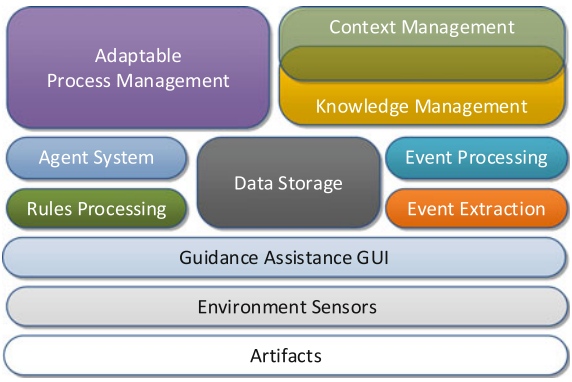

Fig. 8.2 Automated knowledge provisioning conceptual architecture (domain independent)

In order to enable a system to provide knowledge assistance in a holistic and automated way for entire projects, a more comprehensive approach to KM must be taken into account. Our system comprises an active KM component managing the user relevant knowledge in alignment with context data (*Knowledge Management* in Fig. 8.2). Furthermore, it not only stores and manages that knowledge, but also explicitly manages internal knowledge that enables the system to react to various situations in a project in an appropriate way (*Data Storage* in Fig. 8.2).

Finally, system providing comprehensive project support and tackling different areas necessarily implies a certain amount of complexity. Such a system involves a fair number of different components and modules and has to process various kinds of dynamic data. Enabling efficient communication of the different components with various kinds of data while preserving extensibility can be a serious issue. Therefore, all framework communication is event-based and loosely-coupled in order to be able to easily integrate new components as well as new kinds of data.

8.4.2 Knowledge Provisioning Framework

The concept above was then implemented for the SE domain and named CoSEEEK (Context-aware Software Engineering Environment Event-driven frameworK). It unites adaptive process management with semantic web technology and a sensor framework to provide holistic support for SE projects. Users can store and annotate knowledge in a semantic wiki and thus make it machine-accessible and -readable. To be able to not only transfer this knowledge automatically back to the users, but also to maximize the suitability and effect of that knowledge, CoSEEEK tailors it to the current situation of each and every individual participating in the project. This becomes possible on one hand by guiding the users with dynamic workflows; on the other by having a multitude of active sensors in various SE tools connected to the framework. These sensors provide accurate information on the various artifacts users manipulate in a project and also on tasks they execute even if they are external

to their planned workflows. This enables CoSEEEK to match meta information in the knowledge base to various properties of the situations the users are in, and automatically inject the knowledge into the users workflows. That way, users can be provided automatically tailored knowledge that matches their current needs. Figure 8.3 details the technical architecture of CoSEEEK followed by an explanation of the different components and their interaction.

The different parts of the concept previously discussed are realized by the different components shown in Fig. 8.3. To enable communication between the different components that facilitates extensibility and exchangeability, all communication is event-based using a *Data Storage* component for event storage. The integration of CoSEEEK with its environment is realized via an *Event Extraction* and an *Event Processing* component that enable the automatic acquisition and processing of events from other SE tools using sensors. Context data is then centrally managed by a *Context Management* component. To integrate the data with process execution and extend this with additional knowledge, the *Context Management* component is tightly integrated with a *Process Management* component that is in charge of workflow execution. The latter component also manages dynamic adaptations to workflows to conform to changing situations. To enable comprehensive knowledge support for entire projects, a separate component centrally manages knowledge. That *Knowledge Management* component is also tightly integrated with the *Context Management* component to facilitate context-based knowledge provisioning. Finally, an agent system and a rule engine offer tight integration of configurable automatisms into the framework to support users in their complex tasks.

In the following, the technical realization of the different components is briefly discussed. The event-based communication and storage within the framework is implemented via a specialized tuple space [51] that uses the XML database eXist [52]. Each module and the applied sensors can write in that tuple space and register to be automatically notified about events relating to a specific topic. The sensors are realized via the Hackystat framework [53], which offers a rich set of sensors that can be integrated into various applications like source control management systems or IDEs [cf. requirement RB.1 (Context-data Acquisition)]. The sensors automatically create events for various real events like the change of an artifact. Such events can be of rather atomic nature and with low semantic value. Therefore, to produce events with more semantic value and not burden the event system with numerous micro events, the complex event processing (CEP) [54] tool Esper [55] is applied to create higher-level events out of various low-level events [cf. requirement RB.2 (Context-data Processing)].

To enable CoSEEEK to apply various kinds of automatisms and act autonomously in various situations, the multi-agent system JADE [56] and the rule engine JBoss Drools [57] are integrated. An example for such automatisms is automatically determining an appropriate software quality measure to apply to counteract a detected quality problem in the source code, and then automatically assigning the measure to the appropriate user based on various factors. This will be further described in Sect. 8.6.

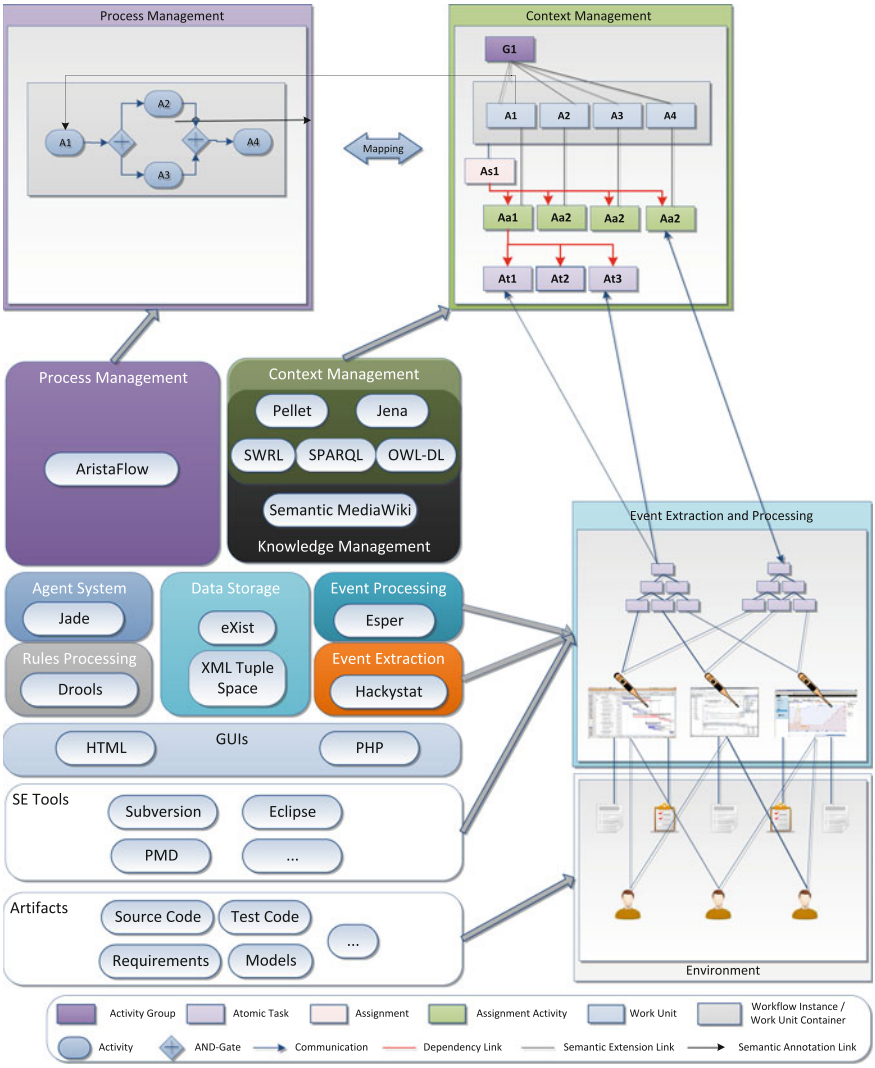

Fig. 8.3 CoSEEEK framework

For management of the workflows in CoSEEEK, the AristaFlow [58, 59] PAIS is integrated. It offers numerous advantages for the correct and dynamic enactment of workflows, featuring a correctness-by-construction principle that only allows the user to create correct workflows. This correctness is continuously enforced during the entire execution lifecycle. In addition, it enables dynamic changes even to running workflow instances [cf. requirement RC.1 (Dynamic Workflow Changes)] and guarantees the correctness of the workflows before and after the adaptations.

The *Context Management* as well as *Knowledge Management* components rely on semantic web technology. For user-related knowledge, the *Knowledge Management* component integrates the Semantic MediaWiki [60]. That way, the users can enter knowledge like in a common wiki, but can also semantically tag their entries, enabling automated usage of that knowledge by CoSEEEK. This will be further detailed in Sect. 8.5. Internal knowledge that the system utilizes with both components is stored within an OWL-DL ontology [61]. To exploit the full potential of the semantic web technology, the reasoner Pellet [62] is used together with the Jena framework [63] for programmatic access to the concepts. In addition to that, rules can be applied via SWRL [64] within the ontology, and queries can be posed via SPARQL [65].

The ontology is not only used to model contextual data, it is also tightly coupled with the *Process Management* component in order to realize useful extensions to the workflows and model complete process models [cf. requirement RA.1 (Additional Process Information)]. That way, it is also possible to enrich operational workflows with various granularities of activities and additional user-related information. It abstracts from the internal workflow logic (cf. [18]) to make workflow use less cumbersome for humans [cf. requirement RA.3 (Seamless Integration)], while still being able to automatically govern the abstract processes to which the operational workflows belong [cf. requirement RA.2 (Abstract and Operational Processes)]. Furthermore, by the close integration of process-related information in the ontology with the contextual data, a seamless integration of both can be applied [cf. requirement RB.3 (Context/Process Integration)]. This tight integration of the Context Management and Process Management components makes it possible to automatically utilize context data to apply automated adaptations for aligning the process with reality [cf. requirement RC.2 (Automated Workflow Changes)].

The environment of CoSEEEK, which primarily consists of artifacts, humans, and tools within a project, is integrated in two ways: the entities are modeled in the *Context Management* component and, via sensors, their state can be kept up to date with the real world entities. For providing the supporting and governing functionalities, CoSEEEK offers a set of simple web-based GUIs. To enable seamless integration into everyday work [cf. requirement RA.3 (Seamless Integration)] and not disturb the software developers, the main GUI was also realized as a plugin for common software IDEs like Microsoft Visual Studio and Eclipse.

8.5 Automated Knowledge Provisioning in Processes

As stated, knowledge worker projects as well as the knowledge management can be challenging. In particular, this applies to SE as it involves new product development, which is a knowledge-intensive task [11]. Further, software processes can be mostly considered as knowledge processes [66]. It has been shown that an automated system supporting KM can be beneficial [67]. In SE projects, nowadays,

wikis are often used for such tasks as they enable distributed access to knowledge. However, the retrieval of respective knowledge is often problematic as the knowledge organization in a wiki used by dozens or even hundreds of people can be challenging [68]. For example, if one developer encounters a best practice for a recurring situation, e.g., the application of a design, he might enter it in such a wiki. The retrieval of that information is problematic. On the one hand, the information is only passively stored and another developer might not even be aware of its existence when encountering a problem. On the other, even when using the wiki, the information might not be found because one might search quite differently than the one who stored the information had in mind. This section gives insights on the knowledge provisioning concept we have created. For further reading on that topic see [21, 22]. Section 8.5.1 discusses specific requirements, while Sect. 8.5.2 shows the different components involved. Section 8.5.3 discusses the specific concepts, and the last sub-section gives a concrete example for automatic knowledge provisioning.

8.5.1 Knowledge Provisioning Requirements

To overcome the aforementioned problems, a system aiming for holistic process and knowledge provisioning should incorporate the following features:

- *Knowledge storage* (R1.1): store user-relevant knowledge in an appropriate way;
- *External knowledge integration* (R1.2): integrate knowledge from external sources;
- *Automatic knowledge access* (R1.3): automatically access, use, and distribute knowledge stored in the system;
- *Context-data utilization* (R1.4): utilize contextual information to select appropriate knowledge for different situations and persons;
- *Knowledge injection* (R1.5): automatically inject knowledge into process enactment and performance; and
- *Knowledge provisioning configuration* (R1.6): enable users to configure knowledge provision.

8.5.2 Knowledge Provisioning Components

To meet the above requirements, we developed a system that comprises tightly integrated active components relating to process, context, event, and knowledge management. These components and their interaction are illustrated in Fig. 8.4.

Recalling the requirements, effective knowledge management and provisioning necessitates that information suitable to the user's situation be seamlessly integrated

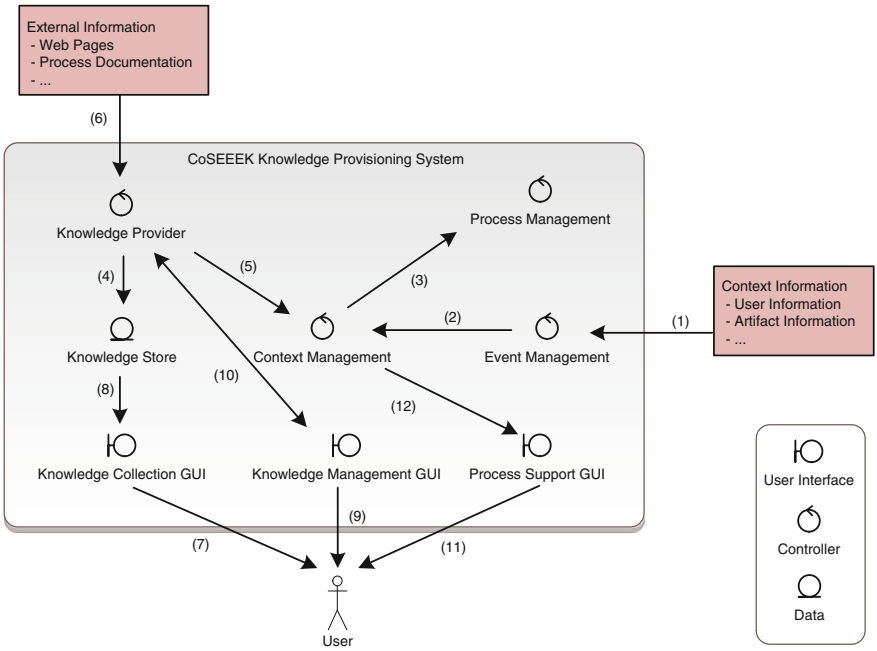

Fig. 8.4 Knowledge management components (using symbols from robustness diagrams)

into his or her current process. This is achieved by the integration of multiple components as described in the following. The *Context Management* component, a central component of the system, stores information about users, artifacts, tools, and various other project entities. The *Event Management* component, in turn, automatically collects information from the environment by the aforementioned sensors (1) and delivers it to the *Context Management* component (2) [cf. requirement R1.4 (Context-data utilization)]. The *Process* and *Context Management* components are tightly integrated and together realize the enactment of entire process models. The *Knowledge Provider* that is in charge of managing the provision of knowledge to users directly communicates with the *Context Management* component (5), and thus has direct access to context information [cf. requirement R1.4 (Context-data utilization)] and to process information [cf. requirement R1.5 (Knowledge injection)].

As also mentioned in the requirements, automatic knowledge provisioning relies on effective acquisition and storage of the knowledge and the ability of the provisioning system to access and utilize that knowledge. The storage is realized by a separate component called the *Knowledge Store* [cf. requirement R1.1 (Knowledge Storage)]. The latter allows the *Knowledge Provider* semantic access (4) [cf. requirement R1.3 (Automatic knowledge access)] to the stored knowledge that is obtained from a special *Knowledge Collection GUI* (8) that allows users to enter and tag their knowledge (7).

However, even if a system contains useful knowledge for users, it would still be marginalized by users if it is unable to deliver it in a way fitting to their current tasks and workflows. Therefore, the knowledge chosen by the system is passed from the *Knowledge Provider* to the *Context Management* component (5). That component, in turn, utilizes its tight connection to the *Process Management* component (3) to determine the time point to inject the knowledge in the process [cf. requirement R1.5 (Knowledge Injection)] and then deliver that knowledge to the *Process Support GUI* (12) that makes it visible to the user (11).

Finally, even if a knowledge provisioning system is effective, it will never comprise all possible matching knowledge. Therefore, the integration of external knowledge sources is managed by the *Knowledge Provider* (6), so that these can be easily provided to users [cf. requirement R1.2 (External knowledge integration)]. The configuration of external knowledge and the entire knowledge provisioning process can be managed by users by utilizing the *Knowledge Management GUI* (9) [cf. requirement R1.6 (Knowledge provision configuration)], which communicates with the *Knowledge Provider* (10).

8.5.3 Knowledge Provisioning Process

This section discusses how knowledge is managed within the system. To be able to explicitly reference and provide each unit of information, a separate concept has been introduced in the ontology that is called a *Guidance Item* (GI). It is used by the *Knowledge Provider* to access and classify the knowledge integrated into the system. The GI has a set of properties enabling information management. The relevant ones are shown in Table 8.1.

The properties of the GI comprise information about the knowledge represented by the GI as well as information relevant to contextual knowledge provisioning. However, the knowledge must be injected into the user's process in a defined way to make it effective. This is governed by four distinct properties, managing when

Table 8.1 GI properties

Type	Knowledge can occur in various types that are distinguished by this property, like checklist, information, best practice, notice, or tutorial
Origin	This property denotes if the GI is stored within the system or coming from an external source
Compilation	This property denotes if the GI is static or if the system dynamically compiles it. In the latter case, the system matches entered tags users add to the knowledge in the Knowledge Store to process and context information and thus creates specifically tailored knowledge support for the users' situation
Tags	This property contains tags used to dynamically compile knowledge for users with dynamic GIs
Link	This property stores a direct link to the knowledge represented by this GI if the GI is static

Table 8.2 Knowledge injection properties

GI alignment	This property governs how the knowledge is shown to the user in relation to the activity it relates to. 'Pre' means that the GI is shown at the beginning of an activity and 'Post' means it will be shown at the end of an activity
GI alignment	This property indicates if the lifecycle of the GI is tied to the lifecycle of the relating activity. If so, the GI will only be available as long as the activity is active
GI usage	This property distinguishes between the values 'Required' and 'Optional'. Required GIs must be reviewed by the user and can even block activity termination if they are tied to an activity
Item Compilation	This property relates to the GI's 'Compilation' property and manages how the system uses runtime context information to dynamically compile GIs matching the current situation. One example would be a database development checklist for junior engineers

and how to apply knowledge support to different kinds of activities as shown in Table 8.2.

Not all combinations of these properties are allowed, for more information see [22].

8.5.4 *Knowledge Provisioning Example*

Recalling the introductory example from this section, this subsection gives a brief concrete example for our knowledge provisioning concept that is illustrated by the following figure and explained afterwards.

During the course of a project, different steps are performed to enable automated knowledge provisioning as illustrated in Fig. 8.5.

1. Utilizing the Knowledge Collection GUI, users can collect knowledge while working in a project. They can tag this knowledge to support later discovery by humans or any automated system. Examples of tags on that information include

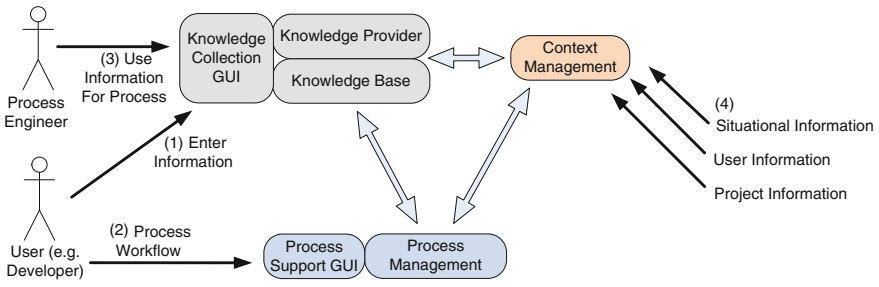

Fig. 8.5 Knowledge provisioning example

'junior' to indicate applicability for junior engineers, or 'backend' or 'frontend' to relate them to a specific implementation area. As a concrete example for this, Fig. 8.6 shows such a knowledge collection GUI concretely depicting different items of knowledge (guidance) a user has created.

2. The process of the project is managed and governed automatically by the system, including various operational workflows belonging to the process. Activities to be processed by humans are automatically delivered to them. Examples of activities governed that way include 'Implement Solution', where new source code is developed, or 'Run Developer Test', where source code is tested by the developer.
3. The governed workflows can be annotated by process engineers to make use of GIs and thus automatically deliver knowledge to the other users. Examples for such GIs include implementation or testing checklists, or specific notes as, e.g., hints about a relevant design pattern.
4. Applying a multitude of sensors in various applications, the system continuously detects new facts about the current situation. This makes it possible to tailor the knowledge provision to the user's current situation. For example, a junior engineer working at the frontend of an application could be provided a pre-GI containing the aforementioned item concerning a GUI-related design pattern when starting his 'Implement Solution' activity.

8.6 Knowledge-Based Contextual Adaptation of Processes

For manufacturers, the state and quality of their produced product is of primary importance. Therefore, knowledge about the product, its quality, relating problems, and quality measures to overcome the problems are crucial. Quality and quality

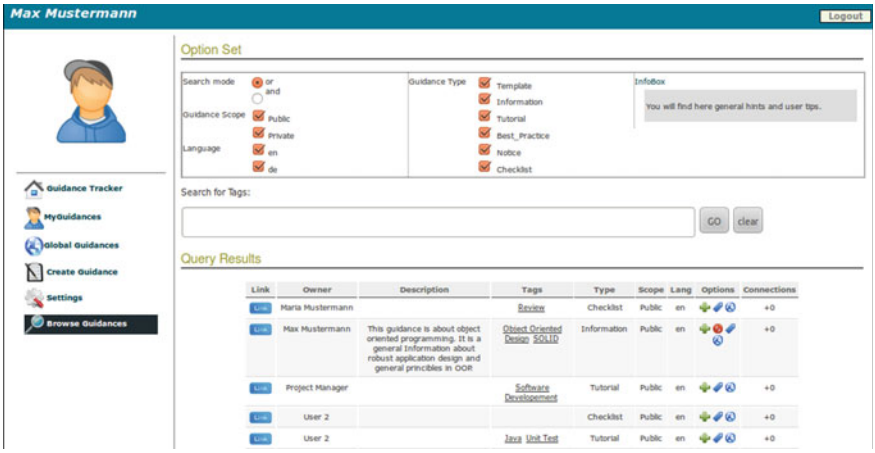

Fig. 8.6 Knowledge collection GUI screenshot

issues should typically be viewed holistically. For SE, software is intangible, and acquiring and relating quality issues to source code artifacts can be problematic. Furthermore, the effective and efficient application of software quality measures to proactively improve the product's quality as well as reactively correct discovered quality issues is even more challenging. One way to address quality issues systematically is to utilize knowledge to adapt processes in alignment with the users' context. For further reading on that topic see [19, 20]. This section is organized as follows: Sect. 8.6.1 introduces the knowledge-based adaptation concept, Sect. 8.6.2 elicits advanced requirements for such an approach, and Sect. 8.6.3 extends the presented approach to satisfy these requirements.

8.6.1 Concept for Knowledge-Based Contextual Adaptation of Processes

As a concrete scenario to illustrate this concept in the SE domain, we will use the automated integration of quality measures into processes. To support this critical area, we have integrated facilities into CoSEEEK that enable the automated integration of software quality measures into the development process via dynamic workflow adaptations. This section will introduce the basics regarding this facility by a simple example. It deals with proactive quality measures that users have identified as being useful, and have been entered into the knowledge base to be easily reused. Figure 8.7 illustrates how our system can facilitate such knowledge reuse actively.

As aforementioned, the user (e.g., a developer) enters a proactive software quality measure (an advice to analyze the modularity of the source code to proactively aid maintainability) into the *Knowledge Store* via the *Knowledge Collection GUI* and tags it in a way such that the system can identify it as such. It is thus available for other users when they are processing tasks relating to software development. In Fig. 8.7, such a workflow is shown: it is the 'Develop Solution Increment Workflow' that deals with the development of new software from the OpenUP [69] process. CoSEEEK governs that workflow within its *Process Management* component and manages related additional information and entities, like the processed artifacts or checklists in the *Context Management* component. That way, CoSEEEK's *Knowledge Provider* is aware of the activities and artifacts of the user's process and can thus provide matching information. In this example, CoSEEEK can automatically integrate a new activity relating to the proactive software quality measure right after the 'Implement Solution' activity, since it was detected that this quality measure would match the artifacts processed by that activity. With this approach, a seamless integration of QM with normal process execution is achieved.

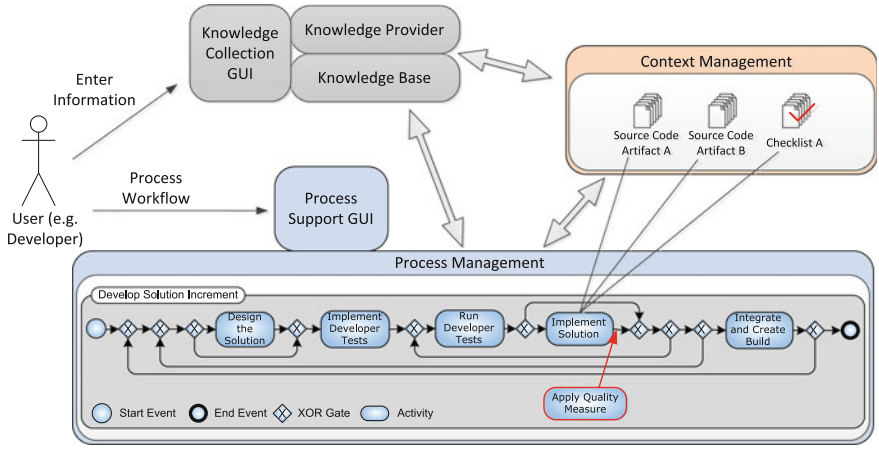

Fig. 8.7 Knowledge integration example

8.6.2 *Requirements for Knowledge-Based Contextual Adaptation of Processes*

In reality, a multitude of different factors influence quality measure provisioning. If they are not considered, the latter cannot be executed in an effective and efficient way. Section 8.6.3 will introduce a more complex extended approach to quality measure provisioning. A system aiming for holistic knowledge-based contextual adaptation of processes should incorporate the following features:

- *Problem awareness* (R2.1): be aware of problems in the assets produced within the organization (e.g., source code for SE);
- *Opportunity awareness* (R2.2): be aware of opportunities when users could apply actions (e.g., quality measures) to improve the situation (e.g., the quality of an artifact) without significantly delaying the process;
- *Strategic action alignment* (R2.3): strategically align possible actions (e.g., software quality measures) with goals of the current project (e.g., quality goals);
- *Proactive actions* (R2.4): Include not only reactive actions (e.g., reactive quality measures) dealing with existing problems, but also proactive actions (e.g., proactive quality measures) to prevent problems;
- *Context-sensitive actions* (R2.5): Enable context-sensitive tailoring of the actions (e.g., quality measures) so that they fit to the current situation and person;
- *Context monitoring* (R2.6): continuously monitor the context (e.g., quality of artifacts) and also identify the impact of actions (e.g., quality measures) on artifacts;
- *Seamless integration* (R2.7): enable seamless integration of the provided actions (e.g., quality measures) with the standard process to not delay the latter or disturb the participants.

8.6.3 Extended Concept for Knowledge-Based Contextual Adaptation of Processes

Recalling the problems and requirements we already elicited, there are many factors that play a role for successful automated quality support. On one hand, the system must be aware of the problems in artifacts [cf. requirement R2.1 (Problem awareness)]. On the other, it must be aware of the users' activities and the process to not hamper the process with inappropriate actions such as quality measures [cf. requirement R2.2 (Opportunity awareness)]. Furthermore, the measures must be in line with the goals of the project [cf. requirement R2.3 (Strategic action alignment)] and the current situation of the person applying them [cf. requirement R2.5 (Context-sensitive actions)]. In order to be able to exploit the usefulness of such measures, the system should manage proactive as well as reactive measures [cf. requirement R2.4 (Proactive actions)] and the applied measures should be assessed for their impact and utility [cf. requirement R2.6 (Context monitoring)]. Finally, the system should enable seamless integration of the measures into the standard development process to not disturb the users [cf. requirement R2.7 (Seamless integration)]. To be able to conform to this set of different and complex factors, we have defined a multi-step approach to automated QM that uses a second internal knowledge system within the *Context Management* component. This approach is illustrated in Fig. 8.8 and explained in the following.

The approach presented in Fig. 8.8 is separated into three phases. The detection phase is applied to generate an awareness of the systems environment. This includes source code artifacts [cf. requirement R2.1 (Problem awareness)] and user activities [cf. requirement R2.2 (Opportunity awareness)]. In the processing phase, a quality trend analysis of the source code takes place and, based on that, a quality measure prioritization including proactive and reactive software quality measures [cf. requirement R2.4 (Proactive actions)] in line with projects goals [cf. requirement R2.3 (Strategic action alignment)]. The proposed measures are then tailored to the users' situations [cf. requirement R2.5 (Context-sensitive actions)] and seamlessly integrated into their running workflows [cf. requirement R2.7 (Seamless

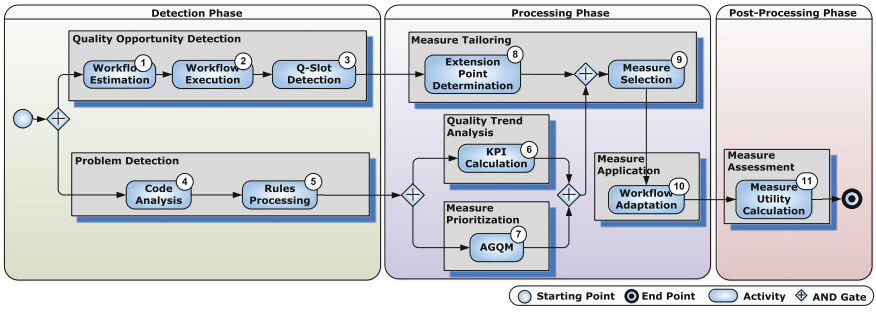

Fig. 8.8 Quality management approach

integration)]. To evolve the knowledge system, in the post-processing phase there is also a measure utility assessment [cf. requirement R2.6 (Context monitoring)] that reveals what measures were effective and ineffective.

The different steps of this approach are briefly explained in the following. They can be separated into three procedures: problem processing, opportunity processing, and measure assessment. The first one, problem processing, comprises the following steps. During the course of the project, the quality of the artifacts is continuously monitored, e.g., by static code analysis tools [Code Analysis (4)]. In turn, via the *Event Management* component, these tools are also monitored and the creation of a code analysis report is recognized by the system. These reports are then automatically transformed into a unified format. On such unified reports, pre-defined rules are executed that assess if any metric exceeds a given threshold, categorizes these cases as problems, and then automatically assigns an appropriate software quality measure to each problem [Rules processing (5)]. To obtain more meaningful values representing the global state of the artifacts, the metrics from the unified reports are aggregated to KPIs afterwards [KPI Calculation (6)]. As the number of assigned measures usually exceeds the capacities of a project, the assigned measures are later prioritized by an agent-based automated goal-question-metric [70] to align them to the quality goals of the project [AGQM (7)].

The second procedure deals with the quality opportunities in the users' workflows. This relates to users' tasks that are part of the process and opportunities to apply actions (i.e., quality measures) without delaying such tasks. Therefore, the different user tasks have to be estimated concerning time consumption by humans at the beginning [Workflow Estimation (1)]. These tasks are then automatically imported into the system and, for each of them, a dedicated workflow is started. After that, the workflows are executed within the system by the users [Workflow Execution (2)]. The system can, based on the estimated times and the actual times, carry out a so-called Q-Slot detection (3). This means that the system determines if a person has time left for the application of an action (i.e., software quality measure) without delaying the planned tasks. When the system has recognized a person with time left for a quality measure, the concrete point in one of his workflows where the measure application shall be integrated is determined [Extension Point Determination (8)]. This is done via semantic enhancements to the workflows in the *Context Management* component (cf. [20]). To make the applied measures as effective as possible, context-based measure selection is carried out by the system incorporating multiple properties of the situation and the intended user [Measure Selection (9)]. When the appropriate person, measure and extension point have been determined, the system automatically and seamlessly integrates the measure into the potentially running workflow of the person via the dynamic adaptation capabilities of AristaFlow [Workflow Adaptation (10)].

The third procedure deals with the assessment of measures that have been applied by the users. Therefore, the calculation of the KPIs representing the state of the source code is continuously executed [KPI Calculation (6)]. Therefore, it can serve as an indicator for the effectiveness of applied quality measures by comparing values before and after their application. At user-configured points in the process,

the effectiveness and usefulness of the applied measures (measure utility) will be automatically calculated by the system utilizing the KPIs [Measure Utility Calculation (11)]. The values obtained by this calculation will then be used in future measure proposals to improve the effectiveness of the applied measures.

Via the described approach, it becomes possible to effectively and systematically manage and provision knowledge regarding the quality of the artifacts an organization produces. Furthermore, that knowledge is actively used by the system to support and improve the situation (e.g., quality) by automatically distributing appropriate actions (i.e., matching quality measures) that fit a user's context and will adapt their process accordingly.

8.7 Knowledge-Based Collaborative Process Support

In knowledge-intensive projects, the essential collaboration between the knowledge workers involves concurrent or cooperative work on various complex artifacts. In some cases, one might depend on the work of others on a certain artifact, in other cases changes might interfere with each other or might entail additional work for someone. In particular, artifacts often relate to and can impact each other, e.g., the requirements specification may change, entailing changes to source code artifacts, while the implementation is already operational. For further reading on that topic see [23, 24]. Section 8.7.1 introduces specific requirements and Sect. 8.7.2 presents the collaboration concept.

8.7.1 Advanced Collaboration Requirements

To provide effective support for such projects, an automated aiming for holistic process and knowledge support should incorporate the following features:

- *Notification delivery* (R3.1): deliver notifications of interest to applicable users in case an artifact or the state of a task of a colleague changes;
- *Impact identification* (R3.2): identify the impact of the execution of a certain activity on certain artifacts;
- *Automatic activity initiation* (R3.3): automatically initiate certain follow-up activities to enable users to react to changes certain activities have caused. For example, if one of two associated artifacts is changed in an incompatible way, another activity could be initiated to also change the associated artifact;
- *Applicable actor identification* (R3.4): Be able to automatically identify the responsible person for a follow-up activity;
- *Configurability* (R3.5): Enable users to flexibly configure the way follow-up activities are initiated.

8.7.2 Collaboration Support Concept

The first requirement deals with passive coordination, where the system delivers information but does not actively affect the process. To enable such information distribution, the system relies on its event management and sensor infrastructure. When activities are executed by humans and artifacts are manipulated, both are usually done using some designated tool and can thus be detected by CoSEEEK. To exploit this for configurable notifications, an explicit notification concept is introduced. The properties of this concept are shown in Table 8.3. Utilizing this notification concept, both generic and personal notifications become possible that will be automatically delivered to the target person by CoSEEEK.

Requirements R3.2–R3.5 deal with active coordination, where the system affects the executed activities. This is a far more complex collaboration situation, in particular when it concerns associated artifacts that are part of different areas of a project, such as requirements management, implementation, or test management. Therefore, a set of prerequisites have to be satisfied to enable automated support: First, the project is split into hierarchically different components, such as areas or modules. These modules are then connected to each other, for example, to model the fact that a specific part of a requirements specification relates to a specific source code package or project (similar to traceability). Second, information is provided to indicate under which circumstances one area affects the other. Finally, different components are classified, for example if one source code package realizes the interface of a component.

With these facts modeled in CoSEEEK's *Context Management* component, a five-step procedure supports the configurable issuing of follow-up activities based on the occurrence of certain events. The first step of this procedure is applied to determine areas that might be affected by an activity. This step is configurable by the users and can take various contextual factors into account. Applied to the aforementioned example, for a requirements change such a configuration could be 'Search for affected areas in case of technical issues if an activity implies a change to a requirement'. Such a configuration would require the system to have access to the requirements. This can be established if the requirements are managed within a requirement management tool for which a sensor can be applied. After that, in a second step, the concrete target for a follow-up activity can be determined. For this

Table 8.3 Notification properties

Source	This denotes the entity to be monitored. Possible sources include various types of artifacts or different granularities of activities
Trigger	This denotes the event happening in context of the source entity that will be the trigger for the notification to be delivered. This can be the completion of an activity or the state change of an artifact
Target	This denotes the target, to which the notification will be delivered. This can be concrete persons or, to enable generic pre-configured notifications, also roles in a project

example, this would be a source code package that relates to the changed requirement. In a third step, a matching responsible person is identified for the follow-up activity. For this example this would be the developer responsible for the identified source code package. If none is defined, the system searches super-components of the package in the hierarchy and if no responsible can be found, the activity would be issued for the development team leader, who could then distribute it to the most appropriate developer. After that, the concrete activity to be issued has to be determined. It can take into account various contextual properties regarding involved artifacts, areas, sections and the activity that was the trigger. In the final step of the procedure, the follow-up activity must be integrated into the running process. This can be done either by starting a separate workflow for it or, if it matches properties of a running workflow, by integrating it into one of these. The adaptation of running workflow is applied in the same manner as described in Sect. 8.6.

By integrating contextual data and the combination of active and passive coordination capabilities, our concept can overcome various problems and support collaboration in knowledge-intensive projects. Active information distribution can be used to proactively counteract emerging problems, while passive information distribution can keep project participants updated and aware without obstructing the current process.

8.8 Summary and Conclusion

To summarize, with the growing volume of knowledge and the need for knowledge workers to efficiently utilize knowledge collaboratively, it is important that organizations have options that go beyond passive knowledge management techniques and that they also pursue the systematic active provisioning of knowledge. For such provisioning not to disrupt ongoing knowledge work, the system must possess contextual awareness and adapt to changes in both context and knowledge, integrating the provisioning of knowledge in such a way that is aligned to their current process (i.e., worker-goal awareness), and utilize knowledge to actively support worker collaboration.

The software development domain was used to exhibit these knowledge challenges, beginning with an overview of related current approaches in the software engineering (SE) domain. This was followed by a discussion of the problems and issues and the resulting requirements. We then described our holistic knowledge provisioning approach, first in an abstracted conceptual form followed then by a technical implementation for the SE domain called the CoSEEEK framework. To exemplify how it addresses the challenges using concrete scenarios, the chapter then illustrated automated knowledge provisioning within processes, knowledge-based contextual adaptation of processes, and support for knowledge-based collaborative processes.

Future challenges include the integration and utilization of distributed extra-organizational knowledge bases, cross-granular process and contextual dependencies, and automated semantic annotation techniques.

Glossary

The terms below are defined practically for the purpose of understanding this chapter, and not intended to be definitive or comprehensive.

Context-awareness. Perception of a system's surroundings via information that can be used to characterize the situation. This information can consist of various things like other systems, humans, actions, events, or related artifacts.

Information. Facts and data organized to describe a particular situation or condition. Knowledge communicated or received concerning a particular fact or circumstance.

Knowledge. Familiarity, acquaintance, experience with, understanding, or perception of some subject, involving facts, truths, principles, beliefs, perspectives, concepts, judgments, expectations, methodologies, or know-how. Within organizations, it frequently becomes embedded in documents or repositories, as well as in organizational routines, processes, practices, and norms [71]. It is a "justified belief that increases an entity's capacity for taking effective action" [72]. Information can be converted into knowledge once cognitively processed, and knowledge can be transformed into information if codified or articulated in symbolic forms.

Knowledge base (KB). A repository of knowledge, typically utilizing some form of storage.

Knowledge management (KM). A systematic and organizational process for retaining, organizing, sharing, and updating (collective) knowledge critical to individual performance and organizational competitiveness [73].

Knowledge systems. Organizations as social collectives can be viewed as knowledge systems, representing the cognitive and social nature of organizational knowledge and its embodiment in the individuals' mind and practices as well as the practices and culture of the organization [72].

Knowledge management systems (KMS). To support human knowledge systems, IT-based knowledge management systems support the codification and sharing of knowledge, the creation and maintenance of knowledge repositories, and knowledge networking [72] or collaboration.

Knowledge-based system (KBS). A system that uses knowledge, either in an open or closed form, to adjust its own behavior.

Process-aware information systems (PAIS). Information systems that enable the automated implementation of processes comprising their whole lifecycle, including modeling, enactment, and monitoring.

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Chapter 9
Towards Near Real-Time Social Recommendations for the Enterprise

Benjamin Heitmann, Maciej Dabrowski, Conor Hayes and Keith Griffin

Abstract The widespread use of social platforms in contemporary organizations leads to the generation of large amounts of content shared through various social tools. This information is distributed and often unstructured, making it difficult to fully exploit its value in an enterprise context. While Semantic Web technologies allow for publishing meaningful and structured data, major challenges include: (1) real-time integration of distributed social data, and (2) content personalization to identify relevant pieces of information and present them to users to limit the information overload. We propose to combine Semantic Web technologies with standardized transport protocols, such as XMPP, to provide an efficient and open source layer for aggregation of distributed social data in an enterprise. In addition, we propose a personalisation approach, which is able to provide filtered and personalised access on top of such distributed social data.

9.1 Introduction

In the context of modern enterprises the employees are often distributed across departments and geographical locations, use different information systems, and share skills and expertise that spans multiple knowledge domains. While users of

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the Social Web have come to expect personalised services for various types of content such as music, books or social activity streams, personalisation for enterprise users remains a challenge due to factors such as distribution of users and the fact that their expertise can span multiple domains.

The provision of social platforms that enable personalized information access in an enterprise environment involves an infrastructure and algorithms to address two main challenges:

1. Aggregation and integration of data from different information systems/social platforms in the IT landscape of the enterprise is required.
2. Existing personalisation methods, such as collaborative filtering or content based recommendations, are highly dependent on the domain and/or the source of the data.

There is a need to ensure that the integration of information from vital sources available in an organization can be performed in, or close to, real-time. This requirement is especially relevant in two settings: (1) in large-scale and distributed organisations, where Social Web systems can be deployed in different geographical localizations, nevertheless they need to interact instantaneously; (2) when the data from one organisation must be integrated into another, either one-way or reciprocally. We propose to combine Semantic Web technologies with the eXtensible messaging and presence protocol (XMPP) to provide an efficient and open source layer for aggregation of distributed social data in an enterprise.

In addition, a personalisation approach that exploits cross-domain data from different sources is needed. Such a method requires more accurate means to capture and model the interests of the user across different domains. This allows to interlink the interests of the user and create the full interest graph of the user out of the profile fragments across distributed social platforms. This interest graph can then in turn be used for recommending more accurate and context-dependant resources available in the enterprise social platform, mitigating the threat of information overload and enabling discovery of valuable information and/or people. This paper provides an overview of the state-of-the-art in personalization methods and introduces a new approach for personalisation in an enterprise context based on Spreading Activation (SA).

In this chapter we present an architecture for a distributed social platform in the modern enterprise. In addition we give an overview of the personalisation approaches applicable to enterprise social networks in general, with a particular focus on graph-based personalisation approaches.

The rest of the chapter is structured as follows: First, in Sect. 9.2, we introduce related work in the areas of distributed organisational environments and personalisation approaches. Then we describe two use cases from social media in the enterprise (see Sect. 9.3), from which we derive the requirements for applicable personalisation approaches. We describe the ADVANSSE distributed social platform in Sect. 9.4. We then describe our Spreading Activation recommendation algorithm and how to apply it to the data which can be aggregated from the ADVANSSE architecture, in Sect. 9.5. The implementation of a prototype for the

ADVANSSE distributed social platform is presented in Sect. 9.6. We conclude in Sect. 9.7 with a summary of contributions and list future work.

9.2 Background and Related Work

Personalised recommendations greatly enhance the user experience of searching, exploring and finding new and interesting content [17], however, mostly using homogeneous data from one source. In contrast, the use of personalisation in a distributed enterprise context is more challenging, as the personalisation has to take multiple sources, formats and genres into account.

In this section we first describe the kind of distributed organisational environments in which our approach can be deployed. Then we introduce a classification of the most well established personalisation approaches. Further, we describe two content-based personalisation approaches which are suitable for distributed organisational environments, as they use semantic graphs.

9.2.1 Distributed Organisational Environments

Organizations build and maintain many information systems to manage large volumes of various data published and consumed by knowledge-intensive workers [12]. With the shift to the Enterprise 2.0 [21], the organizational landscape changes from a centralized environment with a small number of centralized content repositories to a more distributed model in which various peers can both publish and consume information. This shift requires new approaches for delivery of timely and relevant information in a close-to-real-time manner across such peer-to-peer (P2P) [19] networks. Many initiatives [8, 18, 30] focus on building P2P wikis that combine the benefits of mass collaboration with the intrinsic qualities of peer-to-peer networks, such as scalability or fault-tolerance. The main challenge in building such collaborative tools is to ensure the consistency of content replicated on different peers [28].

On the other hand, knowledge workers in contemporary organizations utilize many tools that support collaboration through creation and sharing of information through corporate networks [21]: blogs, wikis, or social networks. Nevertheless, many organizations report that crucial information is often not managed effectively [25] what affects efficiency and generates additional spending. To address this concern, organizations attempt to sustain information exchange through utilization of social networking tools both internally and externally. Once the social network is woven and social connections are established, it is important to gather and reuse information available in this network. Thus, a distributed social network requires efficient data synchronization tools [29] to allow for timely updates and retrieval of relevant content.

The generic categorization of models for communication and content/event exchange in a distributed environment differentiates pull and push approaches. The **pull** model involves an initial request from the (active) client that is responded by a (passive) server and is one of the most commonly used communication patterns in distributed networks. **Polling** is a mechanism related to pull model, which relies on clients actively sampling the server status through repetitive requests. Polling is considered resource expensive and scales poorly [9] as frequent polling may lead to inefficient usage of resources, but infrequent requests "may result in delayed responses to critical situations" [9]. Further, many scenarios require asynchronous delivery of events for better performance and scalability. **Long Polling**, introduced to address these limitations, is an approach based on the request-response model in which the server holds the request open until the response is available (or when the set timeout is reached) [13].

In contrast to the pull approach, the **push** model assumes a passive client that is notified of the occurrence of specific events upon a subscription to the server. The **publish/subscribe** (PubSub) interaction paradigm exploits the push model as it enables agents to subscribe to a particular event (e.g. content update), and to receive asynchronous notifications from the server/publisher when the event occurs [10]. The advantages of the PubSub paradigm over the Polling approach lie in the optimization of the number of request, the required network traffic, and in the full decoupling in "time, space, and synchronization between publishers and subscribers" [10]. Although the push approaches are gaining more popularity, the tools built using the pull paradigm are prevalent (see [3] for a detailed discussion). However, with the expansion of the Semantic Web technologies, more focus is put on applications implementing the push interaction model.

9.2.2 Classification of Personalisation Approaches

The typical recommender systems require three components to provide recommendations [4]: (1) background data, which is the information the system has before the recommendation process begins, (2) input data, also called the user model, which is the information provided about the user in order to make a recommendation, and (3) the recommendation algorithm which operates on background and input data in order to provide recommendations for a user. Based on these attributes the recommendation approaches can be grouped in 4 classes [4]: Collaborative filtering, content-based recommendation, knowledge-based recommendation and hybrid approaches. We also describe what is commonly called the "top-k approach", which however refers to a term from the database community.

9.2.2.1 Collaborative Filtering

Collaborative filtering aggregates ratings for items from different users, and uses similarities between users to recommend items. It is probably the most mature and widely implemented recommendation algorithm, because it achieves fairly good results and is easy to implement [4]. It only requires data about the ratings between users and items as background data, no other information about either the users or the items is required [14]. The input data usually consists of a user profile providing ratings for one or more items. The recommendation algorithm uses the background data to calculate the pair-wise similarity between all items or all users, and then uses the input data to recommend similar users or items [26].

9.2.2.2 Content-Based Recommendation

Content-based recommendation approaches use features of the items as the background data for the recommendation [22]. These can either be directly derived from the content, e.g. keywords from text or tempo of the music piece, or derived from the meta-data of the items, e.g. author, title and genre. The input data needs to describe the users preferences in terms of content features. Both the background and the input data require the consistent description of content features in order to match the user preferences to the features of the content.

9.2.2.3 Knowledge-Based Recommendation

Knowledge-based recommendation approaches aim to suggest items based on inferences about the users' needs and preferences. This requires background data that includes knowledge about users and items, which is sufficient in consistency and scale for making inferences. The input data needs to provide knowledge about the users needs and preferences which can be mapped to the knowledge about users and items in the background data. Knowledge-based approaches are distinguished in that they have functional knowledge, e.g. about how a particular item meets a particular user need, and can therefore reason about the relationship between a need and a possible recommendation [4].

Amini et al. [1] provide an overview of current approaches for knowledge-based recommendation, and suggest that the most important way to apply knowledge to the personalisation task lays in expressing the context of the user.

9.2.2.4 Hybrid Algorithms

Hybrid algorithms combine two or more recommendation algorithms to provide better results with fewer of the drawbacks of an individual algorithm. In order to combine two algorithms different methods can be used [4], e.g.: the scores of

several algorithms can be combined with weights; the output of one algorithm can be used as the input for the next one, thus forming a cascade; the system can switch between different algorithms depending on the situation; the presentation of the output of several algorithms can be mixed in the user interface. Most commonly, collaborative filtering is combined with an algorithm of a different type, e.g. a content-based one, in order to mitigate situations in which not enough background data for an item or a user is available.

9.2.2.5 Top-K Approach

The term "Top-k" refers to a database query which retrieves the first (i.e. best) *k* results for a query. Usually the ranking of the query is based on a scoring function, which utilizes different properties of the entities that are queried [15]. The view present in the recommender systems research community views "Top-k" as a problem of identifying a set of N items of highest interest to a user, also called *top-N recommendation problem* [7]. All previously discussed classical approaches for building recommender systems can be used for the top-N recommendation problem by ranking the recommendation results and returning only the first N results. However, in contrast to top-k queries, top-N recommendations have an explicit user model which heavily depends on the recommendation algorithm.

9.2.3 Graph-Based Approaches

Perugini et al. argue in [23], that all recommender systems make connections among people. These connections are either made directly—as a result of explicit user modeling, or indirectly—through the discovery of implicit relationships. This perspective is reflected in the notion of representing on-line, social interactions of users as a social graph, and their interests as their interest graph. Companies offering products that involve personalization recognize the benefits of graphs and employ graph-based algorithms, such as EdgeRank[1] used in Facebook's[2] activity stream recommendations.

In order to exploit the interest graph for the purpose of personalisation, an algorithm that can operate on a graph-based data structure is required. Next, we discuss two graph-based personalisation approaches: semantic distance and spreading activation. These two approaches can be classified as content-based approaches. In addition, we compare spreading activation to simulated neural networks and PageRank, which are only superficially connected.

[1] https://www.facebook.com/note.php?note_id=206484249362078.

[2] http://facebook.com.

9.2.3.1 Semantic Distance

Semantic distances provide a distance metric between entities in a semantic graph. Rada et al. [24] introduced the notion of using the distance between two entities in a semantic network as a proxy for conceptual distance. They define their conceptual distance as the minimum number of edges separating two nodes *a* and *b*. Passant [20] builds on the work of Rada et al. by defining a measure for the semantic distance between Linked Data entities—Linked Data Semantic Distance (LDSD). Passant proposes different combinations of direct and indirect links between entities, as well as weighted versions that give more weight to less popular links. This is motivated by the fact that two resources are more related if they are the only ones sharing a particular property.

9.2.3.2 Spreading Activation

Spreading activation provides an iterative algorithm for identifying a set of related entities in a semantic graph. It is based on research on semantic memory and case semantics [5]. It is inspired by the fact that human memory retrieves memories by association. The idea was first implemented in the form of associative retrieval in database systems and was further developed out of the associative retrieval. Our approach uses Spreading Activation, and we describe the algorithm as well as how to apply Spreading Activation to our industry use case in more detail in Sect. 9.5.

9.2.3.3 Comparison to Neural Networks and PageRank

The spreading activation algorithm is superficially similar to the activation of simulated neural networks. However in a neural network simulation, the individual nodes do not represent semantic concepts, and the links between the entities do not represent any kind of semantic or conceptual connection or association between the nodes. A neural network is trained to reach a certain level of output activation when it is presented with a given input. The activation functions and the weights between the nodes are manipulated during the training phase in order to achieve this result. In contrast, each node of the semantic network which is used for spreading activation represents a certain conceptual entity, and the links only exist because they also exist in the domain on which the semantic network is modeled.

Another approach which is similar to spreading activation is the PageRank algorithm, or any other form of global, eigenvector-based algorithm. As Berthold et al. argue in [2], the continuous execution of the spreading activation algorithm without checking of the termination function will converge in a resulting activation state which can be interpreted similar to the result of the PageRank algorithm. The explanation for this phenomenon is based on the fact that the random graph walker which is employed to determine the PageRank of all nodes in the graph, basically executes a continuous and unconstrained form of spreading activation.

9.3 Use Case and Requirements

In this section we describe two simple use cases, which arise from knowledge workers who share knowledge in a distributed, Enterprise 2.0 environment. Based on the two use cases, we derive the requirements for the ADVANSSE distributed social platform, which we present in Sect. 9.4.

9.3.1 Use Cases

Use case 1: Andrew, Bob, and Cecilia are experts in Semantic Web technologies employed by the same organization (see Fig. 9.1) working in different departments (or locations). Andrew (CTO) is interested in the Semantic Web. Therefore, Andrew has to follow corporate blogs of Bob and Cecilia (both interested in Semantic Web) to discover any content on that topic published in the organization. Currently, this task requires Andrew to log-into three different social spaces to access relevant content. In addition, as Bob is a new user, Andrew may not be aware of Bob's presence in the system and thus won't not able to discover content published by Bob. Further, Andrew would like to receive instant updates in his social dashboard as soon as new content is published. Although approaches such as RSS seem suitable, they imply regular querying of the information sources for updates across corporate networks with restricted access policies.

Use case 2: Another use case involves the use of different terminology to describe the same or similar topics across departments. While Bob and Cecilia may use different terms to express their expertise and interests, there is a strong implicit relation between the concepts in their respective user profiles (Semantic Web,

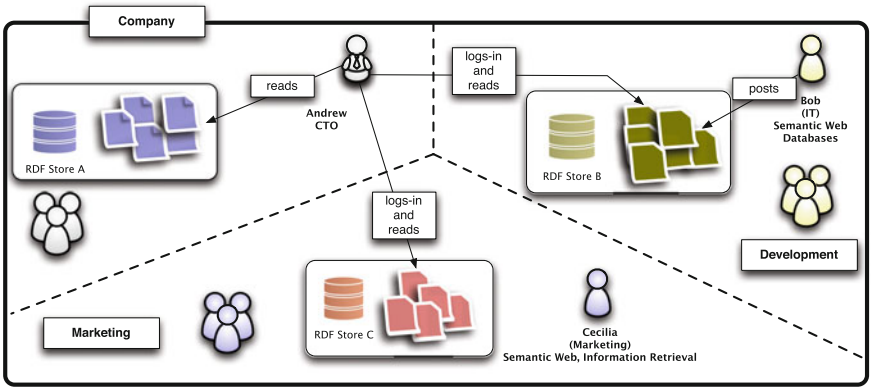

Fig. 9.1 Current state of the distributed enterprise platforms: users publish large volumes of information through disconnected enterprise social platforms. This valuable information may be hard to discover by other users lowering the value of knowledge capital in an organisation

Databases). Nevertheless, a report about a new product published by Bob may be not visible to Cecilia due to a number of reasons such as the use of separate social platforms or no direct match between the resource annotation (tags) and user interests. This second use case drives the majority of the requirements for personalisation of social content in a distributed enterprise context.

9.3.2 Personalisation Requirements for the ADVANSSE Distributed Platform

We now list the requirements for a personalisation approach which is applicable to social platforms in large and distributed organisations, such as those outlined in the use cases.

Mitigation of the cold-start problem: The cold start problem refers to the fact that the quality of recommendations gets worse, if there is no data available about either the user or the recommendable items. The personalisation approach should be able to mitigate this problem by using user/item properties available either in the system or in other (external) sources.

Avoid lack of recommendations: The lack of recommendations is a special case of the cold-start problem as the recommendation algorithm should provide a continuous stream of relevant and ranked recommendations, so that there is no lack of recommendations in the user interface. The problem involves a trade-off between the real-time performance of the algorithm and the pre-computation of potential recommendations, as well as the number of available recommendations and their quality/accuracy.

Scalability: The approach should be scalable and applicable to large amounts of data. Ideally, the performance of the method should not depend on global properties, such as the total number of users and/or recommendable item, but on the density of the integrated graph in the neighbourhood of a user or an item.

Multi-source recommendations: The method must be applicable to data from multiple sources and described with various standards (e.g. spread across multiple RDF stores using different metadata standards).

Cross-domain recommendations: The method should be applicable to data from different genres/domains. Topical variety of documents in the enterprise can be vast: from technical reports that discuss low level technical aspects to marketing plans or budget sheets. The method should exploit data available about users/items across domains to make higher quality recommendations.

Universality: The recommendation approach should be independent of the source data format. The source data might be available in different formats, such as emails, instant messages or office documents and spreadsheets.

Recommendation of sources and items: The use cases suggest the need for two different recommendation scenarios: recommendation of items that fit the

interest profile of a user and discovery of sources of items of potential interest, such as users or discussion groups.

Customization for a specific domain: The personalization approach should allow the provision of generic (topic-independent) recommendations as well as customization for topic-specific suggestions. For example, for a given recommendation context it may be important if people collaborated in the same projects, but not that they play in the same office sports team.

9.4 The ADVANSSE Distributed Social Platform

Organizations build and maintain many information systems to manage a large volume of content published and consumed by knowledge-intensive workers [12]. These systems are inter-connected both internally, within an organization, and with systems external to the organization, for example news feed on the Web.[3] Such environments involve many peers, which share information within a large network that is often distributed across various departments, or sometimes even geographically.

In order to provide a personalisation approach for such distributed social platforms, we first need to provide an architecture which is capable of aggregating and integration data from distributed social platforms.

In this section we describe the architecture of our proposed ADVANSSE distributed social platform. We first introduce the protocols used to synchronise data between different, distributed social platforms. Then we describe the different components of the ADVANSSE architecture.

9.4.1 Protocols Used for Data Synchronisation

For some applications (e.g. news feed), content update can be represented as streams of RDF triples [27] and the problem of RDF content integration can be viewed as a succession of RDF documents available through a feed. Many applications in the Enterprise 2.0 are more stateful (e.g. presence management), thus require not only addition of the new content but also deletion/editing of existing information. Thus, RDF data integration techniques deployed in Enterprise 2.0 platforms should support not only addition, but also deletion and editing of existing content. Further, it is essential that the update operations should be done on the lowest possible level, which is the level of individual RDF triples.

[3]See for example http://www.reuters.com/.

9.4.1.1 SPARQL Update

SPARQL-Update[4] (in version 1.1), currently under standardisation in W3C and following the SPARUL Member Submission,[5] provides a standard update language for RDF graphs. With the syntax derived from SPARQL, SPARQL-Update provides operations to create and remove graphs, as well as to update the existing ones, including *INSERT*, *DELETE*, *CLEAR* or *LOAD*. The granularity of these commands enables triple-level operations on a given RDF graph, demonstrated based on single tag removal.

9.4.1.2 The Extensible Messaging and Presence Protocol

XMPP is an open technology for real-time communication, which enables a wide range of applications including instant messaging, online presence, lightweight middleware, content syndication, and generalized routing of XML data. The core technology behind XMPP was standardized in the XMPP RFCs in 2004, revised in 2011.[6] Although not coupled with any specific network architecture, XMPP usually has been implemented over TCP used for client-server and server-server connectivity. Most clients connect directly to a server over a TCP connection and use XMPP to take full advantage of the functionality provided by a server and any associated services. Further, XMPP PubSub extension, known as XEP-0060[7] offers an implementation of a pubsub paradigm. Another approach, the Bidirectional-streams Over Synchronous HTTP (BOSH),[8] provides an implementation that optimizes the resource usage. The recovery mechanism provided by the XMPP is an important feature that increases reliability of change distribution. When a given server (A) attempts to notify another server (B) about RDF updates to apply and the connection between the two servers is lost for any reason, the protocol implementation provides a mechanism that caters for reconnecting the servers.

9.4.1.3 Using XMPP and SPARQL Update Together

An overview of how XMPP and SPARQL update are used for synchronisation and aggregation of content in the ADVANSSE architecture is given in Fig. 9.2.

The XMPP server has the function of routing and transporting messages between the social platforms which are connected to it. In addition it provides an extensible

[4] http://www.w3.org/TR/sparql11-update/.

[5] http://www.w3.org/Submission/2008/SUBM-SPARQL-Update-20080715/.

[6] http://xmpp.org/rfcs/rfc6120.html, http://xmpp.org/rfcs/rfc6121.html, http://xmpp.org/rfcs/rfc6122.html.

[7] http://xmpp.org/extensions/xep-0060.html.

[8] see http://xmpp.org/extensions/xep-0124.html.

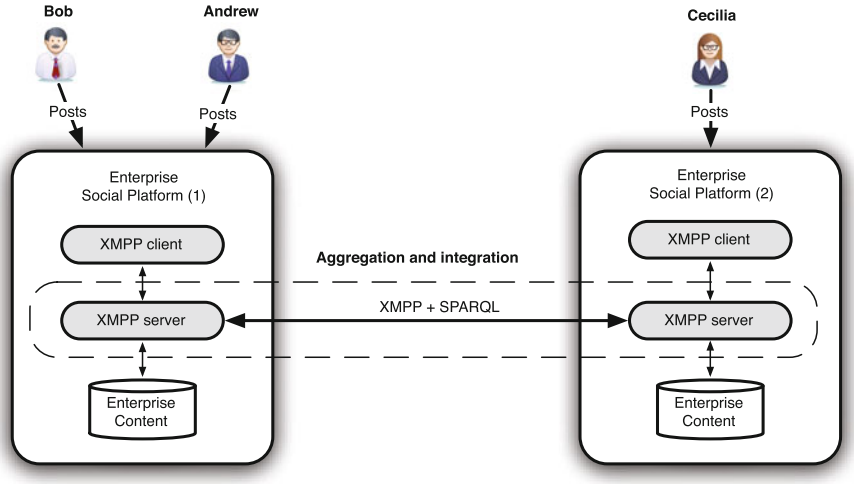

Fig. 9.2 Aggregation of content in the ADVANSSE architecture using XMPP and SPARQL Update

platform that can process all information that it receives, for example to provide content personalisation through pluggable personalization components. As one or more platforms may be connected to a given XMPP server, the servers communicate with each other sending SPARQL Update messages embedded in XMPP PubSub stanzas. XMPP provides the infrastructure for connecting social platforms in a decentralised way and for sharing of knowledge between those social platforms. The server provides a central point for the connected social platforms to exchange XMPP messages. In case an existing XMPP server is used, it must implement the XMPP Publish-Subscribe extension (XEP-0060),[9] which allows XMPP clients to subscribe to updates. In order to publish and receive aggregated content social platforms need to connect to the XMPP server via the XMPP client. This can be accomplished using an open source component[10] that allows easy integration.

9.4.2 ADVANSSE Architecture

We now describe the ADVANSSE architecture which uses XMPP and SPARQL Update to allow different, distributed social platforms to connect to each other via a central ADVANSSE server. Figure 9.3 presents a high level overview of the ADVANSSE architecture. First we give a high level overview of the ADVANSSE

[9] http://xmpp.org/extensions/xep-0060.html.
[10] https://github.com/derixmpppubsub/derixmpppubsub/.

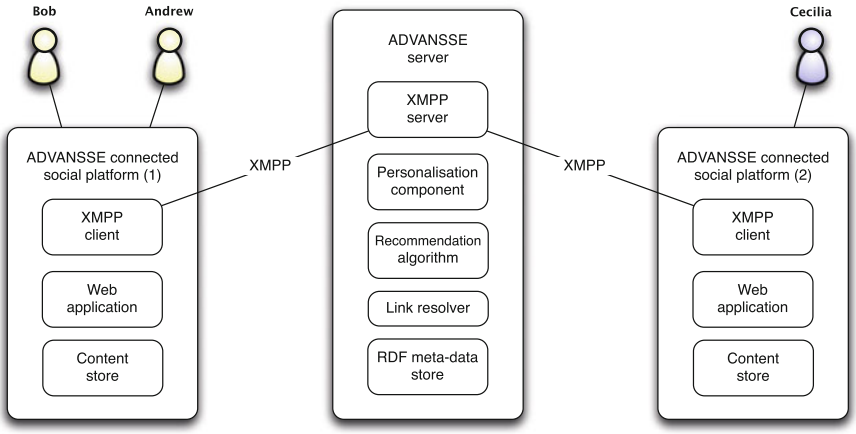

Fig. 9.3 High level overview of the ADVANSSE architecture

server and of social platforms connected to ADVANSSE, then we describe the architectural role of the components in more detail.

9.4.3 ADVANSSE Server

The ADVANSSE server has the function of routing and transporting messages between the social platforms which are connected to it, so it must contain a XMPP server. In addition it provides the service of personalisation of content, for which it requires a personalisation component and a RDF meta-data store for persisting content meta-data and user profiles. Finally, as different connected social platforms could be using different namespaces for their tags, it contains a link resolver.

There may be more then one ADVANSSE server. In that case all of the ADVANSSE servers should be subscribed to each other for the purpose of synchronising.

XMPP server In ADVANSSE, XMPP provides the infrastructure for connecting social platforms in a decentralised way and for sharing of knowledge between those social platforms. The ADVANSSE server provides a central point for the connected social platforms to exchange XMPP messages. The XMPP server component must implement the XMPP Publish-Subscribe extension (XEP-0060),[11] which allows XMPP clients to subscribe to updates, which are published to a specific node on the XMPP server by a publisher.

Personalisation component The personalisation component provides users with recommendations for content which is relevant to their interests. It must have

[11] http://xmpp.org/extensions/xep-0060.html.

access to the meta-data about user generated content and to the user profiles. It then executes the recommendation algorithm on top of the content meta-data and the user profiles, after which it uses the XMPP server component in order to deliver the recommendations to the users.

RDF meta-data store The XMPP server receives meta-data about newly published content from the XMPP clients which are connected to him. This meta-data must be contained in SPARQL 1.1 Update operations which are transmitted as XMPP IQ messages. The XMPP server must store this meta-data to an RDF store, so that it can be accessed by the personalisation component.

Recommendation algorithm The recommendation algorithm is executed in order to generate new recommendations. It uses the user profiles and the content meta-data as input. In addition it uses other sources of background knowledge. The result is a ranked list of recommendations for different types of items (e.g. other users, posts and tags) for every user.

Link resolver The link resolver is responsible for identifying similar entities used in different namespaces or in different data sets. One of the most important tasks of the link resolver is to find concepts from the background data of the recommender system which match tags used in the user profiles and the content meta-data.

9.4.4 ADVANSSE-Connected Social Platform

Multiple social platforms can be connected to the same ADVANSSE server. These social platforms allow users to create new content, and to search existing content or to view recommendations of content. In order to connect to the ADVANSSE server an XMPP client component is required. The social platform provides an end-user facing user interface through a web application. Finally, it has its own content store for persisting content and user profiles.

XMPP client In order to participate in the ADVANSSE architecture, social platforms need to connect to the ADVANSSE server via the XMPP protocol. In addition, each participating social platform must implement the Publish-Subscribe XMPP extension (XEP-0060).

Web client In order to provide a user interface for the users of the social platform a web application is provided. It uses the content store for persistence of user profiles, and it uses the XMPP client component to send the content to the ADVANSSE server.

Content store Each social platform in ADVANSSE must store the content generated by its users in persistent storage, so that it can be retrieved at a later data again. This persistent storage can be an RDF store, or it can be stored in a legacy, non-RDF format such as relational database.

9.5 Application of Spreading Activation to ADVANSSE

The ADVANSSE architecture allows the aggregation of user-specific data from all connected social platforms. In order to provide personalisation for all connected users, a personalisation algorithm is required, which can utilise data from distributed sources.

In this section, we first describe the Spreading Activation algorithm, which we use to provide recommendations. Then we describe how to apply Spreading Activation to data which has been aggregated from connected social platforms via the ADVANSSE architecture.

9.5.1 Spreading Activation Algorithm

Spreading activation is based on research on semantic memory and case semantics [5]. In the established literature about spreading activation, two variations of the algorithm are recognized [6]: basic spreading activation or constrained spreading activation.

9.5.1.1 Basic Spreading Activation

The inputs of the algorithm include the nodes that are activated at the start of the algorithm, which can represent the query or the interests in a user profile. With each pulse the activation spreads through the network. After a number of pulses (or after every single pulse) the termination condition is checked. The activated nodes after reaching the termination condition represent the most similar nodes to the initial activated set of nodes. Each iteration consists of two steps: (1) one or more pulses, which are propagated to all nodes which are directly connected to an active node, (2) a check of the termination condition, usually an upper limit to the number of activated nodes. Each pulse in turn is made up of three phases: (A) pre-adjustment, (B) spreading, and (C) post-adjustment. Each pulse of the spreading phase can activate new nodes. The spreading of the activation is determined by three functions of a node: the input function, the activation function and the output function.

The total input of a node is determined by the **input function**: $I_j = \sum_i O_i w_{ij}$, where I_j is the total input of node j; O_i is the output of node i connected to node j; and w_{ij} is the weight associated to the link which connects node i and node j. Activation along some edged (or edge types) can be controlled (suppressed or strengthened) through the use of weights. On the other hand, the **activation function** of a node is typically expressed as a threshold that is usually the same for each node. If the input of the node is higher then the threshold, then the node is active in the next pulse of the spreading phase. The **output function** determines how much output the node passes to all directly connected nodes in the next pulse.

The output function can either produce a real value, which usually is the level of activation. Or the output function emits a binary value depending on its activation.

9.5.1.2 Constrained Spreading Activation

There are a number of considerable drawbacks of the basic spreading activation approach that include quick and simultaneous activation of all nodes in small and medium sized semantic networks or difficulties in exploiting the semantics of edges beyond the use of weights. Therefore, a number of constraints to limit the spreading activation process have been suggested [6]. The **distance constraint** limits the activation to n links away from the original activated nodes, as in many scenarios the distance between entities relates to their similarity. The **fan-out constraint** poses that nodes with a high number of out-links should limit the spread the activation as they have a very broad semantic meaning, which can lead to the activation of nodes with a weak connection to the initially activated nodes. The **path constraint** relates to the semantics of the links, where types some links are activated as they are relevant to the use case or recommendation scenario. The **activation constraint** poses to control the total level of activation across the network to reflect different levels of importance of given nodes. These constraints can be seen as acting during the pre- and post-adjustment phases.

9.5.2 Application to ADVANSSE Use Cases

Application of the spreading activation in the discussed use cases requires the ability to connect users and recommendable items into one unified semantic network. This enables the execution of the previously described spreading activation algorithm on semantic networks with three types of entities, like the example in Fig. 9.4.

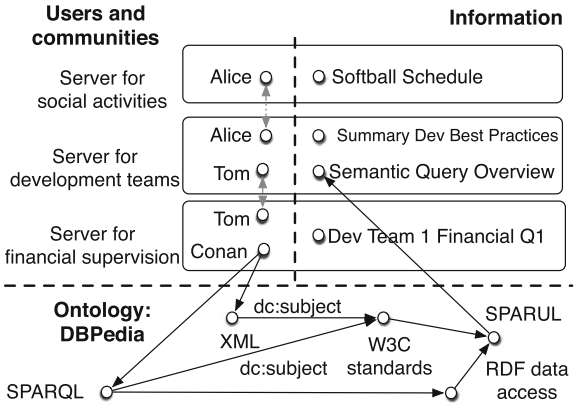

Fig. 9.4 Spreading activation example with data sources

The first type of entities represent **users** and their connections to communities (e.g. the user Conan). Second, there are entities that represent recommendable **items**, that is, social content such as blog posts or wikipages. Finally, there are entities which represent abstract **concepts**, typically used in tagging, often from external sources, linked with typed and directed relations.

Entities representing users are stored in user databases of all the systems for which content needs to be personalised. The nodes that represent recommendable social media are stored in all systems that contain user generated content (i.e. enterprise social platforms). The semantic network is augmented by linked data of DBPedia. DBPedia provides an RDF-based semantic network of all concepts from Wikipedia and their relations, which provide instance data as well as a background ontology. The final part of this example is formed by the links between users and the semantic network, and between the social media content and the semantic network. These links are enabled by the tags which users have used to describe their interests and expertise, and by the tags which users have assigned to the user generated content.

In terms of the data requirements for spreading activation, this translations to the following: The SA requires that the **user model** is provided by a list of concepts (mapped to a DBPedia URI) explaining user's interests/expertise, so that the user entity is connected to the semantic network. The **background data** is provided by the user generated content and the DBPedia RDF dataset. The spreading activation **algorithm** can be executed on the whole semantic graph with the start of activation in the user nodes. The termination condition is reached when a certain number of user generated content nodes is activated.

9.5.3 Qualitative Evaluation

Spreading activation requires a semantic network which provides semantic concepts representing both the items and the interests of the users. In this aspect it is similar to LDSD. However, it combines elements of content-based recommendation and knowledge-based recommendation. Pure spreading activation performs an algorithm on the semantic graph which finds similarities between items. However, constrained spreading activation can take the semantics of the links into account thus enabling reasoning on the domain knowledge represented by the links.

Mitigating the **cold-start** and **empty-box** problems is easy, as knowledge about the user can be taken into account if his profile is empty, such as demographic knowledge (e.g. his location). The approach is more **scalable** then other knowledge-based approaches, as it allows precomputing of parts of the spreading activation algorithm. It can take data from **multiple sources** and **cross-domain** data into account. If semantic meta-data in the form of tags is provided for all data, then this approach is **universal**. Due to the knowledge about users, they can also be recommended as **sources**. In addition, domain specific **customisation** as part of constrained spreading activation is easy to do.

Spreading activation represents a hybrid between content-based and knowledge-based personalisation approaches. Spreading activation can be used as a content-based similarity measure, similar to LDSD. By adding constraints to the activation which are based on the semantics of connections in the graph, the spreading activation can perform domain specific reasoning. The Linking Open Data cloud and DBPedia provide the necessary knowledge for spreading activation to operate. This gives spreading activation the potential to combine the benefits of content-based and knowledge-based approaches, while still staying scalable enough.

9.6 Demonstrator Implementation

In order to provide a demonstration of the ADVANSSE architecture, we have implemented a prototype demonstrator. In this section we will describe the implementation of all components, as well as the details of the data sources and data schemata used for the demonstrator.

9.6.1 Demonstrator Data

For demonstration purposes we use data which is as similar as possible to the data which is described in the use cases. Data about user profiles, tags and posts is provided by StackExchange, semantic background knowledge is provided by DBpedia, and the Cisco ERT vocabulary is used as the schema for representing and integrating all data into RDF. We describe all three kinds of data in the following sections.

9.6.1.1 User Profiles, Tags and Posts from StackExchange

The use cases require data about users and their interests, as well as posts authored by the users. In addition, both user interests and posts need to use the same set of tags (the same namespace for tags). The closest available source of real-world data to approximate this kind of data is provided by the StackExchange network of question answering sites.

StackExchange[12] operates a network of many sites where users can post a question. Then other users try to answer the question, and the user who asked the question marks one answer as being the correct answer. In order to encourage a productive interaction between all participants, correct behaviour such as posting of descriptive questions, tagging of questions, and correct answers are rewarded with a point system. The most prominent site of the StackExchange network is

[12] http://stackexchange.com/.

StackOverflow, which was also the first site. StackOverflow[13] is a generic IT answering site, however there are sites for a wide range of domains, from system administration to cooking and photography. Any user who has an account on any StackExchange site, can use the same account to post on any other site of the network. This also makes StackExchange one of the few sources of cross-domain user profiles, as the data dump allows reconstructing user accounts from their fragments on multiple sites.

StackExchange makes all data from all sites available in an anonymised data dump. The data dump is under a creative commons licence (Attribution-ShareAlike 2.5 Generic (CC BY-SA 2.5))[14] which allows commercial use of the data. The data is made available as a Microsoft SQL Server XML dump.[15] We used the data dump from September 2011, as further updates did not change the data which we extracted significantly.

9.6.1.2 StackExchange Data Extraction Process

In order to use the StackExchange data for the demonstrator, we extracted and transformed the data in multiple steps:

1. Import of XML data dump into MySQL relational database: The StackExchange data dump contains an XML file per site. The XML file has been exported from Microsoft SQL Server 2008. A python script reads the XML file for each site, and then writes the data into a MySQL relational database.
2. Selection of sites: After inspecting the converted data in the MySQL database, a decision was made to select three sites and use their data for the demo: IT Security,[16] Web applications[17] and Bicycles.[18] The sites where chosen with the following criteria: The IT Security and the Web applications site have content which is very close to the content which might be created in an enterprise knowledge sharing setting. The Bicycles site community has a significant overlap with the two other sites, so it was added to realistically simulate adding of expertise from a non-related domain to the user profiles.
3. Extraction of relational data into an RDF graph: A second python script then accesses the MySQL relational database, and queries the data which is required for the demonstrator, and creates an RDF graph using the schema described in Sect. 9.6.1. Only data from users which had accounts on all three sites where extracted. The result is an NTriples file which contains the graph with all interests, posts and tags from all users which have used all three sites.

[13] http://stackoverflow.com/.

[14] https://creativecommons.org/licenses/by-sa/2.5/.

[15] http://www.clearbits.net/creators/146-stack-exchange-data-dump.

[16] http://security.stackexchange.com/.

[17] http://webapps.stackexchange.com/.

[18] http://bicycles.stackexchange.com/.

The resulting data set contains 371 users who have at least one interest or one post in one of the three sites. These users have authored a total of 752 questions and 496 answers (not every question has a valid answer). In addition there are 607 tags in the graph. The StackExchange graph has a total of 2200 entities and 15,000 edges.

To enable the spreading activation algorithm to use the DBpedia data together with the StackExchange data, links between similar entities in both data sets need to be discovered. This is done by the link resolver component, which we describe in Sect. 9.6.2.

9.6.1.3 Background Knowledge from DBpedia

The background knowledge which provides connections between related concepts is provided by DBpedia. DBpedia[19] extracts information from info-boxes and other parts of Wikipedia pages, and transforms it into Linked Data, using RDF and vocabularies such as the Simple Knowledge Organisation System (SKOS).[20]

We used a subset of DBpedia version 3.7,[21] which was available during the development time of the demonstrator. In particular we used the following files:

- `mappingbased_properties_en.nt` Entities and their properties, extracted from Wikipedia info-boxes using strict ontology-based extraction by the DBpedia project.
- `article_categories_en.nt` Connections between entities and categories, extracted from the categories of pages on Wikipedia.
- `skos_categories_en.nt` Connections between categories themselves, extracted from the Wikipedia category tree. Encoded using the SKOS vocabulary, e.g. broader or narrower connections between two categories.
- `disambiguations_en.nt` Disambiguation links between DBpedia entities.
- `redirects_en.nt` Redirects between DBpedia entities.

The resulting DBpedia 3.7 subset includes all available links between entities themselves. As the spreading activation algorithm takes only links into account, while ignoring strings, this was the most important consideration when choosing the subset. The resulting data has a size of 5.46 GB in raw NTriples. The resulting graph contains 11 million entities and 40 million edges.

[19] http://www.dbpedia.org/.

[20] http://www.w3.org/2004/02/skos/.

[21] http://wiki.dbpedia.org/Downloads37.

9.6.1.4 Data Schema: CISCO ERT

For transforming and converting the StackExchange data into RDF we use the Cisco ERT Schema version 10. In addition, we added properties as necessary for the demonstration. Figure 9.5 shows the schema.

Posts have the `rdf:type sioc:Post`. StackExchange makes a distinction between questions and answers. Questions have an additional `rdf:type advansse:Question`, in addition they have a `dc:description` string with the post body, and a `dc:title` string with the post title. Questions can be tagged via the `ert:hasTopic` property, while answers are not tagged. Answers have an additional `rdf:type advansse:Answer`, they have a `dc:description` string, but no `dc:title` string. Questions are connected to answers via `advansse:hasAnswer`, and via `advansse:hasQuestion` vice versa.

Users have the `rdf:type sioc:UserAccount` and they have a `sioc:name` string containing the display name on StackExchange. In addition a user can be connected to zero or more tags via the `ert:interestedIn` property.

Tags have the `rdf:type ctag:Tag`. The string of the tag is expressed in the `ctag:label` string. A tag can be connected with another URI of the same meaning via the `ctag:means` property.

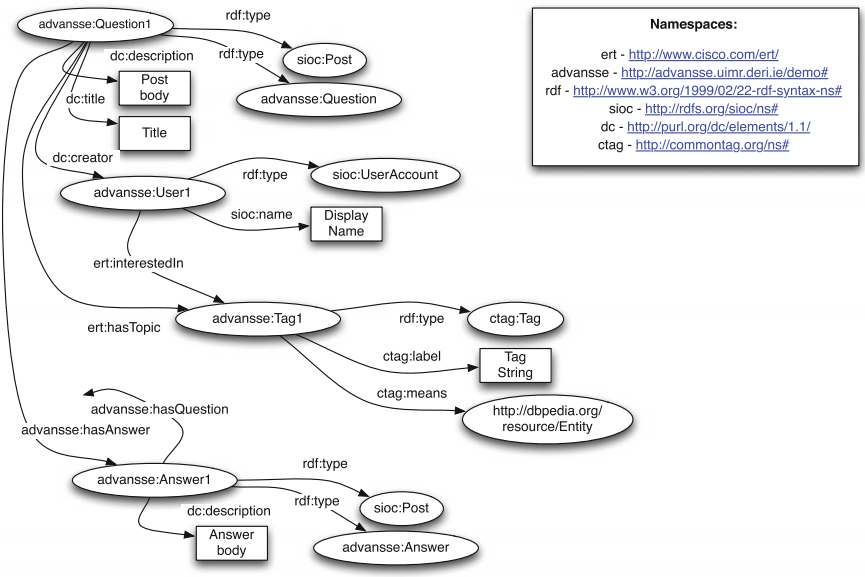

Fig. 9.5 Schema of the transformed StackExchange data

9.6.2 ADVANSSE Server

The implementation of the ADVANSSE server has more components then the abstract ADVANSSE server architecture, as can be seen in Fig. 9.6. The main reasons for this are as follows:

- The server contains both an XMPP client and server, as the Ignite OpenFire XMPP server was not very extensible, so the personalisation component had to be implemented as an XMPP client.
- The server contains multiple RDF stores: No relational databases are used in the prototype, and different components have different kinds of data which they need to persist, so multiple RDF stores had to be used.
- The recommendation algorithm has two RDF stores of its own: The spreading activation algorithm requires a very scalable and fast RDF store, but the best candidate is a read-only RDF store. So a second store was used in conjunction to hold all changeable data.

We will explain the design decisions for each component of the demonstrator implementation in the next sections in more detail.

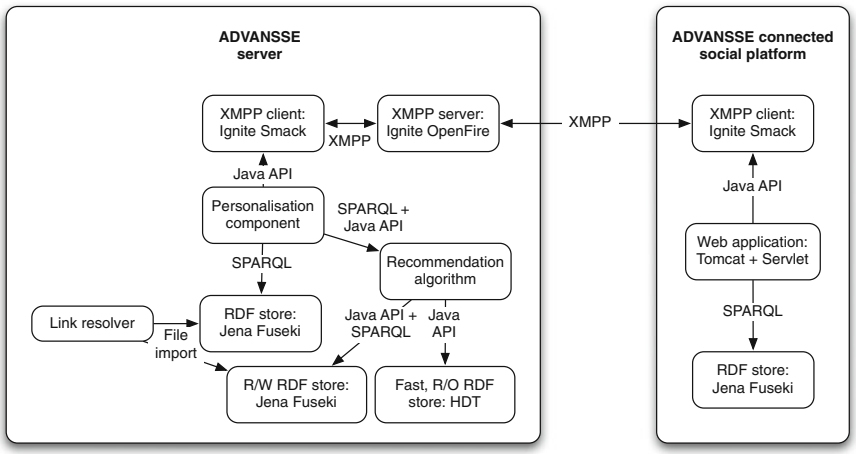

Fig. 9.6 Overview of the implementation of the ADVANSSE server and connected social platform

9.6.2.1 XMPP Server: Openfire

We are using a standard installation of Ignite OpenFire[22] version 3.7.0 as XMPP server, which is configured for the demo with a set of user accounts, and some initial subscriptions. The server will distribute the XMPP stanzas it receives from active publishers to relevant subscribers. RDF content is distributed in the form of SPARQL 1.1 Update queries embedded in XMPP IQ stanzas.

In order to implement all capabilities which are required for the ADVANSSE server, the XMPP server component needs to be integrated with an RDF meta-data store and with the personalisation component. Ignite OpenFire can be extended with plug-ins, however the extension mechanism is very restrictive. Plug-ins can only be executed when certain events are occurring, and the way in which events can be specified is not very expressive. As such, we were not able to use the official OpenFire extension points to integrate the RDF meta-data store and the personalisation component into Ignite Openfire.

However, we choose a different design which allowed the RDF meta-data store and the personalisation component to receive and react to XMPP messages: We integrated the RDF meta-data store into the personalisation component, and we added an XMPP client to the personalisation component. This allows us to specify the interaction between the RDF meta-data store, the personalisation component and the connected social platforms programmatically in terms of XMPP API methods and XMPP subscriptions. We used the Ignite Smack[23] java library as an XMPP client to implement this.

9.6.2.2 Personalisation Component

The personalisation component provides the integration point for the recommendation algorithm, the RDF meta-data store and the XMPP server, as the XMPP server itself is not extensible enough to add components with the functionality which ADVANSSE requires. In order to recommend posts to users or to get updates of user interests, the recommendation algorithm needs to save this data in persistent storage. In addition, recommendation results need to be stored persistently between executions of the recommendation algorithm. This allows the personalisation component to manage the delta between old and new recommendations.

The Personalisation component uses the Ignite Smack[24] XMPP client library in order to subscribe to all users on the connected social platforms. New posts and updates to user preferences are then stored in the RDF meta-data store and forwarded to the recommendation algorithm. The personalisation component uses SPARQL over HTTP to access the RDF meta-data store, and it uses a combination

[22] http://www.igniterealtime.org/projects/openfire/.

[23] http://www.igniterealtime.org/projects/smack/.

[24] http://www.igniterealtime.org/projects/smack/.

of SPARQL over HTTP and Java API calls to access the recommendation algorithm.

9.6.2.3 RDF Meta-Data Store: Jena Fuseki

We use Jena Fuseki[25] (Version 2.7.3) as an RDF meta-data store. Jena Fuseki is a wrapper around Jena TDB,[26] which is a high-performance RDF store. Jena Fuseki wraps around Jena TDB by providing an HTTP endpoint for SPARQL queries and SPARQL updates. This allows the full range of insert, update, delete and query operations, providing all the capabilities which a relational database also provides.

The personalisation component has its own Jena Fuseki instance, which it uses for persisting meta-data about all published posts, and for determining new and already seen recommendations. The recommendation algorithm also uses an instance of Jena Fuseki for holding all the data about user preferences and new posts which can be added, modified or deleted during the runtime of the personalisation component.

9.6.2.4 Link Resolver

In order to use the extracted StackExchange data set together with the background knowledge from DBpedia, it is necessary to link the tags from StackExchange to concepts from DBpedia. StackExchange tags are represented by simple strings, while DBpedia concepts are identified by a URI. RDF entity resolution is an active topic of research which is outside of the scope of this project, as can be seen from the research of Mendes et al. [16].

For the ADVANSSE demonstrator, we implemented a base-line link resolver as a python script. Links get resolved from a plain-text tag to a DBpedia URI in three steps:

1. Assign URIs to tags: Each tag used in the StackExchange data set, is assigned a URI in the `advansse` namespace, and the URI is given the `rdf:type ctag:Tag`
2. Match tag string to Wikipedia page URI: The tag string is resolved to one or more Wikipedia page URIs, by using two Wikipedia search engines: (a) the Wikipedia Opensearch API[27] which does fuzzy matching and which returns exactly one (the highest ranked) result; and (b) the Wikipedia full text Query API[28] which returns the top ranked 5 results. If the Opensearch API returns a

[25] https://jena.apache.org/documentation/serving_data/index.html.

[26] https://jena.apache.org/documentation/tdb/index.html.

[27] https://www.mediawiki.org/wiki/API:Opensearch.

[28] https://www.mediawiki.org/wiki/API:Search.

result, we use that result, otherwise we use the first result from the full text query API.
3. Match Wikipedia page URI to DBpedia entity URI: After obtaining the most likely matches on Wikipedia, we use the DBpedia SPARQL endpoint to find the DBpedia entity URI which corresponds to the Wikipedia page URI. DBpedia encodes this connection with the `foaf:primaryTopic` property.

The result is an NTriple file, which connects tag URIs with dbpedia URIs via the `ctag:means` property. This file can be loaded in an RDF store together with the StackExchange and DBpedia data sets.

9.6.3 Recommendation Algorithm

The recommendation algorithm for the ADVANSSE demonstrator implements the spreading activation algorithm. As described in Deliverable D3, spreading activation is well suited to the ADVANSSE use cases, as it enables recommendations on multi-source and cross-domain user profiles. Any kind of content can be recommended if it can be linked to DBpedia concepts; different kinds of entities, including sources such as users can be recommended; and domain customisations are possible. Finally, the computational complexity is lower then e.g. PageRank or collaborative filtering.

Spreading activation combines traits of content-based and knowledge-based recommendation algorithms, as it requires a semantic network to operate. Both content features as well as knowledge about the recommendation scenario can be be used by the algorithm. The demonstrator implementation uses the following input and background data to provide its recommendation output:

Input data: User profiles and posts from the **StackExchange** data set, which also provides a set of plain-text tags used for both the user profile interests and post tags.
Background knowledge: The **DBpedia** graph together with the results of the **link resolver** provide background information linking similar tags from the StackExchange data indirectly via DBpedia.
Recommendation output: The recommendations for one user are three ranked lists of the **top-k posts, users and tags** respectively.

The recommendation algorithm is triggered by the personalisation component via a Java API. In addition all RDF updates with new posts and user interest updates, are passed from the personalisation component to the recommendation algorithm, which uses them to keep its own data up-to-date.

9.6.3.1 Implementation

The implementation of the spreading activation algorithm uses the Header-Dictionary-Triples (HDT) RDF store [11]. HDT is a very fast and scalable RDF storage back-end, which allows us to return recommendation results in near real-time, and which has been integrated into the ADVANSSE server in a straight forward fashion, as it is a regular Java library.

9.6.3.2 Benchmark Results

In order to test the performance and the success-rate of the implementation, we use the StackExchange data set to run a benchmark. The data set contains 371 users which have an average of 6 interests. Most user nodes have a degree between 2 and 5, with a long tail up to 51, and two outliers who have a degree of 140 and 176.

We experimented with different configurations for running the algorithm on the StackExchange data set, and the configuration with the best results (the highest number of users with the required number of recommendations for posts, tags and users) is the following: distance constraint disabled, fanout constraint enabled, 10 target activations, activation threshold 0.5, initial activation 4.0, maximum out edges 500, and a maximum of 10 waves and 1 phase.

The target of 10 recommendations each for users, posts and tags could be reached for 315 of the 371 users, which is a success rate of 85 %. Out of the 56 users without enough recommendations, 64 % had only 2 out-links and 20 % had only 3 out-links (These out links are interests and/or authorship links). This indicates that interests or posts which are not very popular represent a problem when generating recommendations, resulting in a form of cold start problem for users with not enough interests and authored posts.

The performance of the implementation allows on-demand calculation of recommendations as the results are available in near real-time. The most atomic operation of the algorithm is a simple query on the HDT store. Such a simple query provides a subject or an object and two wildcards. The average length of such a simple HDT query is 0.2 ms, however the duration increases linear with the number of results. This results in an average duration of 200 ms for one run of the spreading activation algorithm. The average case scenario then is to generate recommendations for 5 users per second, or for 1 user on-demand (in less then a second).

9.6.3.3 Data Storage

The HDT based implementation of the spreading activation algorithm uses two RDF stores in order to achieve the speed described in the benchmark: (1) the

Header-Dictionary-Triples (HDT) store [11], and (2) Apache Jena TDB.[29] This is motivated in the different performance characteristics and feature set of the two stores:

HDT is optimised for fast querying and for handling of large data sets completely in-memory. HDT uses a compressed binary tree for storage, which allows it to fit large data sets entirely in memory and answer queries very fast. The DBpedia graph used for the demonstrator has 11 million entities and 40 million edges. Using HDT for this data set results in a compression factor of 92 %, as the original size of the NTriples is 5.46 GB and the HDT file is 436 MB. The average duration of a simple subject or object query on this data set is 0.2 ms. However, the **drawback** of HDT is that it is a read-only store. HDT is used to hold all data from the DBpedia data set, as this is static data.

Jena TDB provides the read/write capabilities which complement the read-only, high-performance HDT store. Jena TDB is a persistent RDF store from the Apache Jena project, which can be queried via SPARQL queries and administered via SPARQL Update. Jena TDB is used to hold all data from the StackExchange data set, as new user profiles and new posts need to be added to this data set dynamically. The StackExchange data set consists of 2200 entities and 15000 edges, which is 0.003 % of the DBpedia data set.

Using Jena TDB in conjunction with HDT for the spreading activation algorithm results in a factor 2 increase in execution time, when compared to pure usage of HDT. However, this is preferable to the speed of using only Jena TDB for all data, which would result in long delays when executing the spreading activation algorithm. Using both stores together allows us to combine fast query execution of HDT on 99 % of the data with data modifications on 1 % of the data. The result is on-demand, near real-time execution of the recommendation algorithm.

9.6.4 ADVANSSE Connected Social Platform

The ADVANSSE architecture allows multiple social platforms to connect to the ADVANSSE server via the XMPP protocol. For the demonstrator we have implemented a simple web site which allows users to emulate the behaviour on a social platform. Our web site persists the user generated content and the user preferences to local persistent storage, and connects to the ADVANSSE server via a XMPP client.

Web application In order to emulate the behaviour of users on a social platform, we have implemented a simple web site. It allows users to create accounts and log into the site itself. On the site users can create posts with tags, add and remove tags from their list of interests, subscribe and unsubscribe from other

[29] https://jena.apache.org/documentation/tdb/index.html.

users, add keyword filters to subscriptions. In addition users can view recommendations for interests, users and posts. We implemented the site as a Java servlet using Apache Tomcat[30] 7.0.

XMPP client The Java servlet which contains the web application with the user facing interface is connected to the ADVANSSE server via the Ignite Smack XMPP client library.[31]

RDF store for content For the demonstrator we use Jena Fuseki[32] as a persistent store for the user generated content and user interests. Jena Fuseki was chosen as it provides a fast storage backend (Jena TDB), and because it provides a SPARQL HTTP end-point. The end-point is used by the Java servlet for querying and updating the stored RDF data.

9.7 Conclusions

In this chapter we have presented an architecture for a distributed social platform in the modern enterprise. We have proposed to use the eXtensible Messaging and Presence Protocol (XMPP) together with the SPARQL query language for RDF in order to integrate data from distributed social platforms.

In addition, we have reviewed the personalisation approaches that are applicable in enterprise social networks, which often require the use of data from different data sources and from different content domains. We presented an enterprise use case and identified requirements for personalization methods. We argued the importance of the following requirements: mitigation of the cold-start and empty-box problems, scalability, applicability to multi-source and cross-domain data, universality regarding the data type and format, the ability to recommend sources of items, and the ability to customise generic recommendations for a specific domain. Further, we explained how the Spreading Activation approach can be applied in the enterprise use case. Then we described both the architecture and the implementation of the prototype of our ADVANSSE distributed social platform.

Our future work includes both qualitative and quantitative evaluation of our distributed social platform. We plan to measure and evaluate the performance of combining XMPP and SPARQL under different architectural constraints. We also plan to perform a qualitative comparative evaluation which allows us to compare Spreading Activation with the state-of-the-art methods, such as Collaborative Filtering (CF) or content-based methods. We will also perform a set of quantitative experiments and user studies to evaluate performance of the proposed method both in using standard Information Retrieval measures (e.g. precision/recall) and user perceptions.

[30] https://tomcat.apache.org/.

[31] http://www.igniterealtime.org/projects/smack/.

[32] https://jena.apache.org/documentation/serving_data/index.html.

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Chapter 10
Enriching Knowledge in Business Process Modelling: A Storytelling Approach

David Simões, Pedro Antunes and Jocelyn Cranefield

Abstract The main goal of Business Process Management (BPM) is conceptualising, operationalizing and controlling workflows in organisations based on process models. In this paper we discuss several limitations of the workflow paradigm and suggest that process models can also play an important role in analysing how organisations think about themselves through storytelling. We contrast the workflow paradigm with storytelling through a comparative analysis. We also report a case study where storytelling has been used to elicit and document the practices of an IT maintenance team. This research contributes towards the development of better process modelling languages and tools.

Keywords Business process management · Process modelling · Storytelling · Collaboration

10.1 Introduction

A recurring issue in knowledge management research is how to effectively externalise or codify organisational knowledge. This is inherently difficult because externalising knowledge involves attempts to convert knowledge that is strongly tacit (embedded in the practice of individuals and groups, and therefore strongly contextual and experiential) into knowledge that is explicit (documented or

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codified) for the sharing, combining and understanding at higher levels of the organisation [41, 42]. Within the process-based stream of knowledge management (one of six streams identified by Binney [12]) the key concern in this problem space is how to effectively codify and share knowledge about business processes, with the ultimate aim of improving organisational knowledge, strategy and practice.

In recent years, Business Process Management (BPM) has come to be seen as a mature, valuable management approach to process work [30]. Beyond a simple instrument increasing automation and managerial control, BPM has also become an enabler of business strategy through coordination of change efforts. An important driver of success is the way that BPM has bridged the human and technical sides of organisations by covering the whole lifecycle of business process analysis, modelling, enactment and management [61]. This is evidenced by a recent industry survey reporting that organisations primarily perceive BPM as "a top-down methodology to organise, manage and measure work", "a systematic approach to analysing, redesigning, improving and managing a specific process", and as a "cost-saving initiative focussed on increasing productivity". They only secondarily saw BPM as "a set of new software technologies that make it easy for IT to manage the execution of process workflow" [30].

Several reasons may explain this successful trajectory. Perhaps the approach is particularly well aligned with the dynamic context that organisations are facing today, or maybe task-technology fitness is increasing [59]. Researchers are still developing explanatory theory about these phenomena (e.g. [4, 8, 59]). We argue that the emergence and use of a new kind of IT artefact is significantly contributing to this success: process models.

Process models are not mere by-products of BPM; they are instrumental in materialising the BPM method through the analysis, modelling, enactment and management lifecycle [52, 61]. Some emphasis has historically been put in the later stages, where process models mainly contribute to automating business activities by translating business rules into instructions specifying a set of workflows, which can then be uploaded and executed by process aware information systems [60]. More recently, some emphasis has also been put in the early BPM stages, where the process of process modelling [2, 25, 28] handles all the activities necessary to eliciting, documenting, visualising, analysing, simulating, and also thinking and designing an organisation. This new trend focussing on the early lifecycle stages of BPM positions process models at the intersection between knowledge and process management by helping executives to analyse and reflect about their organisations' work practices.

Despite the promise of BPM modelling, a number of problems arise from its reliance on the workflow paradigm that is used for the specification of work processes, which emphasises procedure over a more ecological perspective embracing human skills, organisational practices and collaboration [18, 57]. The differences between the procedural and ecological views suggest there is a need to reconsider how process modelling is done. It appears that BPM models are permeated by a set of principles, goals and constraints that are enforced by automation technology, even when the main goals of BPM may not relate to automation.

We propose an alternative approach to process elicitation and modelling, in the context of BPM, with the goal of overcoming the problems associated with the workflow paradigm. Our approach emphasises storytelling, i.e. the telling of business stories. Inspired by the use of storyboards to communicate between product designers, clients and future users [34, 38], the approach builds on the tradition of research into how storytelling can build organizational meaning, extending it to the process realms. Furthermore, we leverage this alternative modelling foundation by supporting collaborative process modelling and empowering end-users to model business processes.

In our research, we are mainly concerned with the potential contributions of process models to understanding how organisations think about themselves, and less so with promoting organisational changes through process automation and management control. As such, we aimed to explore and assess whether rich work models can be produced by centring the modelling on knowledge representation while deemphasising workflow modelling. Specifically, we considered and investigated the following three research questions:

RQ1: Can meaningful business processes be elicited through storytelling?
RQ2: Can storytelling enable and incite users to externalize tacit knowledge and preserve contextualization?
RQ3: Can storytelling contribute to improve process modelling?

The chapter is organized as follows: In the next section we introduce the main theoretical concepts and discuss related work. In Sect. 10.3 we outline the two modelling approaches, workflow and storytelling, the former concerning the procedural specification of work processes and the latter concerning the organisational narrative of work. In Sect. 10.4 we discuss a case study where storytelling was adopted to elicit and document procedural knowledge from an IT maintenance team. Data collection and analysis procedures are driven by the research questions we have put forward in this introduction. Finally, the last section is dedicated to some concluding remarks.

10.2 Main Concepts and Related Work

10.2.1 Process-Oriented Knowledge Management and the Role of Process-Modelling

Since Binney [12] highlighted the process-based stream of knowledge management, interest in process-oriented knowledge management has grown on the part of both academia and business [31]. This particular type of knowledge covers what Binney designated by "engineered assets," which include work practices, procedures and methods. The need for knowledge management of business processes recognises the role of processes as part of an organisation's intellectual capital [11] and a

source of strategic value. BPM is an important tool for process-oriented knowledge management because it supports the transformation of informal knowledge into formal knowledge and facilitates its externalisation and sharing [32]. Process modelling is a foundational aspect of BPM.

A number of comprehensive reviews on process modelling have been published [2, 3, 21, 27, 33, 36]. Since they cover about 20 years of research in this area at different milestones, they also give insights on how the perception of process modelling has been changing through the years. Curtis et al. [21] discuss the wide range of goals that process modelling often has to accommodate, from understanding the organisation to automated execution support. Because of such wide range, they suggest a separation between two different paradigms: (1) programming, more rigorous; and (2) scripting, more pragmatic. The authors also analyse the main advantages and drawbacks of these two paradigms using a set of properties, formality, granularity, precision, and fitness. The focus on these properties highlights a fundamental concern with the process modelling language.

Five years later, Aguilar-Savén [2] suggests considering both technical requirements and political/social requirements when discussing process modelling. Focussing on the latter, the author brings forward two additional properties: customer orientation and ease of use. An interesting consequence resultant from the first property is expanding the list of stakeholders involved in process modelling from modellers, employees and managers towards the customers, who may find themselves involved in the design, remodelling or automation of their relationships with suppliers. Ease of use is suggested by Aguilar-Savén as necessary to bring process modelling closer to organisational goals such as understanding, learning and strategizing. Proposing a framework similar to the one developed by Curtis et al. [21], Aguilar-Savén [2] divides the spectrum of modelling purposes in four categories: to learn about a process, to design and develop a process, to control a process, and to execute a process. Ease of use is considered particularly important when addressing the first two categories, since process models must support capturing and understanding organisational knowledge with the internal and external stakeholders.

Another five years later, Melão [36] presents an updated review of this subject. The author observes that process management has been evolving from a technology-centred view towards a more holistic approach, which encompasses technology as an enabling factor among many others. In particular, the author discusses how organisations extend their business through e-business, i.e. offering services based on the interaction and composition of human and automated functions, usually based on Internet technology. Once again, this view emphasises customer orientation as an important property to consider when evaluating process models and modelling practice. However, Melão also brings forward two new properties: flexibility and effectiveness. Flexibility concerns avoiding monolithic customer interactions, which usually require multi-channel communication, loose coupling, and dynamic behaviour of all involved actors, both human and automated. The effectiveness property puts some emphasis on the successful implementation of e-business processes. Melão [36] notes that “there is evidence that

e-businesses have not always been successful" and also that "managers need to be more sensible about the claims of ICT gurus and popular press statements." Of course the effectiveness of process modelling concerns technical issues. For instance, the adoption of e-business standards, including process modelling languages, process interoperability and information exchange, contributes to effectiveness. But Melão also refers other drivers such as the capability to adapt process models to the BPM lifecycle (through configurable model constructs) and to different modelling techniques and tools (through the combination of generic and niche support).

Aldin and de Cesare [3] provide a more recent overview in this area. They suggest that organisations are nowadays striving for agility, i.e. being able to "more readily and flexibly adapt" to changes in the environment, increasing competition, expanding markets, and new customer expectations. The authors also note that current procedural approaches to process modelling tend to generate large and complex models, and that the emphasis on procedural knowledge can result in over-specification, which may adversely affect striving for agility.

To summarise, this short historical overview shows that process modelling has been evolving from being centred on technical matters towards the inclusion of social issues, and from targeting modellers towards targeting various additional stakeholders including internal users and customers. This evolution is illustrated by the proposition of new and more challenging properties, including in particular ease of use, effectiveness, flexibility and agility, according to which modelling techniques and tools are evaluated.

10.2.2 Workflow Paradigm

The workflow paradigm in BPM precludes a functional, deterministic view of work in organisations, representing what is being performed and what flows of information and control are necessary to process work [21, 37]. Aldin and de Cesare [3] characterise its main constituents as a collection of seven elements: process, activity, service, role, goal, event, and rule. This characterisation is consistent with others found in the research literature (e.g. [61]). Several researchers argue that this paradigm dominates BPM [9, 37, 48, 54, 61, 62], a view that is supported by industry surveys [29].

Of course any paradigm proposes a restricted view over a complex phenomenon, usually adopted with the purpose to efficiently accomplish certain goals. However, as previously discussed, process modelling not only has to serve a wide range of goals but has also been evolving to accommodate new requirements. So an issue to discuss is whether the workflow paradigm is still as relevant as it was in the past [1, 46].

The workflow paradigm has been thoroughly analysed by Recker [48, 49], Recker et al. [53]. Their survey of current practices in process modelling indicates that users find the workflow models lacking and often have to complement the

models with narrative descriptions. Users also find modelling languages difficult to use. One concrete example is given by the use of pools and lanes in BPMN (Business Process Modelling and Notation) to indicate who is responsible for a process or activity, an approach that is considered a burden by users [48]. Another example is the inadequate representation of state-based concepts, which often constitute the basis of business rules [51]. The authors found out that BPMN, in comparison to other leading process modelling grammars, affords the highest level of representation completeness (which we relate to language) but also the lowest level of clarity (which we associate to ease of use) [51]. Another study reports an interesting conflict between IT and business people, with IT people demanding the use of more symbols, increasing expressiveness and rigour, and business people becoming satisfied with simpler models [50].

Recker et al. [53] also investigated the use of different representational schemes by students. The results indicate that flowcharts, combining abstract graphics like boxes and arrows with text, performed better. This would suggest that the workflow paradigm is actually the best approach to process modelling. However, the experiment collected data after 13 weeks of training in business process modelling, which probably biased the students towards that paradigm.

Often process modellers operate according to a worldview that filters out ecological information [57, 63]. This attitude can be related to the historical roots of the field, when process modelling essentially served a subsidiary role supporting systems integration and automation.

Following the same line of reasoning, we note that the historical relationships between process modelling and automation lead modelling languages to be permeated by a set of rules strictly imposed by automation [5, 6, 52]. For instance, model completeness and soundness may not be important in the early BPM stages, but are nevertheless enforced by most process-modelling languages. Such forced adherence to automation rules can make it more difficult to capture organisational knowledge. An example concerns exception handling, which is recognisably difficult to handle with existing modelling approaches but easily handled by humans [5].

10.2.3 The Storytelling Approach

Long-associated with the transfer and preservation of knowledge in human civilisations, storytelling has more recently been seen as a useful tool for organisational knowledge management. In the 1970s organisational stories were recognized as valuable resources for enriching understanding (e.g. [20, 39]). Since then, researchers in diverse disciplines have investigated the use of storytelling to express and manage organisational meaning at both an individual and collective level, to "nurture and create meaning" and to "reinforce control and manipulate meaning" [15]. For example, Swap et al. [58] view the use of storytelling and mentoring as a means to transfer core competencies, whereas Denning's work on storytelling

focuses on the creation and framing of shared knowledge with the goal of organisational change [23].

Storytelling uses stories to elicit and document organisational knowledge, norms and practices [16, 22]. A key characteristic of storytelling is its contextual richness: stories convey great quantities of information in simple ways, can take advantage from uncertainty and imagination, and make the readers or listeners feel engaged in the story [26]. Storytelling is of increasing interest as a way of helping organisations to externalise knowledge that has a tacit component [45]. Because the knowledge in organisations is typically distributed, group storytelling has been suggested as a convenient knowledge management approach [14, 56]. Perret et al. [45] used a group storytelling tool to help externalise knowledge from software projects, and Carminatti et al. [19] found that group storytelling was more effective than interviews at eliciting collective knowledge. Santoro et al. [56] used group storytelling to elicit knowledge from stakeholders about business processes. Although a group storytelling approach may also expose inconsistencies and conflicts, this can be regarded as an opportunity to enrich organisational knowledge: Boyce [15] has emphasised the value of taking multiple perspectives into account in storytelling research. Our study builds on this stream of interest, focusing on the application of group storytelling to process modelling within BPM.

When combined with the use of a collaborative tool, we suggest that group storytelling can also facilitate the integration of personal knowledge into collective organisational knowledge and intelligence. (In the case of Web 2.0 tools, Razmerita et al. [47] have shown how collaborative tools can support such integration.) We follow Newell et al.'s [40] definition of collective knowledge as knowledge of the shared organisational environment of rules, laws and regulations, extending it to include processes and the ways in which things are done. Collective intelligence is the shared intelligence that emerges during, and from, the collaboration process. In this case, the collective intelligence of interest is based within process-based stories.

The adoption of storytelling in process modelling raises several theoretical and practical challenges. A fundamental issue is that a model presupposes some ontological constructs, such as state tracking [64]; otherwise we would be talking about diagrams or even sketches. However, these ontological constructs may conflict with storytelling. For instance, stories are often episodic, evocative, situated and may have significant gaps between the narrative elements. In addition, often stories are not task- or time- oriented, which makes it difficult to track states.

10.3 Process Modelling with Storytelling

10.3.1 The Modelling Tool

In response to the issue outlined above, our approach to storytelling is based around the use of storyboards to capture and convey stories. Storyboards capture stories in

a visual way, combining text with visual elements to emphasise expressiveness [26]. A storyboard can be related to reality, including things, events and transformations. It also suggests a particular way of reading a story, which can be used for state tracking. We therefore argue that storyboards have the ontological structure necessary to bridge the gaps between modelling and storytelling.

We developed a collaborative tool supporting the integration of storytelling and business process modelling through storyboards. From now on we refer this tool as the "storytelling tool". The storytelling tool provides a database of generic pictures that can be selected to build a storyboard. A storyboard developed with the tool consists of a linear sequence of images selected from the library and configured individually. Each generic picture is characterized by metadata depicting situation, location, and presence of specific objects including business objects. Pictures are then given context through dialogue lines, descriptions and contextualized metadata to compose a scene belonging to the story. Figure 10.1 depicts the characterization of a waiting scene, where specific metadata is used to register the basic justification why the actor is waiting in that particular situation, as well as a time limit that may trigger a reactive action. Further details about the scene may be given in the narrative. As shown in the figure (on the right), scenes are arranged sequentially in a storyboard. Notwithstanding, parallel story lines are also supported. At the end of each scene the storyteller is given a number of choices concerning the flow of

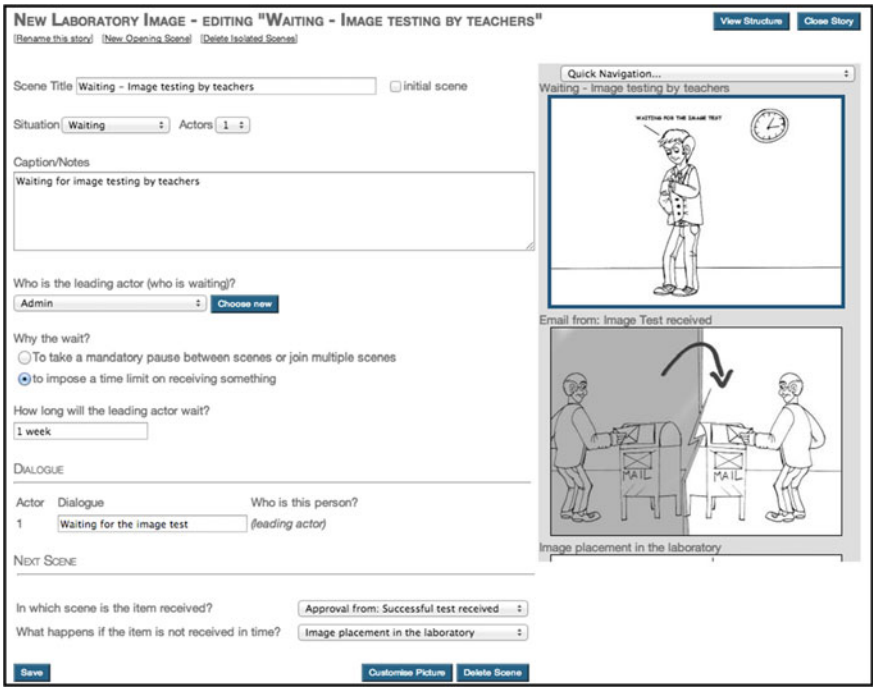

Fig. 10.1 Sequential display of scenes (composer view)

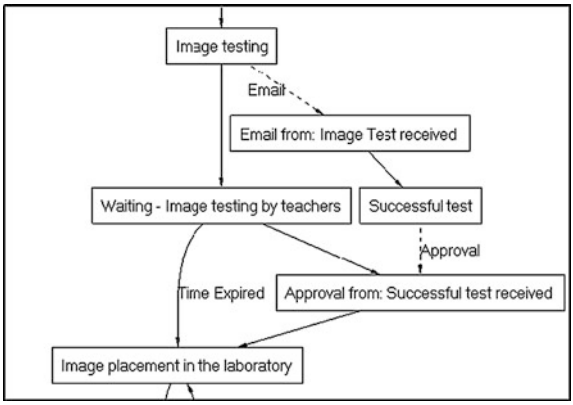

Fig. 10.2 Parallel story lines (structure view)

action, and a special display mode is used to expose the story structure (see Fig. 10.2). Figure 10.3 in the following section, and Figs. 10.5, 10.6 and 10.7 throughout the chapter provide more examples. They show people interacting in typical business situations, with events and activities such as having a meeting, signing a document, sharing information, etc. They also show typical business objects such as documents and computers. The tool allows users to assign specific names to the "generic" people and objects appearing in pictures (see the example in Fig. 10.5), add dialogue lines to people (see example in Fig. 10.6), and associate captions with pictures (see example in Fig. 10.7); features which contribute to document interaction, events and states.

Storyboards can be concurrently developed by a number of users, contributing diversity to story building. In a previous publication [7] we discuss the tool in more detail, describing its information model and functional features. Details about the tool design and implementation are not repeated here and interested readers are pointed to the aforementioned paper.

10.3.2 Storytelling Versus Workflow

We now provide a comparative analysis of main differences between the storytelling method and the workflow paradigm. To represent the workflow paradigm, we selected the BPMN notation and ARIS tool. BPMN is currently the dominant notation for process modelling, reportedly having 60 % of industry penetration [30], and ARIS is representative of how visual tools typically support BPMN. For instance, ARIS is very similar to Visio and Visual Paradigm. The storytelling tool is used to represent the storytelling approach.

In Fig. 10.3 we compare screen dumps from the storytelling tool and ARIS for six modelling situations. The process being modelled is the Pizza Collaboration,

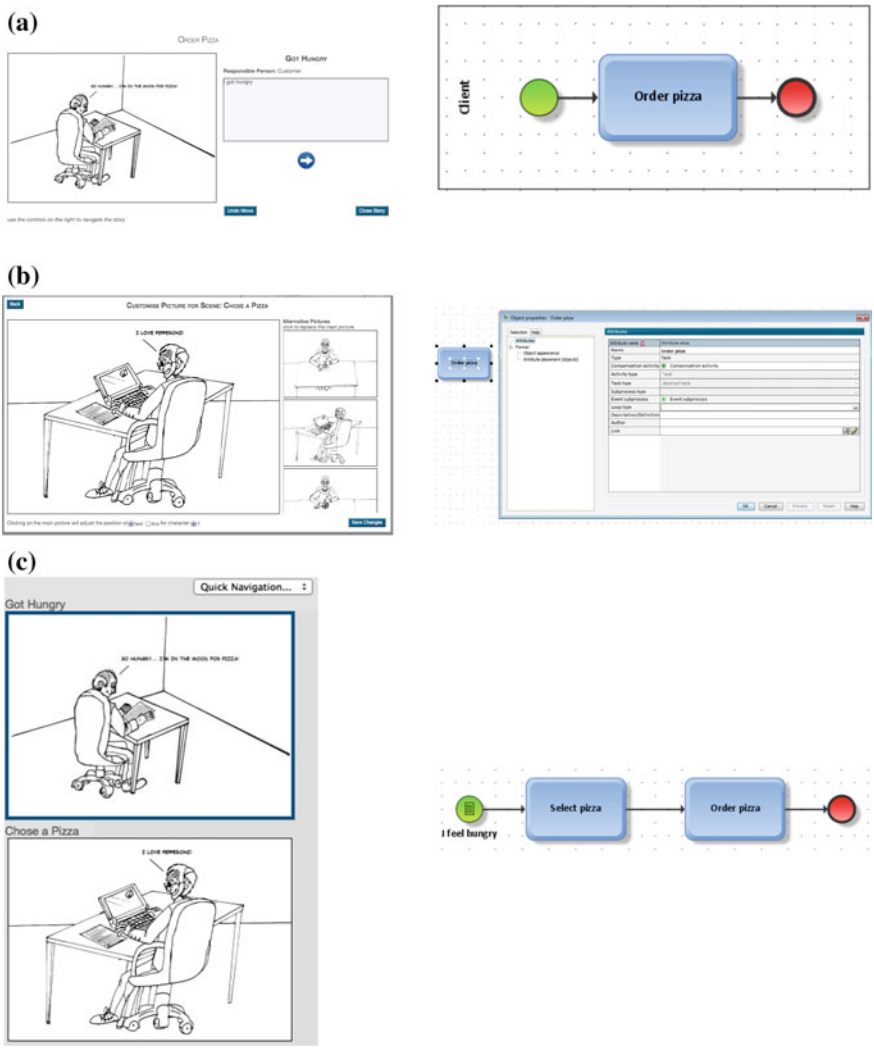

Fig. 10.3 Comparison between the storytelling tool (*left*) and ARIS (*right*)

which is discussed in BPMN documentation from the Object Management Group [43]. In brief, the Pizza Collaboration outlines the various steps involved when a client contacts a store to buy a pizza.

In the analysis that follows we compare properties of the storytelling tool and ARIS, focusing on how they differ in respect to specifying activities, adding context, dealing with sequence flows, dealing with conditions and flows, supporting communication and collaboration, and overviewing business processes.

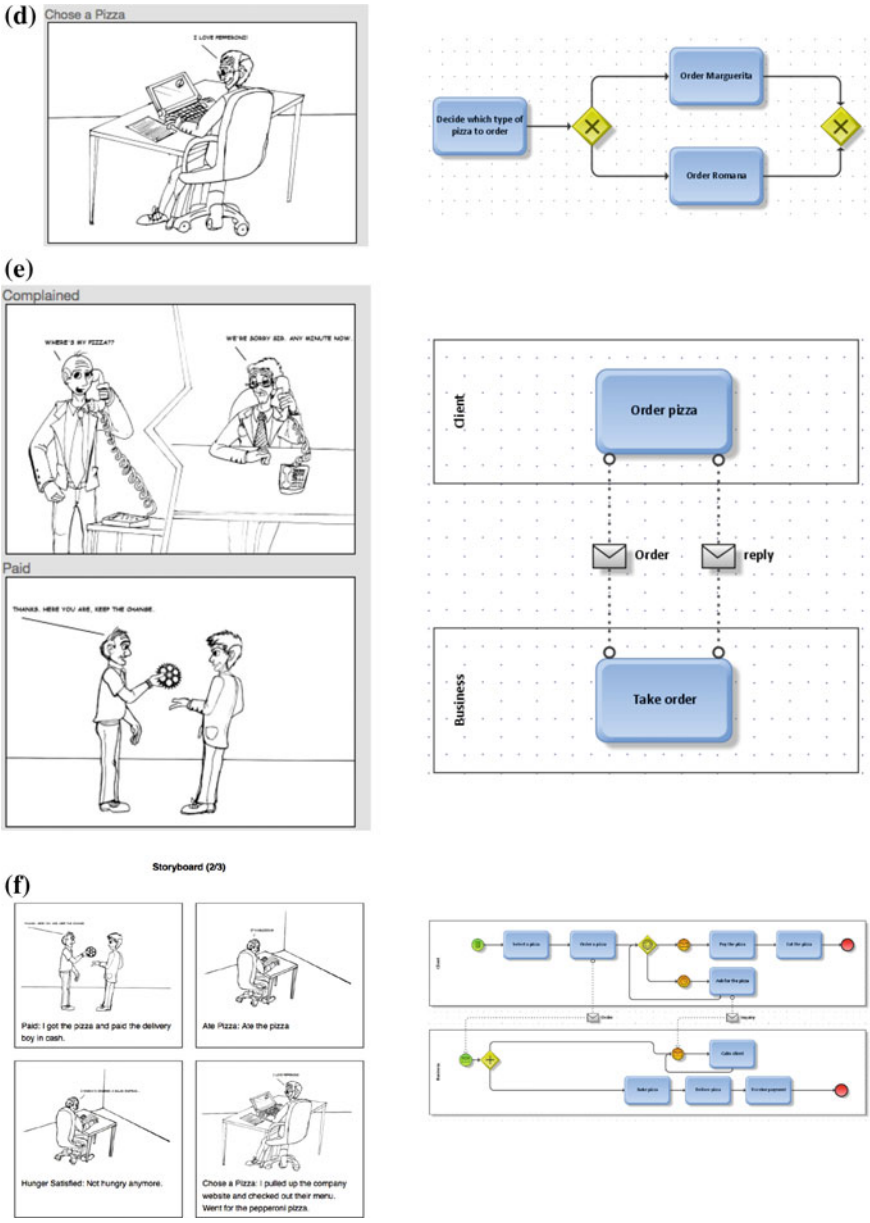

Fig. 10.3 (continued)

(a) **Specifying activities**
According to BPMN [44], activities are one of the three main constituents of processes, which also include events and gateways. ARIS follows the BPMN convention of representing activities with rounded rectangles. The activity shown in Fig. 10.3a is ordering a pizza. The storytelling tool uses instead a more complex element, named scene, which comprises a picture plus textual and visual elements on top of the picture. The activity is therefore implied by what the picture implicitly evokes and what is explicitly commented with text. Combining pictures with textual elements on top implements a storytelling mechanism usually seen in comic books and graphic novels.

Scenes, besides providing richer visual information than activities, also afford conveying more than procedural information. For instance, a scene may be used to introduce the narrative, describe a work setting, present the participating actors, describe the social atmosphere, etc. Such information may be added in ARIS using annotations, but the advantage of using scenes is integrating such information with activities in a more natural way.

The way actors are associated to activities is also completely different in the two cases. In ARIS, actors are associated to activities through pools and lanes. Pools are represented with rectangles. The pool shown in Fig. 10.3a indicates that the client orders the pizza. In the storytelling tool, actors are anthropomorphic and can be named using the aforementioned textual elements on top of the picture. This is a more natural approach than using pools and lanes. All in all, scenes explore familiarity with existing storytelling mechanisms and the human capacity to interpret context, while the ARIS approach relies more on learning the language rules.

(b) **Adding context to activities**
Figure 10.3b illustrates how users can add contextual information to activities. In the case of ARIS, typical user-interface elements like text boxes and buttons are used, while the storytelling tool supports adding contextual information in a more interactive way. For instance, the text elements on top of the picture can be edited inline and moved with the pointer. This suggests that the storytelling tool emphasises visual composition rather than configuration. Besides, the mapping of attributes in the storytelling tool is visible to users, while in ARIS some attributes are hidden.

(c) **Sequence flows**
Following the BPMN notation, ARIS represents sequence flows between activities using arrows. These arrows have strong semantics attached: they explicitly define the order of activities. On the other hand, the storytelling tool does not have such a strong mechanism defining the order of scenes. Scenes are displayed in a sequential way in the storyboard, e.g., Fig. 10.3c shows two consecutive scenes, got hungry and chose a pizza. Storyboarding has a convention that the story is read from left to right, but authors and readers can enrich and often subvert that convention. The end result is that the storytelling approach provides more narrative freedom.

(d) **Conditions and flows**
One fundamental characteristic of BPMN is showing how activities evolve over time by combining gateways with sequence flows representing the possible paths that a process may take depending on certain conditions. Figure 10.3d shows the case where a client decides to either order a pizza Margherita or a pizza Romana. On the contrary, the storytelling tool does not have explicit flows. It also does not have a formal way to represent conditions or gateways. This does not mean they cannot be specified, but users have to incorporate these elements in the storytelling using the available narrative elements. For instance, the scene shown in Fig. 10.3d indicates that the client makes a choice towards a certain type of pizza. This scene can be used to describe what happens next as a consequence of that decision, and other scenes may be added to describe other decisions. But again, the storytelling tool privileges narrative over using specific modelling elements.

(e) **Communication and collaboration**
As previously mentioned, the workflow paradigm emphasises the sequencing of activities. However, often activities involve some communication or collaboration between actors. ARIS follows the BPMN specification, which represents communication with message flows between activities—the order and reply messages shown in Fig. 10.3e. The specification requirements are relatively complex because they involve activities, two types of flows (sequence and communication) and pools.
Quite on the contrary, the storytelling tool relies on anthropomorphic information to describe communication and collaboration. For instance Fig. 10.3e shows a specific scene with two persons communicating over the phone, which implicitly represents the communication flow. The tool's library includes various scenes describing different types of communication and collaboration, such as one-to-one contacts and face-to-face meetings. This approach is definitely less formal. It also avoids using different notations for sequence and communication flows, which may be difficult to differentiate in practice, especially for less experienced modellers.

(f) **Process overview**
Figure 10.3f illustrates how ARIS and the storytelling tool overview business processes. ARIS gives a procedural view with the whole collection of pools, activities, flows, gateways, and other modelling elements. On the other hand, the storytelling tool, besides generating a streamlined procedural overview (shown before in Fig. 10.2), also generates a storyboard with all the scenes and textual descriptions about what happens in each scene.
One advantage of ARIS over the storytelling tool is that there is no difference between the overview and the composition space, i.e. users overview the process while composing the model. During composition, the storytelling tool can only show a few scenes at a time, so users must navigate between scenes using a scrollbar. However, this limitation is compensated by the capacity to print out the storyboard. One significant advantage of generating a storyboard

Table 10.1 Summary of main modelling differences

Characteristics	Storytelling tool	ARIS
Activity representation	Scenes, anthropomorphic, combining pictures and text, and having visible attributes	Rounded rectangles, hidden attributes
Actors	Anthropomorphic, blended in activities	Rectangles, separate from activities, add complexity to diagrams
Flows	Implicit in the scenes or in the sequence of scenes	Arrows, explicit
Communication and collaboration	Implicit, anthropomorphic, using specific scenes to convey meaning	Explicit, mixed with sequence flows
Overview	Structured overview and storyboard, with text and pictures, no formal notation	Structured, with all BPMN modelling elements

is that the output does not rely on a formal, technical notation to express the process.

In Table 10.1 we summarise the main differences found in the two approaches to business process modelling.

10.4 Case Study

We now outline and discuss a case study where we tested the storytelling method. We first present a set of considerations regarding the study design, including objectives, data collection procedures, analysis, and validity. We then follow with the case description and analysis.

10.4.1 Case Study Design

As detailed in the first part of this paper, our study was motivated by the problems that are imposed on BPM by the workflow paradigm, which led to a reconsideration of the way business processes are modelled. The objective of the study was aligned with our research focus: to investigate and evaluate the potential of the storytelling method. We used the case study method in the software engineering tradition [55], gathering a range of data in a real-world setting. The study design involved three phases and several data gathering methods (outlined later). We were interested in testing the storytelling approach in a typical scenario. As such, we sought an organization that was externalising their work procedures. The unit of analysis was the process being modelled. The specific type of organization was of no particular

importance to the study design, since the requirements pertained mostly to the process under study: each process needed to encompass a minimum level of complexity to allow for rich stories addressing problem solving and unexpected situations, and it needed to span multiple roles in the organizational hierarchy in order to capture collaborative scenarios, which are central to most stories.

As discussed earlier in this paper, we had previously developed a tool implementing the storytelling approach. The study participants used that tool as an authoring environment for eliciting and modelling their business processes. As we were focusing on the ability to do the modelling autonomously, we avoided direct contact with the subjects while they were using the tool, and adopted an indirect method of data collection, classified by Lethbridge et al. [35] as a second degree data collection technique. The subjects created their stories autonomously and data was collected at a later time, from both the tool's print outs and raw usage logs. We used a goal-based metric definition technique similar to the methodology proposed by Basili and Weiss [10]. The goals for the measurement activity were defined so as to provide relevant data to fulfil each of the research questions. Refined questions for each goal and corresponding metrics are shown in Table 10.2.

We took a number of steps towards addressing validity both during case study design and later through data collection and analysis. A case study protocol was developed with the engagement of all participants, detailing case objectives, field procedures and timings. This protocol was established with the intent of ensuring consistent data collection and addressing threats to validity, by aligning the researchers' and participants' views of the study and its objectives. This alignment was further pursued by choosing an organization well known to the researchers, with a long-term history of past cooperation. Reliability and internal validity threats were addressed by ensuring that subjects understood the tasks they were to perform and were not influenced by the researchers who conducted the study and analysed the data, and by isolating factors that could affect causal relations. Two key factors were whether participants were correctly using the tool and the tool's adequacy for authoring business stories. The latter is part of our study objectives and is evaluated through data collection and analysis. We addressed the former by devising a multiple phase field procedure strategy (Fig. 10.4), where we first explained the tool usage to the participants, and then engaged them in a test-run where subjects began telling their stories and tested the tool. After these initial sessions, we carried out individual unstructured interview sessions that served a dual purpose: (1) helping subjects overcome difficulties caused by incorrect use of the tool; and (2) identifying shortcomings or aspects of the tool that should be improved. Once both issues were addressed, we entered the second phase whereby subjects would develop their stories to completion with no further interference from our part. Finally, in the last phase, the subjects worked together to reach a unified story. We used different forms of triangulation to increase the quality of our measurements and data analysis. This procedure is of particular importance considering that in our research we must rely primarily on qualitative data, richer but less precise than quantitative data points. We gathered data from different data sources, namely from the tools' print outs (storyboards and structure diagrams), from raw system logs, and from the

Table 10.2 Goal-based measurements

RQ	Goal	Questions	Metric	Type of data	Data categories
1	Evaluate meaningfulness	Did the subjects create detailed stories? Can workflow be derived from user stories?	Number of scenes	Quantitative	(None)
			Use of narrative	Qualitative	Low/ medium/high
			Use of dialogue	Qualitative	Low/ medium/high
			Structural complexity	Qualitative	Low/ medium/high
			Story verifies process validity restrictions (see [7])	Qualitative	Yes/no
2	Evaluate tacit knowledge externalisation and contextualization	Did the stories portray emotion? Were unexpected situations depicted? Was contextualized knowledge applied?	Presence of emotional elements in the dialogue/ narrative	Qualitative	Yes/no
			Depiction of unexpected situations	Qualitative	Yes/no
			Predominance of contextual reasoning	Qualitative	Low/ medium/high
3	Evaluate whether collaborative storytelling contributes to process modelling	Did sharing stories help the team better understand the process? Did the gathered stories influence the final adopted practices?	Sharing of stories helped collaboration	Qualitative	(None)
			Stories enriched the organisational practice	Qualitative	Yes/no

Fig. 10.4 Field procedure

subjects' feedback in interviews. We took both quantitative and qualitative measurements whenever possible, and data was analysed independently by two researchers.

External validity threats are also acknowledged, specifically the extent to which we can use our findings in the present study towards building a generalized storytelling approach to process modelling. We deliberately chose a specific process as the unit of analysis abstracting organizational-specific aspects, and the subjects were selected among the participants in the chosen process.

We nevertheless report issues regarding the higher level of technological literacy of our subjects in comparison with a broader, more typical organizational environment. We also suggest that the particular environment and leadership of the selected organisation may influence the obtained results. The strong research orientation of the organisation and the leadership by a researcher in the field of Computer Science may have influenced the observed modelling practices. We therefore recognise that further research is necessary involving other types of organisations.

10.4.2 Case Description and Results

Our study took place at an IT supporting unit belonging to the Faculty of Sciences of the University of Lisbon. Many courses taught at the university depend on computer laboratories supported by this unit, which covers around 1000 students. Some of these laboratories have to comply with specific software and hardware requirements presented by various courses running at the same time and changing every six months. Therefore, such requirements must be reported by the teaching staff to the IT team prior to the beginning of each semester so that the appropriate operating environment is ready for use by students when classes commence.

Because resources are limited, the laboratories cannot be dedicated to a single course, so a set of base image files must be created and configured by the IT team and replicated and installed across all computers available in the laboratories. This is an intricate process encompassing a series of activities involving the preparation of base configurations, requests for requirements, analysis of technical problems, negotiating requirements with teachers, approvals, generation of images, upgrades, compatibility tests, deployment, and final tests.

Since there is currently no process model supporting these activities, difficulties are not uncommon. For instance, with no mechanism for retaining knowledge year after year, the IT team often works on the same problems and devises repeated solutions. What is worse, it is troublesome to keep track of communications going back and forth between teachers and the IT team, often leading to conflicts, unnecessary delays and incorrect configurations. Furthermore, because procedures are not well defined, the IT team ends up receiving new requests throughout the semester, and such exceptions are not easily handled.

In this context, the leader of the IT unit decided to use the storytelling tool with the objectives of improving consistency, efficiency, transparency, accountability, and learning. The team was invited to use the storytelling tool to describe the desired IT configuration process. Again, keeping with our stance of focusing on the

operators' knowledge and points of view, we reserved our involvement to a minimum. After a brief explanation on how the tool worked, all IT team members including the leader were asked to, in their own time, tell and record a story about the configuration process.

As explained in the previous section, work with the tool was divided into three phases. In the first phase, lasting one week, the subjects tested the tool and began using it for telling stories. Following the interviews and the analysis of these first stories, we identified a few issues regarding the tool use. For instance, one subject was unsure how to associate the actors in the story with the respective organizational roles—he solved it by using the dialogue lines to identify each actor (Figs. 10.5 and 10.6). Another subject experienced difficulties structuring his story because he wanted to describe parallel story lines and the scene frames were displayed sequentially. He later found out there was an option whereby the tool would show the relations between the various scenes, thus exposing the parallel activities.

Another discovery that was made by inspecting the initial stories was that all subjects told stories about how they thought the process ought to function, as opposed to producing concrete narratives based on recollections of past, specific occurrences. We later found out that this was a deliberate approach by the team: they had agreed that they were not happy with the existing configuration process and were seeking to implement a whole new process. (Owing to our study protocol, it was inappropriate for us to intervene.)

In phase two, lasting roughly two weeks, the team members were invited to use the tool to outline their stories. Table 10.3 provides a quick summary of the six stories that were produced by the end of phase two. Since the participants were purposely trying to model a desired process, most stories were poor on implicitness and heavily reliant on structure. In fact, the team felt the tool was not powerful enough to model complex story lines and asked us to improve the support for

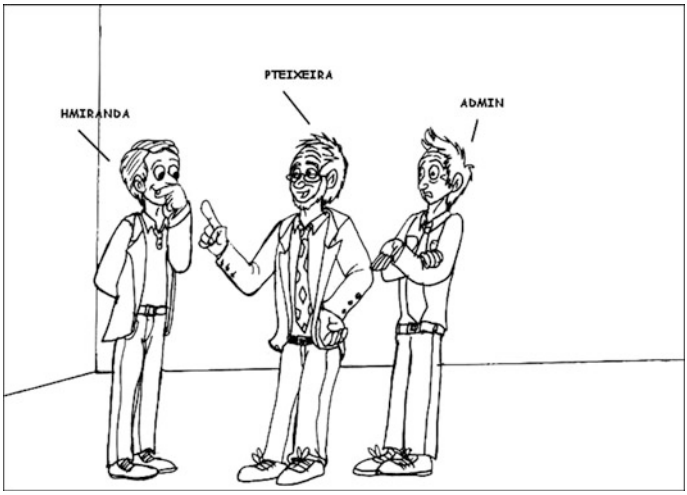

Fig. 10.5 Using dialogue lines as identification tags

Fig. 10.6 Typical scene with dialogue line

Table 10.3 Collected data per story at the end of phase two (metrics for RQ1)

Story #	Number of scenes	Use of dialogue	Use of narrative	Structural complexity	Story verifies process validity restrictions
1	10	None	Medium	Medium	Yes
2	8	Low	Medium	Medium	Yes
3	37	None	Medium	Very high	Yes
4	14	Medium	Medium	High	Yes
5	13	Medium	Low	High	Yes
6	15	Low	Medium	High	Yes

scenes representing decisions (the tool only supported simple yes/no type decisions initially). Two team members did not use dialogues at all, and all of them used structure as the primary means of telling a story. Most team members adopted narrative to describe what happened in a scene and for connecting scenes when using non-sequential patterns. In a few stories, narrative was also used to convey implicit story elements such as uncertainty, frustration and disbelief (see examples in Fig. 10.7).

In the final phase, participants were asked to collaboratively produce a converged story. Since the storytelling tool allows viewing and changing each other's stories but does not support any explicit convergence process, the team had to improvise a way for reaching a common, agreed upon story. The improvised process began with the team leader gathering the stories from all participants for analysis and comparison with his individual story. He also suggested the team members to use the storytelling tool to study each other's stories in preparation for a convergence meeting where the final story would be discussed face-to-face.

Fig. 10.7 Expressing emotions

Actually, because of the unanticipated complexity of some stories, two meetings were necessary to complete the discussion. After these two meetings, the team leader used the storytelling tool to record the collective portrayal of the new IT configuration process.

We found out that the individual stories played a significant role in these meetings, serving both as a key facilitator in exposing each participant's view on the process and, as multiple subjects accounted in interviews, as a tool to record and organize the participants' ideas, improving their own understanding of the IT configuration process being depicted.

To evaluate the impact of each individual story on the converged story, we analysed the storylines and identified four distinctive plot segments: image preparation and evaluation (IPE), management of teacher requests (MTR), image testing and problem solving (TPS), and image deployment (ID). We then analysed the relative weight of each segment in each story, including the converged story. As shown in Fig. 10.8, the coverage of these story segments was not homogeneous among all participants, with team members dedicating greater shares of their stories to the parts of the procedure they were more familiar with, and/or had an interest in changing.

Considering that the team leader developed an individual story and then developed the converged story, we paid particular attention to the differences between these two stories. The individual story developed by the leader is referenced as story #3 in Fig. 10.8. It shows that the leader dedicated the majority of storytelling to the first segment, which mainly involves planning activities, while omitting more operational activities such as dealing with teachers' requests and installing image files in the laboratories. In contrast, almost all other team members ignored the first segment and covered the remaining segments in varied proportions. However, what is interesting to observe is that the team was able to converge on a balanced account of the new IT process, which is clearly shown in story #7 (Fig. 10.8).

We also analysed the level of detail of each story segment, and constructed the parallel coordinate plot shown in Fig. 10.9. In the horizontal scale we list the four story segments outlined above, while in the vertical scale we consider a measure of detail in 5 levels, from none to very high. The polygonal lines show how the details of each story changed as the story evolved from preparation to deployment.

We find that the IPE and TPS segments are covered in very high detail in the leader's individual story (#3, shown as a dotted line in Fig. 10.8) but much lower

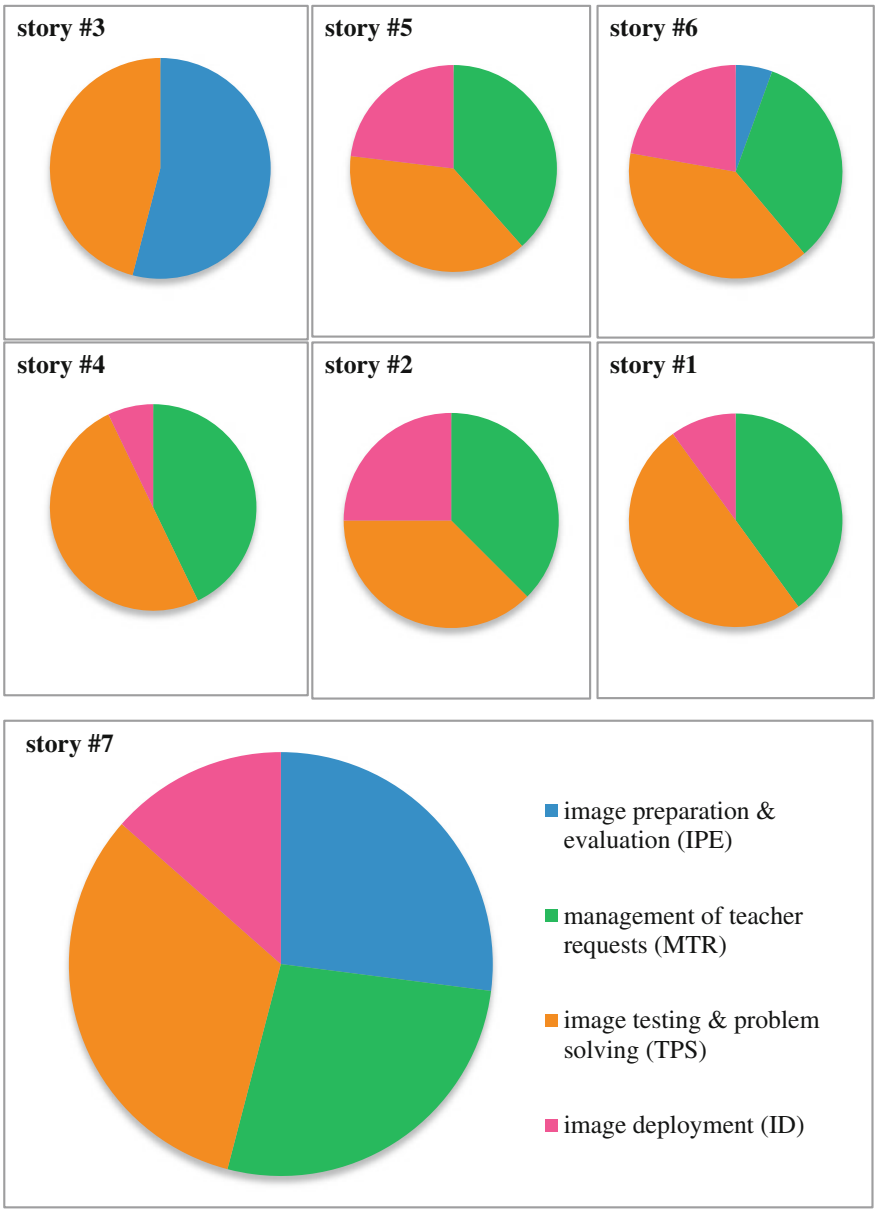

Fig. 10.8 Balance of story segments in individual stories versus the converged story

detail in the other team members' stories. Actually, four stories do not have any details at all about IPE. The other team members portrayed the MTR and ID segments, which were not addressed by the leader, in low to medium detail.

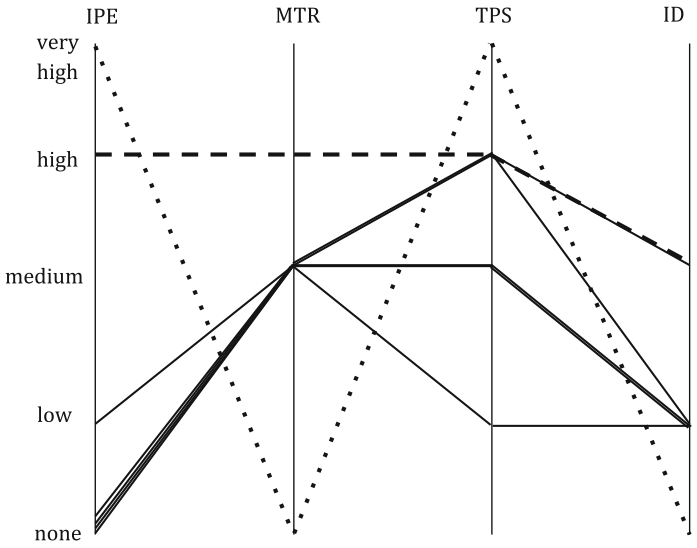

Fig. 10.9 Level of detail for each segment in individual stories. The *dotted line* corresponds to the leader's individual story, which is #3; *Solid lines* correspond to the other team members' individual stories; and the *dashed line* displays the converged story, which is #7

The level of detail of the converged story (#7, shown as a dashed line in Fig. 10.9) shows a considerable balance when compared with the individual stories. Remarkably, the MTR segment of the converged story is more detailed than any of the individual stories. This was partially explained by the team members in the interviews, where they noted the convergence meetings allowed to discuss several issues about the management of teachers' requests, which were then integrated in the final story. These results suggest that sharing different views during the convergence meetings sparked discussion and resulted in a very detailed story segment.

However, in the IPE and TP segments the opposite occurred. The simpler and more general accounts by the team members may have influenced the leader to streamline these story segments. Finally, the ID segment of the converged story closely follows one of the stories. A member recognised by the team as the most experienced with IT deployment practices developed this particular story. Therefore the ID segment reveals deference to expertise. Still, the team was able to add some information to the segment, which was related to documenting procedures.

To conclude this case description, we emphasise that the team's main goal was transitioning to a new IT configuration process. Both the individual and the converged stories were developed with this goal in mind, which explains why the stories had low implicitness and high levels of structural complexity. After finishing the converged story, the organisation used it to develop a more traditional business process model, using the BPMN notation, and started automating it using the Bonita Open Solution BPM platform [13].

10.5 Conclusions

The case study was set up to obtain answers to three research questions. It is now time to revisit them.

Can meaningful business processes be elicited through storytelling? The answer is a resounding "yes." After the short training period, the users were able to develop both individual and converged stories. Though the converged story required discussion in face-to-face meetings. Most developed stories combined pictures with medium-sized narrative descriptions. All stories had medium to high structural complexity. And most stories had low to medium use of dialogue.

Feedback obtained from the interviews indicates that the team was satisfied with the results. The organisation later on developed a more formal IT configuration process model based on the converged story, using the BPMN notation. This provides another positive indication that the storytelling approach can generate meaningful processes.

Can storytelling enable and incite users to externalize tacit knowledge and preserve contextualization? Based on the case study, the answer leans towards a "no." It was ironic that in the first phase of the study, users seized the opportunity to use the tool to create a fiction that they wanted to see, instead of telling the existing reality. If a process scenario has not been experienced, perhaps it is less readily outlined as a story in rich terms? This somewhat subversive use of the tool to outline prescriptive processes arose from information politics.

However, the fact that the majority of stories lacked the expected contextual richness seems to reinforce the "no" answer, even if we argue that some degree of externalization was achieved. We note that a future research question may involve asking *how* can the storytelling tool be used to elicit rich, ecological business processes from end users. It seems that a challenge with certain sets of users is to break the established frame of abstract process-based thinking so as to encourage a more narrative approach based on experience. In our case, the IT team and especially the team leader were highly entrenched in the workflow paradigm and the end results clearly show a predominance of that view. So, the tool itself may not be sufficient to establish a different practice. The combination of tool and training could potentially contribute to overcome this barrier. Another possibility would be providing exemplars of best practice to users.

A further challenge may be how to support users in converting narrative stories into visual stories. The participants in the study developed an emergent practice of emphasizing narrative over visual elements and so a possible recommendation for future tool development is to more fully support narrative integration into visual elements.

Can storytelling contribute to improve process modelling? The results from our study favour a "yes" answer. Our analysis of the story segments reveals that the converged story is not only broader in scope but also more balanced and detailed

than the individual stories, while retaining and integrating the views from all team members.

Revisiting our validity concerns, it can be argued that any comprehensive team discussion, whether or not based on business stories, would surely contribute to an agreed upon, better process model. We elaborate on two factors that may counter that argument. Because the team members were tasked to tell their story, they were forced not only to reflect on how they thought the process ought to be, but also to materialize that mental model in the form of a business story. While we could not identify a predominance of tacit elements in the recorded stories, we argue that some degree of knowledge externalization has indeed taken place. This was confirmed by the capacity some team members had to influence the converged story developed by the team leader. The second relevant factor is that by reading each other's stories, the team became more aware of different if interrelating views of the process under study. This was evidenced not only by the inclusive converged story, but also by the focussed rather than exploratory nature of the discussion in the face-to-face meetings, and the central role played by the stories in driving conversations, revealing the team's comfort in dealing with information portrayed in this form.

This research contributes to overcome several constraints imposed by the incumbent workflow paradigm on business process modelling. In our comparison of the differences between the storytelling approach and the workflow paradigm we show that storytelling relies less on formalism and more on interpretation and familiarity. It also gives more latitude to complement procedural with contextual information. The case study shows that the modellers were capable to discuss the business processes in which they were involved using a less formal language, and could translate them into a formal language when such necessity arrived. Although the case provides significant qualitative insights about process modelling using an informal approach, we recognise that quantitative research is necessary to measure the gains, e.g. in terms of modelling efficiency, meaningfulness, and perceived value. Though as usual in many qualitative studies, the obtained results provide a significant baseline for future quantitative research.

Our case illustrates how business process models may capture contextual richness, narrative freedom and implicit flows. We note however that additional steps seem necessary to stimulate knowledge externalisation and contextualisation of business processes beyond procedural knowledge, for instance through training, group facilitation and incentive mechanisms.

The move towards less formal process models, closer to the business reality, also raises the interesting possibility of bringing end-users (employees, managers, executives, customers, etc.) to the process of process modelling. The expertise required to master incumbent process modelling languages has naturally lead to a situation where modelling became the exclusive playground of experts; and yet expert modellers often find it difficult to apprehend the knowledge and practice of every organisation [17, 24]. Our case reveals a breakthrough not only allowing a team to develop individual process models, but most importantly allowing the team to integrate individual contributions into a balanced solution.

The opportunities brought by shifting process modelling from expert modellers towards end-users opens up interesting possibilities for both BPM clients and suppliers. On the client side, it could bring financial gains, increased agility, fewer privacy concerns, and increased participation and engagement in the BPM approach. On the supplier side, it raises opportunities to offer innovative modelling tools and services to clients. In particular, it may support remote modelling and massive modelling arrangements. It may also allow changing the traditional, fragmented, time-consuming approach to process discovery towards more innovative service provision schemes relying on crowdsourcing, coaching and group facilitation.

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