JOURNAL OF INFORMATION TECHNOLOGY THEORY AND APPLICATION

ISSN: 1532-3416

The Evolution of Design Principles Enabling Knowledge Reuse for Projects: An Action Design Research Project

Silvia Schacht
University of Mannheim
Schacht@es.uni-mannheim.de

Stefan Morana
University of Mannheim

Alexander Maedche
University of Mannheim

Abstract:

Knowledge is a fuzzy phenomenon and managing it a complex endeavor. In particular, knowledge reuse possesses the possibility to increase project performance since project teams can benefit from knowledge of former projects. Therefore, knowledge reuse is an essential knowledge management (KM) process phase that needs to receive special attention. Studying KM in general requires one to consider both social and technical aspects. On the one hand, KM highly depends on individuals, their interactions with each other, organizational rules, and cultural aspects forming KM's social perspective. On the other hand, contemporary information technologies promise to support organizations, teams, and individuals in managing what they know. Today, the KM research field is tremendous and full of social and technical insights. However, independent of which aspect of KM is studied, most researchers follow either a technology-driven approach for building innovative KM technologies or a behavioral-research approach to observe and understand complex KM phenomena. Few papers report the design of a KM system that integrates the social and technical perspective by expressing and evaluating design principles according the design science research approach. In this paper, we address this challenge and present a comprehensive action design research (ADR) project in the context of managing project knowledge reuse. Thereby, we present our KMS artifact called Just KNow and discuss the entire process from specifying its requirements to its implementation step by step. This paper helps KM researchers and practitioners make informed decisions. We support researchers in deciding whether the ADR approach is appropriate for their particular research project and provide a guideline for how to apply ADR. We support practitioners by helping them make design decisions when creating and implementing an effective KMS.

Keywords: Action Design Research, Information Systems Research, Project Knowledge Management, Knowledge Reuse.

Jan vom Brocke acted as the Senior Editor for this paper.

1 Introduction[1]

Companies are increasingly organized in a project-based structure (Ajmal & Koskinen, 2008). From a knowledge perspective, managing project teams is not easy for several reasons. First, project teams comprise employees with different knowledge backgrounds and skills. The primary goal of such heterogeneous teams is to pool knowledge required to complete a project. In large companies in particular, team members might not know each other nor each other's skills and experiences (Choi, Lee, & Yoo, 2010). Therefore, they need to share their experience in social interactions to structure and coordinate their activities. Second, project teams exist only for limited timespans (Julian, 2008). When a project phase is finished, often some employees leave a team while others then join it. Such fluctuation tends to result in knowledge loss (Petter & Randolph, 2009). Third, projects seek to create unique products or services. Therefore, the new project cannot directly use insights from previous projects. Nevertheless, information systems (IS) projects can particularly benefit from knowledge reuse since, in all IS projects, a large number of activities are similar (Reich, Gemino, & Sauer, 2008). Owing to the complexity of managing projects and the low knowledge exchange in and among project teams, projects tend to repeat known mistakes, reinvent the wheel by finding already-known solutions, or perform redundant work (Eskerod & Skriver, 2007).

To address these issues, some researchers have studied the factors that impact knowledge management (KM) from a behavioral perspective by focusing on social aspects such as trust (e.g., Staples & Webster, 2008; Zaheer, McEvily, & Perrone, 1998), social interactions (e.g., Bondarouk, 2006; Eskerod & Skriver, 2007), or organizational structures and cultures (Ajmal & Koskinen, 2008; Swan, Scarbrough, & Newell, 2010). Others have focused on KM artifact design by developing, for instance, KM maturity models (see Berztiss, 2002; Paulzen, Doumi, Perc, & Cereijo-Roibas, 2002) or by designing KM technologies (see Akscyn, McCracken, & Yoder, 1988; Wei, Hu, & Chen, 2002). However, few papers consider both social and technical aspects in combination when designing KM systems (KMS) and, thereby, apply the socio-technical perspective that Bostrom and Heinen (1977) discuss.

Contribution:

This paper contributes to two fields of IS research. First, reporting our findings on project knowledge reuse provides a substantial contribution for the KM research community. The KM literature primarily covers how to create, store, and transfer knowledge. Researchers, however, seem to omit knowledge reuse or assume that reuse automatically happens, when knowledge is captured, stored, and transferred. Thus, our research addresses a research gap in KM literature. In addition, our research contributes to the KM area since it designs a socio-technical KMS. In the KM literature, researchers either study the behavioral aspects related to people, their behavior, and organizational structures and culture, or they design a KM artifact by purely considering technical possibilities and functionalities. By formulating design principles for a socio-technical project KMS, we not only present the design of an effective KMS but also its evaluation. In particular, interventions regarding the social facet of KM are only seldom evaluated. Some researchers (e.g., Meyer, 2010; Surridge & Harris, 2007; Tan et al., 2007) have purely observed various roles related to KM implemented in organizations (e.g., chief knowledge officer, knowledge manager), but have not evaluated their effects on knowledge reuse. Consequently, by presenting the pre-evaluation and discussing its results, our research contributes to KM literature by demonstrating the effects of both the technical and social subsystem of the project KMS.

Second, by applying the action design research (ADR) approach that Sein, Henfridsson, Purao, Rossi, & Lindgren (2011) describe, our research also contributes to a methodological discourse in the IS community. Due to our applying the ADR approach, our research follows the call of various scholars (e.g., Baskerville, Pries-Heje, & Venable, 2007; Hevner, 2007) to balance rigor and relevance in design science research projects. By conducting the entire ADR project in a case company, the research results are practically relevant at least for the case company. In addition, the ADR project can be described as rigorous due the applied research methods that have been demonstrated in the IS community. In addition, our detailed description of the conducted ADR project also contributes to the design science community. Most design-related research focuses on describing the challenge and discussing the proposed solution. However, we perceive the step-by-step presentation of the entire research endeavor as a vital and fascinating contribution. Reporting all intermediate results of the research project generates a more complete picture and enables the reader to better understand the ADR approach. In particular, describing the evolvement of theory-grounded design principles when implementing them in an organizational setting is a valuable contribution for fellow ADR researchers. Our research also follows the call of Peffers, Rothenberger, Tuunanen, & Vaezi (2012) for more research in collaboration with practitioners to demonstrate that the design can be applied in real-world environments.

[1] This paper is based on a prior version published on the DESRIST 2013 (see Schacht & Maedche, 2013)

Some researchers (e.g., Pan & Scarbrough, 1999; Schütt, 2003) argue that the lack of research on the socio-technical perspective in KM research is the main reason why companies still struggle to manage what they know. Although some studies provide guidelines on how to design a KMS by formulating design principles, most researchers primarily focus on storing, retrieving, and transferring knowledge, which are only a subset of the entire KM process. However, researchers and KMS designers often omit knowledge reuse (Nesheim & Olsen, 2011). As Choi et al. (2010, p. 866) conclude, “no matter how much knowledge is shared among team members, it cannot enhance team performance unless it is effectively applied”. In our view, knowledge reuse is a critical KM process phase. Because few studies seek to guide practitioners and KM researchers by explaining how socio-technical KMS should be designed to increase project knowledge reuse, we address this gap by asking:

RQ: How can a socio-technical knowledge management system be designed to increase project-related knowledge reuse in and among project teams?

2 Related Work

IS scholars often define knowledge via a hierarchy of data, information, and knowledge (e.g., Ackoff, 1989; Tuomi, 1999). According to this hierarchy, knowledge is authenticated information, information comprises processed data, and data comprises raw numbers and facts (Alavi & Leidner, 2001). Although many researchers consider data and information as a precondition of knowledge, others such as Tuomi (1999) argue that raw data cannot exist without knowledge and that it needs to be articulated and structured to become information. To define knowledge, some researchers present and study various knowledge forms. Special attention is given to tacit knowledge (e.g., Nonaka & Konno, 1998; Polanyi, 1966) as the complement of explicit knowledge. Another distinction of knowledge can be formed by considering who obtains the knowledge. Either knowledge is created by and inherent in an individual (individual knowledge) or a group (collective knowledge). Alavi and Leidner (2001) overview various taxonomies and knowledge forms.

In addition to efforts to define knowledge, much research has sought to understand it and to solve certain issues related to knowledge. The entire KM field can be divided into various schools (Earl, 2001) that produce a vast amount of research results. In the behavioral schools, some studies examine environmental factors such as the organizational structure (e.g., Boh, 2007; Swan et al., 2010), management support (e.g., Carrillo et al. 2013; Tan et al. 2007), or cultural characteristics (e.g., Ajmal & Koskinen, 2008; Sutton, 2001). Another factor that impacts the success of knowledge exchange and its subsequent reuse is individuals’ motivation. To address the motivational factors, the literature addresses, for instance, questions about beliefs of knowledge ownerships (e.g., Carrillo, Ruikar, & Fuller, 2013; Leseure & Brookes, 2004), the benefits and costs of knowledge sharing (e.g., Bresnen, Edelman, Newell, Scarbrough, & Swan, 2003; Davidson & Lamb, 2000), or trust (e.g., Hsu, Ju, Yen, & Chang, 2007; Zaheer et al., 1998). In their detailed and systematic literature review, Wang and Noe (2010) overview research studying the various factors influencing knowledge exchange and, thus, on the behavioral schools). With the emergence of contemporary technologies, the technocratic school has also been studied intensively. Scholars regard repositories or databases as the first generation of KM technologies (Firestone & McElroy, 2003) and primarily focus on knowledge sharing. However, such central knowledge bins are sporadically used in practice (see Kankanhalli, Tan, & Wei, 2005; Newell & Edelman, 2008). Rather, people prefer to contact their colleagues directly (Petter & Randolph, 2009). Based on these findings, the second generation of KM technologies emerged, which seek to support collaboration and communication between individuals (Garcia, 2009). With the second generation, the focus shifted “from collecting knowledge to connecting people” (Huysman & Wulf, 2005, p. 85). Researchers have intensified their efforts by studying conversational technologies such as wikis (e.g., Hasan & Pfaff, 2006; Meloche, Hasan, Willis, Pfaff, & Qi, 2009), blogs (e.g., Wagner & Bolloju, 2005; Wattal, Racherla, & Mandviwalla, 2010), or collaboration technologies (e.g., Bélanger & Allport 2008; Riemer, Steinfield, & Vogel, 2009) as technical enablers of communication and knowledge exchange. To be successful, second generation KM technologies mainly rely on the crowd’s participation, which is generally very low (Palmisano 2009). Currently, researchers increasingly aim to address the social processing of knowledge in an organization supported by appropriate technologies by designing third generation KMS (Firestone & McElroy, 2003), which must connect different system types and balance IT and “the motivation of knowledge workers and the mitigation of other non-technological barriers to the participation in the knowledge-related activities” (Dingel & Spiekermann, 2007, p. 522).

Few studies address knowledge reuse as the final phase in the KM process (Nesheim & Olsen 2011). Petter and Vaishnavi (2008) design a KMS to support software project managers in exchanging knowledge. While their work is similar to our own, there are differences. A key difference is the resulting KMS artifact's audience. While Petter and Vaishnavi (2008) focus solely on software project managers, we focus on the entire project team. Project managers have much knowledge that is valuable to other project managers. However, at the operational level, project team members also collect much knowledge that is valuable for other projects. Thus, extending the focus to the entire project team is reasonable. In addition, our research differs from that of Petter and Vaishnavi (2008) since the resulting KMS does comprise only a technical artifact but also considers the social aspects of knowledge reuse, which results in a socio-technical project KMS. Finally, our research is based on design principles that are inspired by practice and rooted in theory. We also evaluate the resulting artifact in a real-world environment in the case company. In sum, our research contributes to the KM research community by addressing knowledge reuse, which researchers have often neglected (Nesheim & Olsen, 2011).

3 Methodology

3.1 Methodology Selection

Given the interdependency between the social and technical aspects related to KM, we decided to design a socio-technical project KMS. Therefore, we need to understand technical and social requirements of individuals and organizational structures and cultures to design a KMS for effective knowledge reuse. Consequently, given our overall research goals, we could have conducted this research in two ways. First, to design a KMS that solves issues of project knowledge reuse, we could have applied the design science research (DSR) approach (Hevner, March, Park, & Ram, 2004). Today, DSR is generally accepted in the IS field as a rigorous method, although some critics argue that DSR results in an imbalance between rigor and relevance (Sein et al., 2011). Second, considering the technical aspect to design the KMS for project teams in combination with the social aspects requires one to constantly interact with and observe the affected project team members. In consequence, action research (AR) is also appropriate for our research project. AR has a long tradition in psychology and organizational sciences, and, unlike DSR, AR is strongly oriented toward collaboration between researchers and practitioners (Susman & Evered, 1978). AR seeks to solve current practical problems and to expand scientific knowledge simultaneously (Baskerville & Myers, 2004). However, AR is often criticized for focusing too much on practical relevance at the cost of methodological rigor and is often maligned as consultation projects (Davison, Martinsons, & Kock, 2004) or "research with little action or action with little research" (Dickens & Watkins, 1999, p. 131).

Based on the possible research approaches and their advantages and disadvantages, we decided to apply a combination of DSR and AR called action design research (ADR) as Sein et al. (2011) present. Combining these two approaches alleviates the typical risks of both, and some researchers have intensively discussed it (e.g., Baskerville et al., 2007; Järvinen, 2007; Sein et al. 2011). A key advantage of the combination is improved problem understanding and evaluation. Researchers discussing the DSR process (e.g., Hevner et al., 2004; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007; Sein et al., 2011) generally suggest iterating a built-and-evaluate loop several times until the final design artifact is created. Because AR typically seeks to link theory and practice, one also implements it as an iterative process in which various hypotheses are refined in multiple cycles of thinking and intervening (Susman & Evered, 1978). Since ADR combines DSR and AR, scholars also suggest that one implements multiple cycles when conducting an ADR project. Another advantage of performing an ADR project is the opportunity to not only build a technical, software-based artifact but also a social, organizational artifact to design a project KMS.

3.2 The ADR Project in Detail

In line with the ADR process that Sein et al. (2011) presents, we implemented the ADR project in a four-stage model split into two cycles. In the first cycle, various case company employees developed and theoretically evaluated a conceptual design of a project KMS—the first system state. Based on the first ADR cycle's results, we refined the artifact's design, which resulted in the second system state that will be implemented and evaluated in future work. We display the activities we performed in the ADR project in Figure 1 and discuss them in the following subsections.

3.2.1 Selection of the Case Company

An ADR research project is strongly oriented toward collaboration between researchers and practitioners. Therefore, we needed to identify a company for the common research activities. Given IS projects' focus on project knowledge reuse and their special characteristics, we purposefully selected a financial service provider as our research subject. Owing to the high demand of IS projects in financial service companies, we expected an increased need for knowledge reuse to achieve high organizational performance. We conducted our study in the IS service department of a large German financial service provider. To ensure research subject anonymity, we name the financial service provider "GeFiS" and its IS service department "IS@GeFiS". At the time of writing, GeFiS operated in over 70 countries and employed more than 100 000 employees. IS@GeFiS was organized in a project-based structure and engaged about 180 employees, which external consultants regularly supported.

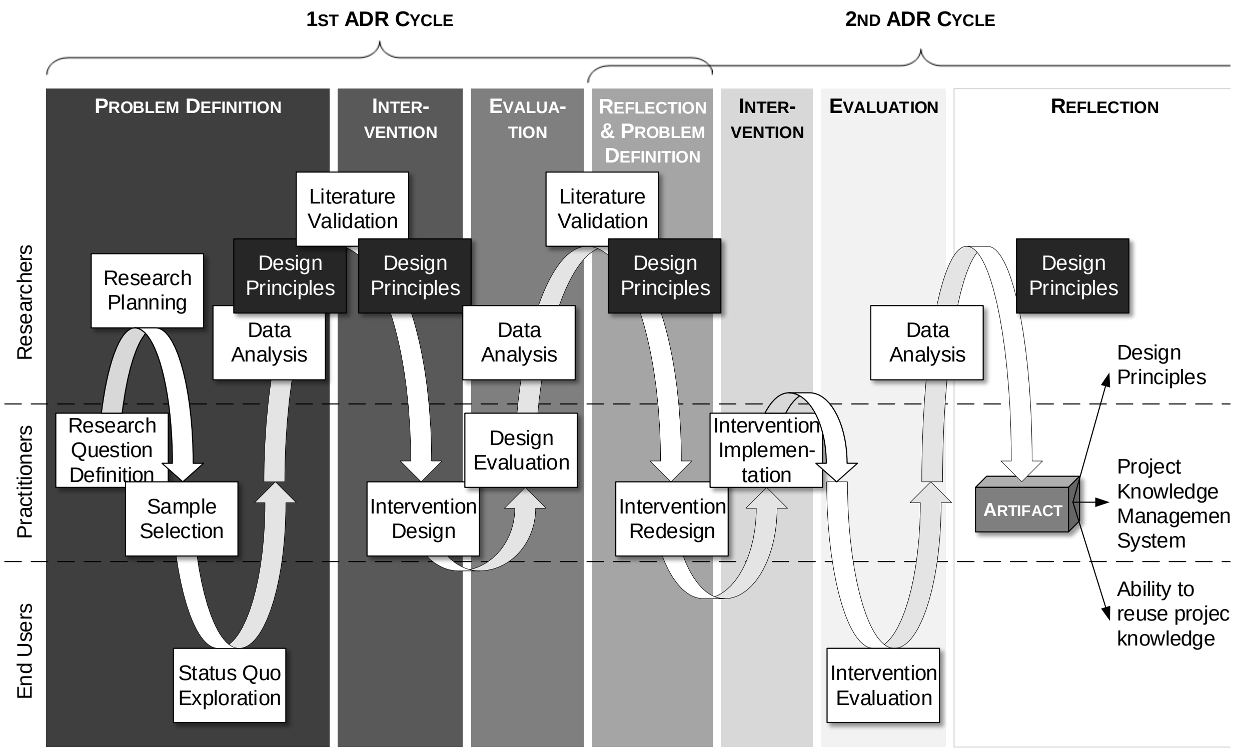

Figure 1. Action Design Research Methodology (Based on Sein et al. 2011)

At the start of the project, the ADR team (comprising five employees from the IS@GeFiS and the first author as researcher) conducted several meetings to negotiate the project's conditions, goals, and activities. In the discussions, the case company representatives emphasized their need for a KM technology that would solve their project knowledge reuse issues.

3.2.2 Problem Definition

Having selected an appropriate case company and negotiated the joint collaboration, we conducted the ADR project. In the first stage, we identified an issue being relevant for both practitioners and researchers.

To obtain a deeper understanding on the knowledge reuse issues in the case company, we conducted an exploratory interview study. By examining practitioners' perspectives on knowledge reuse, the ADR project followed Sein et al.'s (2011) first principle (i.e., the principle of research inspired by practice). As a preparation and to triangulate gathered data, we started our investigations by studying some documents regarding project knowledge of IS@GeFiS. In total, we scanned 31 documents, including guidelines for collecting and documenting of project knowledge, some exemplarily lessons learned, and role descriptions of various professionals. Based on the results of our document analysis, we defined some working assumptions, which formed the basis of our interview study. While the ADR project team's researcher prepared the semi-structured interviews, the practitioners coordinated the sampling of the interviewees.

To prevent selection bias, we briefed the practitioners on how to deploy a good sample. In total, we selected 27 interviewees (14 project managers, eight technical specialists, two functional analysts, two professional development managers, and one department head), which reflected the distribution of roles in the department. We can describe the interviewee selection as a purposeful sampling according to Coyne's (1997) guidelines. At the beginning of an interview, we provided some information to the interviewees regarding anonymity, the study's purpose, and the use of gathered data (Myers & Newman, 2007). The interviews lasted between 20 and 50 minutes and were conducted by two researchers: one doing the interview and one taking notes. The interview questions addressed a wide range of KM topics to cover all aspects regarding both the social and technical subsystem of a project KMS. When needed, we extended the interview guidelines with additional questions in a particular interview. We recorded all interviews and transcribed them as text files. We stored all data sources anonymously and they could not be traced back to the participants.

To analyze the gathered data, we followed the inductive coding approach that Thomas (2006) describes, which helped us to extract themes that the interviewees mentioned frequently, dominantly, or significantly. As a result, we did not have any codes or categories at the outset. To increase internal validity (Morse, Barrett, Mayan, Olson, & Spiers, 2002), two researchers coded all transcripts (though one was not involved in any other aspects of the project). In a first step, both researchers carefully read the text files. Using MaxQDA, a software application for qualitative data analysis, we identified, marked, and labeled with codes themes related to project knowledge reuse that the interviewees mentioned frequently. Thus, codes and categories emerged and evolved during the data analysis. In total, we marked and labelled 971 text segments according to one of 51 categories. In a discussion, we reduced the amount of categories to 20. Finally, we identified subtopics and connections between the subtopics and categories. Based on the results, we translated the identified issues into a set of meta-requirements for the project KMS (Walls, Widmeyer, & El Sawy, 1992) and into a first set of preliminary design principles. We formulated the design principles so as to enable practitioners and researchers to create further artifacts that belong to the same kind of system in different organizational setting and environments (Markus, Majchrzak, & Gasser, 2002; Walls et al., 1992).

Although all design principles seemed to be valid, we checked their validity by studying the existing literature. Thus, our design principles are based on not only the principle of practically inspired research but also theoretically ingrained research, which Sein et al. (2011) suggest. To prove the identified design principles' validity, we explicitly searched for publications that mention principles for designing a KMS in general or for designing one for knowledge reuse in particular. Grounded on the literature we found, we reformulated or refined our design principles, which resulted in their second versions.

3.2.3 Planning the Interventions

In the second stage, we planned and conducted the interventions. The interventions were concrete decisions on the KMS design (hereafter referred to as design decisions) inferred from the design principles and existing literature in IS research (Sein et al., 2011). Based on insights of various researchers from the research areas organizational learning, IS, and computer science, we selected functionalities and mechanisms that have been evaluated for their effects in literature and that hold promise for addressing the meta-requirements of a project KMS in an appropriate way. We transformed the resulting design decisions into a conceptual design that described (1) the functionalities of the technical subsystem of the project KMS and visualizing it in form of mockups, and (2) the responsibilities of a new organizational role and the procedure of a process as social subsystem of the project KMS.

3.2.4 Evaluation of the Artifact

In the third stage, we evaluated the effects of the interventions. Rigorously evaluating the artifact is the essential part of each DSR project (Peffers et al., 2012). The same is true for ADR projects. Evaluations in an ADR project pursue three primary goals: (1) to test whether the design principles' intended effects are realized, (2) to assess whether there is a need for additional cycles, and (3) to evaluate the artifact in a real setting by considering the environment of an organization rather than synthetic situations (Sein et al., 2011). Therefore, in the first ADR cycle, we evaluated the artifact's conceptual design to obtain first insights regarding anticipated consequences to prevent resource consuming expenditures. Hereafter, we refer to our evaluating the first ADR cycle as pre-evaluation. We divided the pre-evaluation into two parts: in a first part, we conducted three workshops. The workshop series is designed as a set of focus groups that facilitate open discussion and, thereby, enable one to gather qualitative data on participants' attitudes, opinions, and beliefs (Myers, 2009). In the focus groups, which lasted between 60 and 90 minutes, we presented the conceptual design to three to eight IS@GeFiS employees and asked them to provide their feedback. Based on the workshop series results, we conducted a pilot project, which formed the second part of the pre-evaluation. With the pilot, we simulated and tested designed artifact to obtain first insights on the interventions' effects.

3.2.5 Reflection and the Second ADR Cycle

Finally, in the fourth stage, we identified and formulated the design artifact's strengths and weaknesses. This phase reflects on the research in terms of practical and theoretical contributions (Sein et al., 2011).As such, our results served as input for the second ADR cycle, which focuses on refining the project KMS to increase project knowledge reuse in and among project teams. Based on the first cycle's results, we again adapted the design principles to the needs of individuals and the organization, and, thus, refined for the overall design theory. The new design principles served as input for planning new and redesigning existing interventions in the second stage. After implementing the interventions, we evaluated the project KMS instantiation results (hereafter referred to as ex post evaluation). Based on the ex post evaluation results and by considering all activities and their outcomes within both cycles, one can formulate a first design theory and, if necessary, plan further cycles.

4 Just KNow—A Project KMS Artifact

4.1 Problem Definition and First Set of Design Principles

To obtain first insights of the case company's knowledge reuse issues, we analyzed the documents we gathered. As we say above, to prepare the exploratory interview study and to triangulate gathered data (Benbasat, Goldstein, & Mead, 1987), we scanned a total of 31 IS@GeFiS documents. These documents showed considerable differences in their appearance and content—owing, perhaps, to a lack of consistency in and according instructions of the project KM process. During the negotiations between the ADR project parties, the practitioners emphasized that they perceive designing and developing KM technology as appropriate to enable knowledge reuse in projects. However, the first author strongly recommended gathering employees' requirements on KM in general (including social and technical aspects) rather than purely focusing on a technical solution. As a result, the ADR project team agreed to conduct an exploratory interview study to determine employees' experiences in managing project-related knowledge. By analyzing the 27 interview transcripts, we could extract 12 meta-requirements covering the social and technical subsystem of the project KMS. These meta-requirements refer to four main subtopics: (1) access to project insights, (2) support for project KM, (3) structure of captured knowledge, and (4) feedback provision on project insights. Table 1 overviews the meta-requirements for each subtopic and some example quotes. Based on the meta-requirements, we formulated a first version of design principles (also included in Table 1).

As Sein et al. (2011) suggest, an ADR project should be not only inspired by practice but also rooted in theory. Thus, we checked the identified design principles' validity by studying the existing literature. The following sections summarize the key insights from existing research and serve as the baseline for our refining and rewording our design principles in a second version.

4.1.1 Access to Knowledge

Our first design principle postulates that KMS must provide access to documented knowledge and internalized experience. Since knowledge becomes explicit when it is documented, one can store it by implementing an appropriate technology. The spectrum of possible technologies in our case company ranged from traditional storage media such as repositories or databases to contemporary technologies such as wikis or blogs. However, all technologies have advantages and disadvantages. Traditional storage media, for instance, rely on hierarchical structures to find stored documents, and such hierarchical structures need categorization mechanisms. The categorization complexity increases over time to an extent that users have difficulties distinguishing where to search for specific documents or where to store them (Dourish et al., 2000). In contrast, contemporary technologies such as wikis ease the documentation process in terms of authoring, sharing, and finding knowledge. Such technologies aim to solve the issues related to hierarchical structures and categorizations by including functionalities such as content-to-page mapping, indexing, hyperlinking, duplication removal, searching, and functional realizations of using the

Table 1. Meta-requirements and First Version of Design Principles of Project KMS

Meta-requirements		Example quotes
Access	MR1: Full accessibility to project insight database for all organization members	*"I was out of the project. At some stage, my account was cleared. That means I have no access to the [project] drive anymore."*
	MR2: Central storage, including consistent filing and search functionalities	*"It must be somewhere central, so everybody can access it."*
	MR3: Enable informal knowledge exchange between knowledge seekers and knowledge providers	*"This actually happens quite informally. Either you know someone working on a project, then you talk with him or her over coffee, lunch, and so on, or sometimes if you want to know something about a specific topic, then you ask: What were your experiences?"*
DP1: Ensure access to documented knowledge and internalized experience		
Support	MR4: Extend project teams with KM experts	*"[…] you have to plan and schedule a meeting, and search for a moderator – someone who approaches the topic as neutrally as possible, in the broadest sense. This might be someone from the project office who accompanied the project but is not involved in decisions or critical situations, in order to enable neutrality."*
	MR5: Ensure maintenance of project insights	*"It is a time exposure to maintain and manage it. I mean, information that is important in one project can later be invalid or outdated."*
	MR6: Provide a standardized KM process	*"There is no standardized approach or process that is documented."*
DP2: Support project teams to manage project knowledge		
Structure	MR7: Possibility to structure documents by indexing, categorizing, and clustering	*"Of course, it has to be structured and tagged so that you can pick key information to a certain topic."*
	MR8: Provide pre-structured documents for easy completion	*"You have to structure it in some way so that you can use it afterwards. And also efficiently for similar future projects."*
	MR9: Include sufficient free space for additional explanations	*"… but I think every project is different. It should also contain plenty of space for free text. Yes, of course, there are some aspects where I can tally: good, moderate, bad. But a lot of a project's specifics…cannot be pre-structured."*
	MR10: Including contextual information in addition to project insights	*"I think the main important thing is that a third party is able to put themselves into the project's shoes."*
	MR11: Use short, concise, clear, and comprehensible wording	*"It must be concise and assignable. Concise in the sense: Half a page is probably not sufficient, since it will be too specific. Few words are not really helpful…. It must be concise, so that I can reuse it; and to be able to reuse it, it must be assignable. This means I must get a feeling from which situation this insight emerged."*
DP3: Provide contextual, packaged knowledge in structured documents, using a terminology appropriate to both novices and experts		
Feedback	MR12: Provide feedback on documented project insights	*"… if anyone says to you: 'I read your lessons learned. Thank you for your presentation, which made the issue transparent for us…'. I think this kind of recognition is incentive enough, or should be incentive enough."*
DP4: Provide incentives for both contributing and reusing project knowledge		

"power of the crowd" (Wagner, 2004). Unfortunately, contemporary technologies are used rarely in organizational settings (Arazy, Gellatly, Jang, & Patterson, 2009). In fact, only 10 percent of technology users actively create content, while 90 percent are purely consumers (Palmisano, 2009). In addition, to share knowledge, people prefer to exchange their experiences in bilateral communications rather than documenting their knowledge (Petter & Randolph, 2009). Project-related insights often include knowledge bound to people involved in the problem-solving process of projects (Schindler & Eppler, 2003). Thus, project knowledge is, to a large extent, tacit, which makes documenting and storing it in IT difficult (Sutton, 2001). Access to projects for all employees is critical to ensure knowledge reuse in and among projects. In our literature analysis, we also considered Petter and Vaishnavi's (2008) DSR project; one of their principles calls for access to knowledge and knowledge providers. Since their design principle is very similar to our first principle, we rephrased our design principle using their words:

DP1: Ensure access to both experts and expertise.

4.1.2 Support Project Teams

Our second design principle calls for supporting project teams to manage their knowledge. While technology can ease knowledge storage and retrieval, issues related to other KM activities are still unresolved. To document and store knowledge, much human effort is needed to prepare knowledge for its reuse. In many projects, knowledge and experiences are collected in formal project reports by the project manager (Schindler & Eppler, 2003). However, project managers seldom invest much effort into creating these reports since they feel that "these reports never reached the places in the organization where they could be utilized and transformed into (new) organizational practices" (Kautz & Hansen, 2008, p. 98). To support project managers, Markus (2001, p. 61) recommends employing a knowledge intermediary "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". In our study, many activities of a knowledge intermediary were also described by some interviewees as key tasks of a neutral moderator in projects. In addition to preparing knowledge for its reuse, knowledge intermediaries can ensure high knowledge quality by filtering and updating documents or developing knowledge maps; and, as part of the project team, they can act as coaches (Markus, 2001). By interpreting a company's demands, they can also provide knowledge seekers with fitting knowledge (Earl & Scott, 1999). Thus, intermediaries offer the possibility to centralize knowledge, which results in an improved learning curve, increased experience sharing among project teams, decreased repetitive work, and efficient problem solving (Chen & Hsiang, 2007). However, employing knowledge intermediaries in organizations has seen little research attention (e.g., Earl & Scott, 1999; Herschel, 2000), yet these intermediaries can play various roles in organizations. One role is the chief knowledge officer (CKO). According to McKeen and Staples (2004), the CKO role has existed in firms since the early 1990s. The CKO is responsible for developing a strategy on handling intellectual assets and to foster a corporate culture of learning (Herschel, 2000). Thus, CKOs, as the literature describes, operate at a strategic level. Another role discussed in the literature is the knowledge broker, which scholars have mainly studied in relation to knowledge transfer. Lind and Persborn (2000) identify five key activities of the knowledge broker in facilitating knowledge transfer: (1) to support knowledge consumers to formulate their knowledge need(s), (2) to find an appropriate knowledge source for the consumer's need, (3) to connect the knowledge consumer with the knowledge source, (4) to enable knowledge producers to identify valuable knowledge, and (5) to provide an infrastructure that supports intermediation between knowledge consumers and knowledge producers (Lind & Persborn, 2000). Thus, the knowledge broker primarily connects knowledge seekers and knowledge providers. Meyer (2010, p. 119) extends the role to facilitate knowledge creation, sharing, and use by establishing and maintaining "links between researchers and their audience via the appropriate translation of research findings". Typical knowledge broker tasks include organizing seminars or developing a knowledge database. In our study, the interviewed employees called for more support at the operational level. While knowledge brokers mainly pool knowledge to support strategic decision making, the interviewees called for a role supporting project teams to document, store, retrieve, and reuse project knowledge on an operational level.

In sum, the literature rarely discusses roles such as knowledge intermediaries that actively support the project team. Based on the limited number of papers that do discuss the effects of such a role, we perceive the benefits of employing knowledge intermediaries in a project team as beneficial, which results in the new version of our second design principle:

DP2: Extend project teams with knowledge intermediaries to support project knowledge management.

4.1.3 Content and Structure of Project Knowledge

Searching for procedures explaining how to structure, document, and store project knowledge has resulted in much literature. Many companies consider documenting project insights at the end of projects to be a standard procedure (Newell, 2004). In project reviews, key project events are documented so as to improve future work practices. These documents can have various formats and can take one of three perspectives: reflective, formal, or narrative (Desouza & Evaristo, 2004). Reflective project reviews are mainly subjective, while formal project reviews are objective as possible. Project reviews in the narrative perspective tell a project's story to appeal to emotions (Nielsen & Madsen, 2006). Such narrative project reviews have a format that makes them easy to remember, but they require much effort to create (Desouza & Evaristo, 2004). As a result, pre-structured documents, which enable one to include free-text fields for storytelling, best support project teams to document their knowledge.

Documenting project knowledge that is reusable for other projects seldom takes place (Schindler & Eppler, 2003) for several reasons such as lack of time and perceived low benefits. Even if project teams are willing to document their experiences, they often struggle (Petter & Vaishnavi, 2008) because projects are very complex. Owing to high complexity, much contextual information is needed to understand the resulting documents. Thus, documented project knowledge often lacks in structure, degree of granularity, or contextual information (Davenport, De Long, & Beers, 1998). However, to enable inter-project and intra-project and organizational learning, documenting project knowledge is an unavoidable necessity (Alavi & Leidner, 2001). Thus, documented insights should be structured by expressing, codifying, and preparing knowledge for its sharing and storage in ways that make it easy to find (Wu, 2009). Related to documentation of project insights, Petter and Vaishnavi (2008) obtain similar results and formulate their findings in various design principles. Our literature study revealed the importance of our third principle, which we inherit to its second version:

DP3: Provide contextual, packaged information in structured documents by using a terminology appropriate to both novices and experts.

4.1.4 Incentivizing Knowledge Reuse

In the KM literature, many studies (e.g., Davidson & Lamb, 2000; Lin, 2007) discuss the importance of motivation. Incentivizing employee contributions is one way to influence individuals' willingness to exchange their knowledge. Incentives help enable communication in and between teams. When individuals are motivated by incentives to collaborate with each other, they increasingly communicate their knowledge and insights (Van Alstyne & Brynjolfsson, 1996). An appropriate rewarding process increases knowledge documentation, discovery, and sharing (Davidson & Lamb, 2000). Nevertheless, organizations using such rewarding structures should use this instrument with care (Petter & Vaishnavi, 2008). Focusing only on extrinsic rewards increases the quantity of contributions but does not ensure a high quality. Even if employees are willing to provide their knowledge, the incentive may not be strong enough to overcome the costs (e.g., time) of documenting it (Markus, 2001). When organizations implement reward structures, the perceived value of knowledge increases, but employees may refuse to share their knowledge with others (Chen & Hsiang, 2007). Another powerful motivator for KM is providing feedback since "knowledge self-efficacy is an important antecedent to employee knowledge sharing attitudes and intentions" (Earl, 2001 p. 145). By documenting project insights, managers will be enabled to provide structured feedback and, hence, increase the performance of project teams (Desouza, Dingsoyr, & Awazu, 2005). Providing feedback is an essential mechanism to develop and maintain trust in project teams, which motivates the team members to higher performance (Geister, 2006; Jarvenpaa & Leidner, 1999). Furthermore, feedback mechanisms help organizations to maintain knowledge since they enable their employees to identify project knowledge, which is often used and rated as very important (Dellarocas, 2010). Knowledge "has a limited shelf life and can quickly become obsolete" (Allee, 1997, p. 10). Outdated knowledge will frustrate users and will undermine their searching for valuable knowledge. By feedback and rating mechanisms, project insights rated as less important or outdated can be easily identified and removed from the knowledge base. Thus, providing feedback fulfills two purposes: (1) it enables one to maintain documented project knowledge concerning its actuality and usefulness, and (2) it motivates project team members to contribute and reuse project knowledge. Based on the seventh principle of Petter and

Vaishnavi (2008, p. 1789) and the literature on the effects of feedback on individual motivation, we reformulate our fourth design principle as follows:

DP4: Enable project insight maintenance based on feedback concerning its usefulness and actuality.

4.2 Design of Interventions

Based on the design principles, we designed Just KNow—a project KMS comprising two parts: (1) the definition of a new, organizational role covering the social subsystem, and (2) the design of a software artifact based on an existing platform in the case company as a technical subsystem of the project KMS. We translated our design principles into concrete design decisions by considering research results reported in related literature.

4.2.1 The Technical Subsystem of Just KNow

Organizations rely on externalizing individuals' experience to facilitate project-based learning (Crossan, Lane, & White, 1999). Thus, the technology should at best promote direct communication with experts (e.g., social networking sites, forums, chats, etc.) on the one hand and the externalization and storage of project knowledge on the other hand. Consequently, Just KNow comprises a technical subsystem considering the requirements examined in the exploratory interview study and the design principles validated based on existing literature. To design the technical part of Just KNow, we translated the design principles into concrete design decisions by intensively studying existing literature. Thereby, the second design principle was out of scope since it purely refers to the social subsystem. Since most design decisions result from our meta-requirements and literature discussed in our related work, we summarize the functionalities of the project KMS in Table 2.

To increase project knowledge reuse, all KM process phases (documentation, storage, transfer, reuse, and maintenance) should be considered. In the case of the technical subsystem of Just KNow, we addressed the knowledge documentation phase by providing templates and a project characteristics questionnaire that support project teams in documenting their project knowledge and contextual information. To adapt the interventions to organizational settings, Just KNow builds on the integrated platform existing in IS@GeFiS. The platform design is generally appropriate since platforms are an "extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate" (Tiwana & Bush, 2005, p. 676). Ease of extensibility is the key advantage of platforms that results in the possibility of continuously improving the system by adding or removing modules. Thus, we decided to design the project KMS based on the platform because of two reasons: (1) a platform bundles multiple functionalities in one system, and (2) the case company has already implemented a platform that primarily served as a document management system and, thus, ensured central storage (knowledge storage phase). Functionalities such as tagging, hyperlinking, searching, and overviewing various projects and their characteristics focus on the knowledge-transfer phase and enable employees to retrieve project knowledge. Knowledge maintenance is fostered via feedback and rating mechanisms.

Based on the design decisions, we designed the technical part of Just KNow in the form of mockups to visualize its functionalities and design (see Figure 2).

4.2.2 The Social Subsystem of Just KNow

Instead of reusing existing knowledge, project teams in organizations, including our case company, often tap into the same mistakes that previous projects experienced (Swan et al., 2010). However, knowledge reuse can enable project-based learning and result in higher project performance. Thus, project knowledge reuse is directly associated with project-based learning (Kotnour, 2000). According the situated learning theory, social interactions are the central element of knowledge reuse, and, thus, organizations need to provide an infrastructure that enables effective and efficient interactions between individuals (Adenfelt & Lagerström, 2006).

To structure the social interactions in and between project teams, the exploratory interview study revealed a need for a central role supporting project teams in managing their experiences. By considering this need and the situated learning theory, we designed a new organizational role called project knowledge intermediary (PKI) to form the social subsystem of Just KNow (see Table 3).

Table 1. Design Decisions for the Technical Subsystem Derived from Design Principles

Design decision	Source
DP1: Ensure access to both experts and expertise	
• **Social networks and communities:** knowledge communities are an instantiation of communities of practice. By implementing communities, companies promote informal knowledge exchange, which facilitates knowledge reuse. Examples of technological implementations can be social networks, forums, or chatrooms.	Ardichvili, Page, & Wentling (2003), Julian (2008)
• **Search functionality:** today, many platforms have semantic search functionality. This allows users to find unstructured information captured in various documents or other knowledge documentation formats.	Markus (2001), Popov, Kiryakov, Ognyanoff, Manov, & Kirilov (2004)
• **Hyperlinking and tagging:** hyperlinking and tagging are mechanisms that ease knowledge documentation, search, and retrieval. Each time a document is stored on the platform, individuals provide some keywords or links relating to documents. This enables the development of an information network that eases the exploration of project insights.	Petter & Vaishnavi (2008), Wagner (2004), Yang, Hu, & Davison (2010)
• **Access control:** by implementing user authentication and authorization mechanisms, users with various roles may get different access rights to documents. Thus, project team members can share their knowledge in documents that are either open for all project KMS users, or for private for use by a project's team members.	Tolone, Ahn, Pai, & Hong (2005)
DP3: Provide contextual, packaged knowledge in structured documents, using a terminology appropriate to both novices and experts	
• **Project characteristic questionnaire:** a questionnaire on project characteristics is a structured way to enable the provision of project's contextual information. The questionnaire supports the standardization of processes, is easy to complete, and provides some metrics that ease the comparability of various projects.	Interview study
• **Project overview:** using the project characterization conducted in the starting phase and stored in a central database, a project KMS can be enriched by a project overview, which visually relates projects to other projects based on its characteristics.	Interview study
• **Project insights overview:** in addition to an appropriate search engine, the provision of an overview on the project insights that relate to another project eases knowledge search and retrieval. Here, a rating mechanism can be used to display insights perceived as most useful for other users.	Kautz & Hansen (2008), Markus (2001)
• **Variety of formats:** various projects possess varying complexities. Thus, full standardization of project insight documentation is unfeasible. The more complex a project, the more individuals should be able to include additional information, for instance by providing additional documentation formats (e.g., photos, videos, etc.).	Nielsen & Madsen (2006), Petter & Vaishnavi (2008)
DP4: Enable project insight maintenance based on feedback concerning its usefulness and actuality	
• **Rating:** the rating of products or services is intensively used in electronic markets. Rating mechanisms summarize the opinions of users and provide a brief overview of a product or service for potential users. By implementing a rating functionality in the project KMS, knowledge seekers get a quick overview of the usefulness and applicability of documented insights.	Dellarocas (2010)
• **Feedback provision:** if individuals receive constructive feedback on their work, they are more willing to share their knowledge. By implementing mechanisms that enable project teams to assess the received expertise or the knowledge providers, continuous learning owing to regular updates of existing, organizational knowledge can be facilitated.	Bartsch, Ebers, & Maurer (2012), Desouza & Evaristo (2004)
• **Automatically updating:** using the assessment functionality, project insights can be ranked according to their usefulness and applicability. The resulting ranking enables the identification of project insights that are no longer used because they are no longer useful.	Dellarocas (2010), King, Marks, & McCoy (2002)

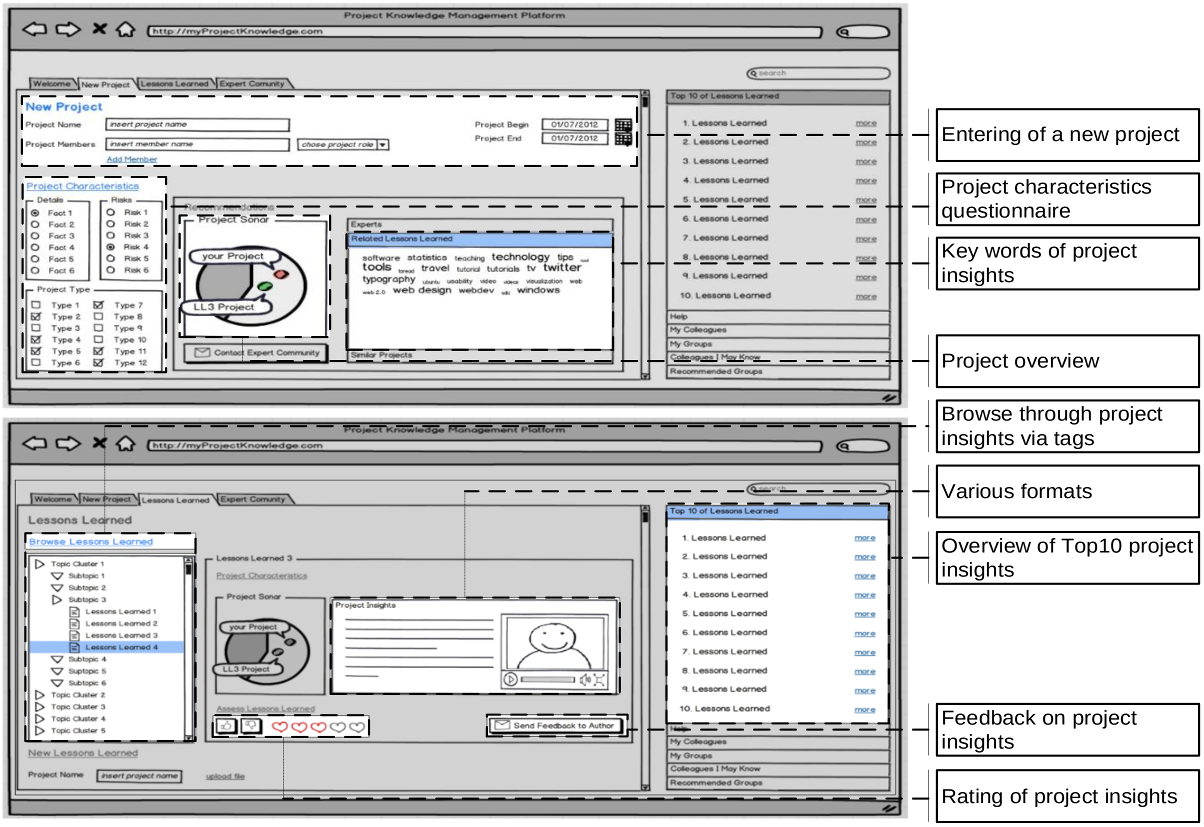

Figure 2. Mockup Design of the Technical Subsystem of the Project KMS

One can classify the PKI as a knowledge intermediary that combines the tasks and responsibilities of different roles discussed in the literature. According to Markus (2001), the knowledge intermediary should connect knowledge seekers with knowledge providers and should prepare relevant knowledge for its reuse (Markus, 2001). Another role discussed in the literature is the knowledge broker (e.g., Meyer, 2010; Surridge & Harris, 2007) whose key task is to translate knowledge so that knowledge seekers are able to understand and reuse it (Meyer, 2010). However, the descriptions in the literature of roles such as the knowledge intermediary or knowledge broker lack detailed descriptions that could enable practitioners to implement these roles in their organizations. Wong and Aspinwall (2006), who introduce the knowledge manager and list 16 points describing their responsibilities in a firm, provide a more detailed description of roles to support projects in managing valuable knowledge. Similarly, Blessing et al. (2001) and Tan et al. (2007) describe a project knowledge manager's tasks. Although the studies not evaluate the effects of all the roles in an organizational setting, the tasks are reasonable, and, thus, we adapted the PKI in the project KMS design.

4.3 Pre-evaluation

To test our design principles, we evaluated the conceptual design of Just KNow in two steps: first, we conducted a series of workshops where key case company decision makers assessed the design in discussions. Second, we implemented the PKI and evaluated its effects in a pilot study. The pre-evaluation results served as input for the second ADR cycle, with which we could refine the design principles and Just KNow as our project KMS artifact.

Table 3. Tasks of the Project Knowledge Intermediary Derived from Design Principles

Design decision	Source
DP1: Ensure access to both experts and expertise	
• **Connect knowledge seekers and providers:** PKIs should form a central point of contact in order to help knowledge seekers to find expertise and experts.	Meyer (2010), Wong & Aspinwall (2006)
• **Support in knowledge needs formulation:** to find valuable knowledge, accurate questions should be formulated. Knowledge seekers find it difficult to formulate questions since they do not have the necessary vocabulary.	Lind & Persborn (2000), Wong & Aspinwall (2006)
• **Search for and finding of knowledge sources:** as a central knowledge base, PKIs should provide an overview of various knowledge storage locations to help knowledge seekers to find appropriate knowledge sources.	Lind & Persborn (2000), Wong & Aspinwall (2006)
• **Provide infrastructure to support knowledge exchange:** PKIs enable knowledge exchange, either by implementing an appropriate technology or by establishing communication structures.	Lind & Persborn (2000), Wong & Aspinwall (2006)
DP2: Extend project teams with knowledge intermediaries to support project knowledge management	
• **Prepare and organize knowledge collection:** to reuse project knowledge, such knowledge first needs to be collected. Knowledge collection often takes place in lessons learned sessions at the end of a project. The PKI should prepare the sessions since they have the knowledge about appropriate methodologies.	Blessing, Goerk, & Bach (2001), Meyer (2010)
• **Moderate knowledge collection:** PKIs should ensure the gathering of reusable knowledge and should support problem-solving by asking questions related to the project insights. They should also act as neutral actors to guide and, if needed, to calm heated discussions and render them productive.	Blessing et al. (2001(, Tan et al. (2007)
• **Draw attention to useful knowledge:** since the PKI attends many sessions where knowledge is gathered and discussed within teams, he or she can draw attention to valuable knowledge and can provide guidance.	Blessing et al. (2001), Wong & Aspinwall (2006)
DP3: Provide contextual and packaged knowledge in structured documents, using a terminology appropriate to both novices and experts	
• **Prepare knowledge for its reuse:** PKIs should prepare the knowledge by eliciting, indexing, summarizing, sanitizing, and packaging it.	Markus (2001), Tan et al. (2007)
• **Translate knowledge: k**nowledge documented by experts is often difficult to understand for non-professionals. PKIs have to translate the gathered knowledge using a terminology appropriate for every employee.	Blessing et al. (2001), Surridge & Harris (2007)
• **Collect and document contextual information:** to decide whether knowledge can solve a problem, one needs background information. PKIs should link the contextual information to project insights, easing decision-making on whether and how to apply knowledge.	Tan et al. (2007)
DP4: Enable project insight maintenance based on feedback concerning its usefulness and actuality	
• **Maintain knowledge base:** the knowledge gathered in projects should be stored in a central knowledge base. The PKI should assess the stored knowledge, keep it up-to-date, and maintain the knowledge base.	Blessing et al. (2001), Tan et al. (2007), Wong & Aspinwall (2006)
• **Identify questions for knowledge reuse:** based on existing and requested knowledge, PKIs should be able to identify knowledge that may become important and valuable for future projects.	Lind & Persborn (2000), Wong & Aspinwall (2006)
• **Maintain links to knowledge sources:** PKIs should know the relationships between knowledge and knowledge sources. When knowledge seekers request a specific knowledge, PKIs should be able to connect them to the according source.	Meyer (2010), Surridge & Harris (2007)
• **Collect feedback on knowledge from knowledge consumers:** knowledge consumers should be encouraged to give feedback on whether or not knowledge provided by PKIs is useful. Based on this feedback, PKIs should be able to maintain the knowledge base concerning its actuality and usefulness.	Geister (2006), Jarvenpaa & Leidner (1999)

4.3.1 Workshop Series

In the first workshop, we sought feedback from key IS@GeFiS decision makers. Thus, we invited the department's head, one professional development manager (responsible for several employees and their development and training), and one project manager to participate. The session lasted 60 minutes. After summarizing the key findings of our interview study and literature review, we presented Just Know's meta-requirements, the resulting design principles, and the conceptual design. In an open discussion, we asked each participant to provide feedback on the design. We can summarize the key results of this first session can by a statement by the head of department: "The design seems to be a good one. However, I think it makes more sense to evaluate the design by asking the people who will be supposed to use the system.".

Therefore, we conducted a second workshop. We invited 10 participants with various roles in the department. However, only five participants were able to attend. The session lasted 90 minutes and comprised two parts: (1) presenting the conceptual design, and (2) gathering feedback on the design. To obtain structured feedback, we asked the participants to assess the design on its strengths, weaknesses, opportunities, and threats (SWOT analysis), which revealed that the participants perceived the PKI as a valuable support for project teams to reuse project knowledge already existing in the case company. However, some participants cautioned that implementing such an organizational role may result in unclear areas of responsibility and work overload on the part of single persons. Regarding the technical part of Just KNow, the participants added some functionalities (e.g., providing templates, refining the project characteristics questionnaire) that might support effective knowledge retrieval and reuse

Because the second workshop's participants comprised four project managers and one professional development manager, we decided to conduct a third workshop with various project team members. We invited eight project team members. In coordination with some IS@GeFiS employees, we purposefully selected the participants, this time also including functional analysts and technical specialists. For comprehensive feedback, we selected participants known as skeptics and participants with a positive attitude toward project insights. Similar to the first workshop, we asked all participants to provide their feedback in an open discussion round. After discussing some advantages and disadvantages of the conceptual design, one project manager recommended a pilot study to test the PKI as formulated in our second design principle. The project manager offered to conduct the pilot study in his own project. Table 4 summarizes the main feedback on Just KNow that we collected in the workshops.

Table 4. Key Results of Workshop Series

Feedback related to social subsystem	Feedback related to technical subsystem
• Methodological tool set is needed to support knowledge intermediaries in their tasks	• Existing platform in the case company should be used to realize the project KMS's functionalities
• Identification of employees that would be appropriate to be knowledge intermediaries	• A template for documenting and storing project insights needs to be developed and implemented
• Knowledge intermediaries need to be trained	• System should provide the possibility to highlight interesting content and characteristics of project insights

4.3.2 Pilot Study

To prepare the pilot study, the ADR project team analyzed the key results of the workshops. The pilot study sought to test the PKI's effects on knowledge reuse within and among project teams. Therefore, the ADR team started its activities by realizing the knowledge intermediary as designed. Since the PKI role did not previously exist in the case company, we had to identify and train employees considered to be appropriate. Owing to the limited timeframe to prepare the pilot study, we had to simulate a knowledge intermediary. Therefore, we selected two employees of the case company: (1) one topic expert serving as consultant owing to his experience with similar projects, and (2) one method expert with moderating skills as a neutral moderator. Within two weeks, the method expert and the project manager prepared the lessons learned session after intensive discussions. The project manager provided all information on the project context. In a joint brainstorming session, the project manager and the method expert planned the workshop in detail (e.g., schedule, key questions that should be answered in the lessons learned sessions, methodology, and session participants). Since the case project was at an end, the topic expert's role was simulated. The topic expert had to prepare post-its that noted which knowledge he would provide to the project if at its outset. For all other preparation activities, the topic expert had been explicitly excluded.

Method expert (standing in front of the participants) opens the lessons learned session

Topic expert (right) presents his project insights

Results of lessons learned session, including. the insights of the topic expert (yellow post-its)

Figure 3. Impressions from the Pilot Study

We conducted the pilot study in the form of a lessons-learned session, which lasted three hours. In total, 29 people attended the session, of which 20 were part of the project, and one topic expert, one method expert, and the entire ADR team. The ADR team divided the lessons learned session into four parts. Part one served as introduction. After introducing all participants, an ADR project team representative briefly explained the ADR project and the conceptual design artifact resulting from the project. In part two, the ADR team asked the project team members to form groups and discuss their main insights. After the brainstorming phase, the groups presented their results to all participants. In part three, the topic expert added 13 project insights noted before the workshop. Of the 13 insights, we found that 12 were redundant to insights collected by the project team. The remaining insight triggered an intensive discussion among the participants. All the participants agreed that this insight was a valuable one and that it would have been beneficial to know prior to the project. Part four served to discuss the final results. By asking questions, the method expert refined the collected project insights, which resulted in valuable and reusable lessons learned. Figure 3 provides some impressions from the pilot study.

At the end of the workshop session, we asked each project team member to complete a paper-based questionnaire that included questions on their opinion regarding the experts and the applied methodology. The questionnaire did not seek to gather quantitative data by measuring valid and reliable items; it sought to gather, quickly and in a structured way, each participant's opinions of the applied methodology, the topic, and the method expert. In sum, 14 participants (70% response rate) returned the questionnaire; two were female. On average, the participants were 39 years old with more than 10 years' work experience. Table 5 overviews the results of this evaluation.

4.4 Discussion of Results and Reflection

After the pilot study, the ADR project team conducted a lessons-learned workshop to identify the strengths and weaknesses of Just Know's conceptual design. By analyzing the pilot study, the ADR project team identified six primary insights. First, all ADR project team members and the participants of the pilot study and workshop series perceived the PKI concept as valuable and beneficial for the case company. Thus, the ADR project team decided to strengthen and realize the concept organization-wide. Second, they thought that the procedures applied in the lessons learned-sessions needed to be defined in greater detail. They thought that, by applying a set of standardized procedures, it would be easier for the PKI to moderate the lessons learned sessions and to focus on the relevant tasks as consultant and knowledge provider. Third, they noticed that the PKI needed training in moderation skills. In a lessons-learned session, the PKI should prevent unintended subgroups from forming and should keep participants' attention on the topics under discussion. The PKI also needs a set of procedures and methods to enable this individual to adapt the lessons-learned session to the particular needs of the project team. Based on the first three insights, we slightly refined the design of the PKI as part of the social subsystem and implemented it in the case company. Fourth, the ADR project team agreed that knowledge reuse within projects will have the highest impact when lessons learned sessions are not only conducted at the end of a project (enabling inter-project learning) but also at the outset and for its duration (enabling intra-project learning). It is useful when knowledge of prior projects is reused at the outset, during preparation, and during projects to reflect on own activities, resulting in higher perceived benefits from lessons-learned workshops. Owing to the fourth point of improvement, we extended our set of principles by formulating a fifth design principle:

DP5: Document and reuse project-related knowledge in all project phases.

Fifth, the PKI and the project team required appropriate technological support. Although we also designed and presented a technical part of Just KNow, the case company put little effort into realizing the designed artifact. However, in the pre-evaluation, the need for such technology again become clear for all members of the ADR project team. Valuable lessons learned and best practices need to be documented and centrally stored. In addition, PKIs employed in the case company need a shared, digital platform to exchange their experiences and increase their body of both project-related and methodological knowledge. As a result, the ADR team accelerated the implementation of the functionalities described in Table 2. Figure 4 displays the resulting artifact.

Table 5. Evaluation of Knowledge Intermediary in Pilot Study

Method expert	**Mean***	**SDEV**
It makes sense to employ a method expert in the project.	4.3	0.97
The method expert helps to find reusable knowledge.	4.4	0.51
It makes sense to integrate the method expert into the collection of project insights.	4.2	0.69
Owing to the method expert, the project insights could be gathered satisfactorily.	4.0	0.71
The method expert supported us to find reusable knowledge.	3.5	0.90
Topic expert		
It makes sense to employ a topic expert in the project at the start.	4.2	0.73
It makes sense to employ a topic expert in the project for its duration.	3.8	0.83
Employing a topic expert prevents mistakes and enables knowledge reuse.	3.9	0.49
The topic expert is a valuable support in the project.	3.7	0.75
Workshop procedure		
The workshop was well organized.	4.6	0.50
I was able to contribute my insights.	4.5	0.52
My contributions were noted in a value-neutral way.	4.5	0.76
My contributions were taken seriously.	4.4	0.63
The collected insights adequately reflect the project.	4.3	0.47
I took away valuable insights from the workshop.	3.8	0.80
The atmosphere in the workshop was comfortable.	4.6	0.51
The procedure applied in the workshop was reasonable.	4.1	0.77
* We measured all items on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree)		

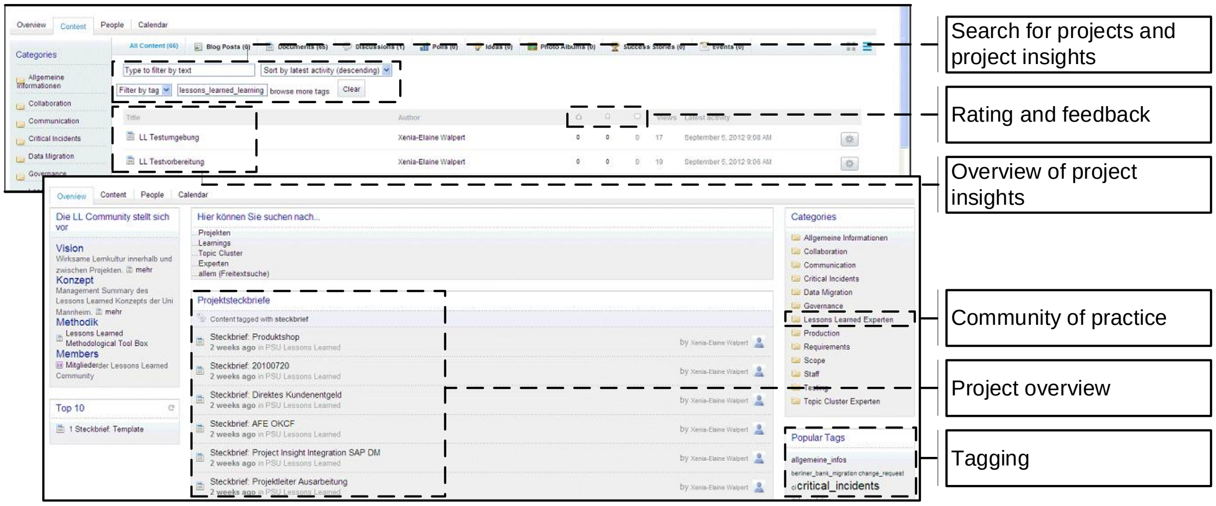

Figure 4. Screenshots of Technical Subsystem of the Project KMS

However, while project teams regularly requested support from the PKI, the technical part of Just KNow was seldom used. On the one hand, not all functionalities as defined in the design phase were implemented; on the other hand, it seems that project teams were less motivated to consult a technology when they also could contact a PKI to receive valuable knowledge. In dialogue with ADR project team members and by consulting existing literature, we identified three reasons for low adoption and use of the technical subsystem: First, project teams often perceive a lack of time and are not motivated to document their insights. Because most teams gather their experiences at the end of the project, documenting project knowledge is often perceived as a waste of time (Schindler & Eppler, 2003). However, succeeding projects reusing these insights can prepare themselves and their activities based on the knowledge and are able to increase their performance. Thus, the perceived benefits of documenting project insights for a project is low compared to its following projects. Second, a primary issue of deploying a new technology intended for knowledge documentation and reuse is the initial set of documented knowledge. A knowledge base will be used when its users realize that it will provide solutions for their issues. Since documented project insights in the case company were highly heterogeneous in form, usefulness, actuality, and comparability, it was difficult to import existing insights into Just KNow. Thus, the initial system was empty. However, as often observed in studies on knowledge sharing (e.g., in wikis) only 10 percent of all users actively document and maintain knowledge in such a knowledge database (Palmisano, 2009). As a result, at its initial state, the technology provides low benefit for project teams. Third, entering data or information in a storage bin is simply no fun. As studies (e.g., Hwang, 2005; Venkatesh & Bala, 2008) demonstrate, the "degree of user perception of the usefulness and enjoyment…are strong factors that influence individual intentions whether to utilize this technology" (Serenko, Bontis, & Detlor, 2007, p. 127). As a result, employee motivation to use Just KNow is a key driver for its success. As such, we formulate a sixth design principle:

> **DP6:** Motivate knowledge management in projects by including emotional, affective functionalities.

At the end of the first ADR cycle, our DPs had evolved twice. Figure 5 overviews the six DPs determined in the first ADR cycle.

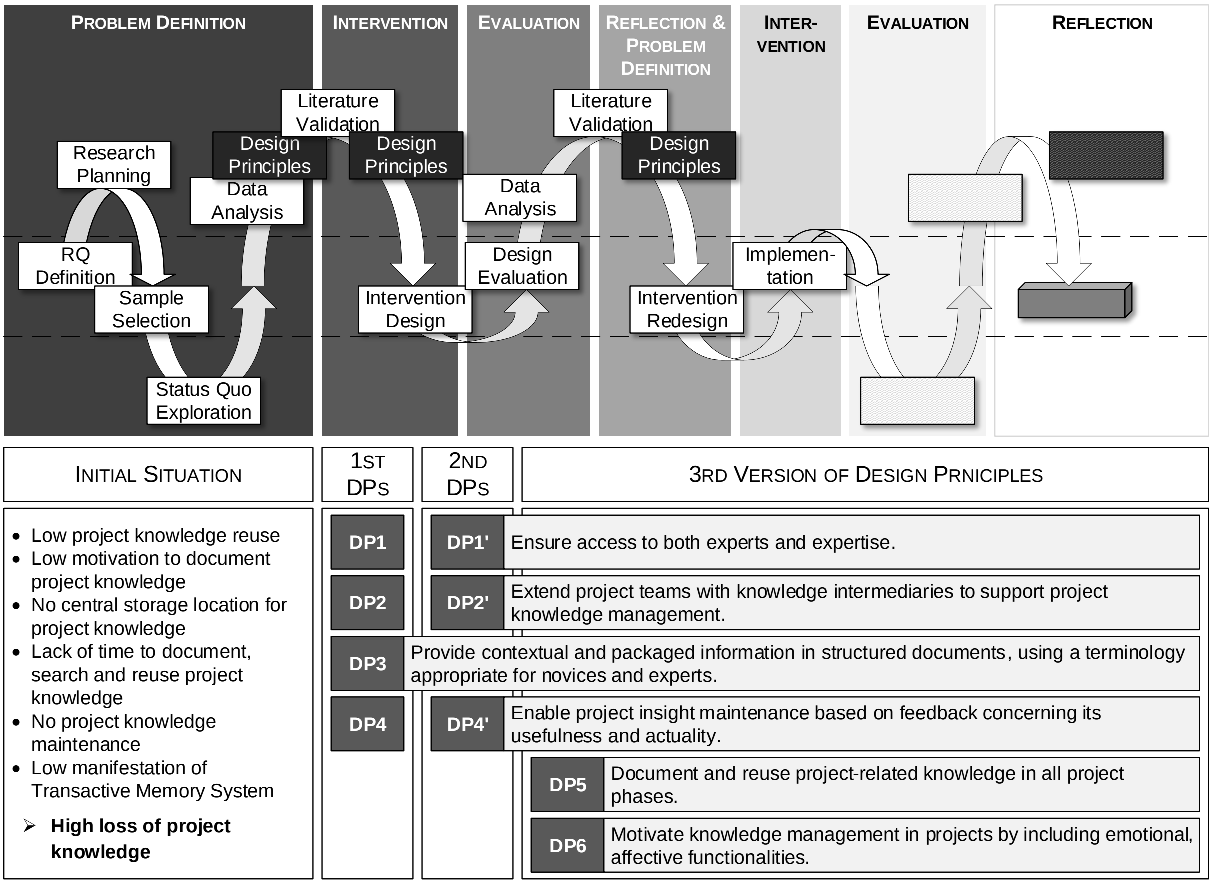

Figure 5. Third Version of Design Principles

4.5 Second ADR Cycle

In the first ADR cycle, we explored six principles to design an effective project KMS. While we evaluated the design principles in the first ADR cycle based on the conceptual design, in the second cycle, we implemented the interventions and the observations and measurement of their effects. We took the results of the first cycle's reflection phase into the second cycle's problem definition phase. Because some issues were not fully covered by our actual design, we conducted a second intervention phase after redesigning both Just KNow's social and technical subsystems.

Based on the fifth design principle and Schütt's (2003) call to consider the organization, its culture, and processes in addition to its IT infrastructure when designing socio-technical KMS, we extended Just KNow's social subsystem via a knowledge-centric project management process (KCPMP) to support project teams in their KM activities. KCPMP seeks to guide employees on when and how to gather and reuse project knowledge. In analyzing the case company's state-of-the-art methods on handling project knowledge, some employees reported that they were following the project management institute's (PMI) project management guidelines. Knowledge and knowledge management plays a subordinate role in the PMI framework. Although the PMI framework suggests reusing knowledge in nearly all project phases, it does not provide guidelines regarding timing and procedures. In addition, the framework only suggests gathering project-related knowledge at the end of the project to share experiences with other projects (inter-project learning). However, as Kasvi, Vartiainen, and Hailikari (2003) propose in their project-learning model, knowledge reuse will result in higher benefits when it takes place multiple times in a project (intra-project learning). Another point of criticism on the PMI framework is that it focuses solely on explicit knowledge. In their work, Reich and Wee (2006) study the knowledge objects referenced in the PMI framework and note that none of the 47 knowledge objects are tacit. Considering the conversion process of knowledge that Nonaka, Toyama, and Konno (2000) introduce, Reich and Wee (2006) realize that no process described in the PMI framework refers to the socialization or internalization of knowledge.

Therefore, we refined the PMI framework by including various knowledge reuse stages to the KCPMP. As described in the PMI framework, in the KCPMP, the project teams should also follow the classical project lifecycle, which comprises (1) project planning and preparing, (2) project execution, and (3) project closure. In all the phases, the project work has to be monitored and controlled (PMI, 2011, p. 40). However, in addition to the traditional PMI framework, the KCPMP suggests conducting multiple lessons learned sessions to gather and reuse knowledge. Thus, lessons-learned sessions not serve not only as reflection on but also as preparation of the various project phases. Therefore, such session should also be conducted at the outset of and during a project rather than only at the end. During the project lifecycle, the project should be supported by a PKI as consultant and knowledge coordinator. We depict the KCPMP in Figure 6 and then briefly describe it.

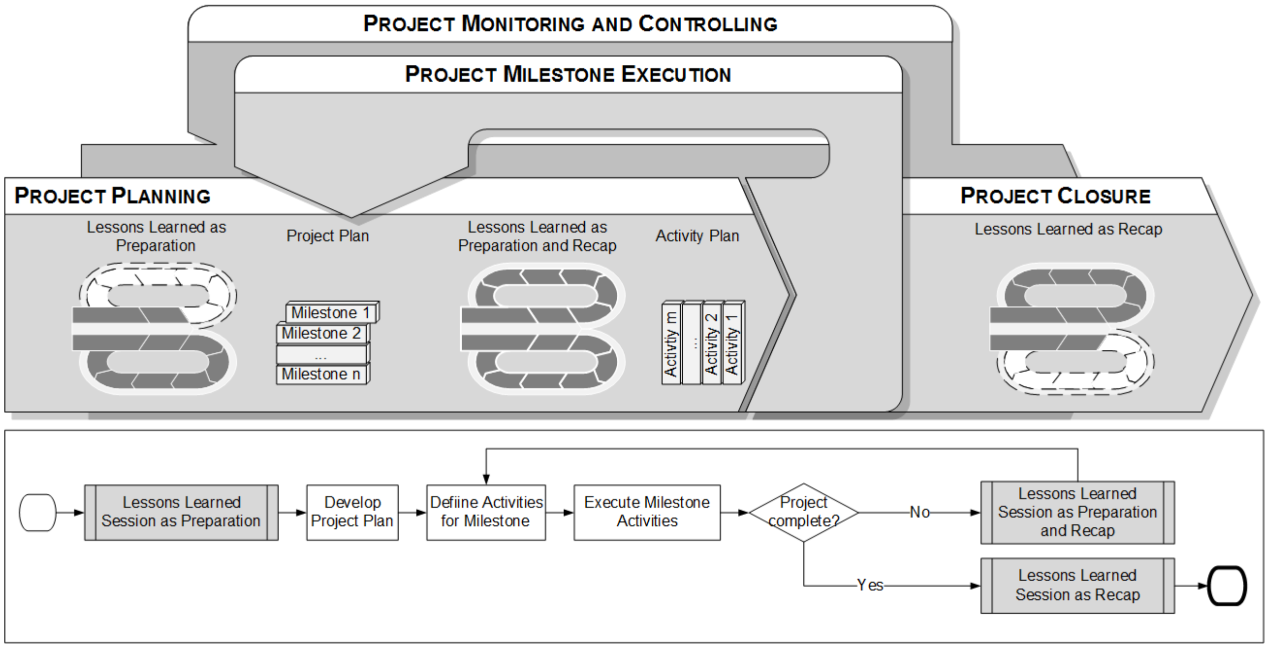

Figure 6. Knowledge-centric Project Management Process (KCPMP)

To refine the technical subsystem, we studied the literature on motivation and contemporary functionalities of technical systems. We became aware of gamification, an upcoming research field promising to motivate individuals to adopt and use new technology. Gamification is “the use of game design elements in non-game contexts” (Deterding, Khaled, Nacke, & Dixon, 2011, p. 7). By including functionalities such as ratings, badges, leaderboards, or points, one can increase individuals’ motivation to use a system. However, researchers studying gamification caution against its non-deliberate usage. Gamification applications need to be designed by applying design thinking and design processes to (1) understand why users engage in gamification applications, and (2) include game elements that are appropriate to organizations’ and users’ needs and goals (Paharia, 2012). Implementing game-elements such as points, badges, or leaderboards is just one aspect. To change individuals’ behavior (e.g., to document and reuse project knowledge more often and more consistently), there must be some kind of meaningful story implemented in the gamified application. This means that activities and goals implemented in the application need to be derived from the overarching goals of the organization and its employees (Laschke & Hassenzahl, 2011). When elements of a game have no meaning in the real world, they can be annoying (Cramer, Zeynep, Holmquist, & Rost,, 2011). Furthermore some researchers caution against making participation in such gamified applications mandatory since it “might create rule-based experiences that feel just like school” (Lee & Hammer, 2011, p. 4). Therefore, the gamified application should be designed so that the knowledge documentation and reuse can take place in both a traditional and a gamified way.

Based on existing literature related to gamification, we redesigned the technical subsystem of our project KMS. Figure 7 depicts the overall architectural design of the gamified project KMS, called Project World. Schacht, Morana, and Maedche (2014) discuss details of the project KMS redesign.

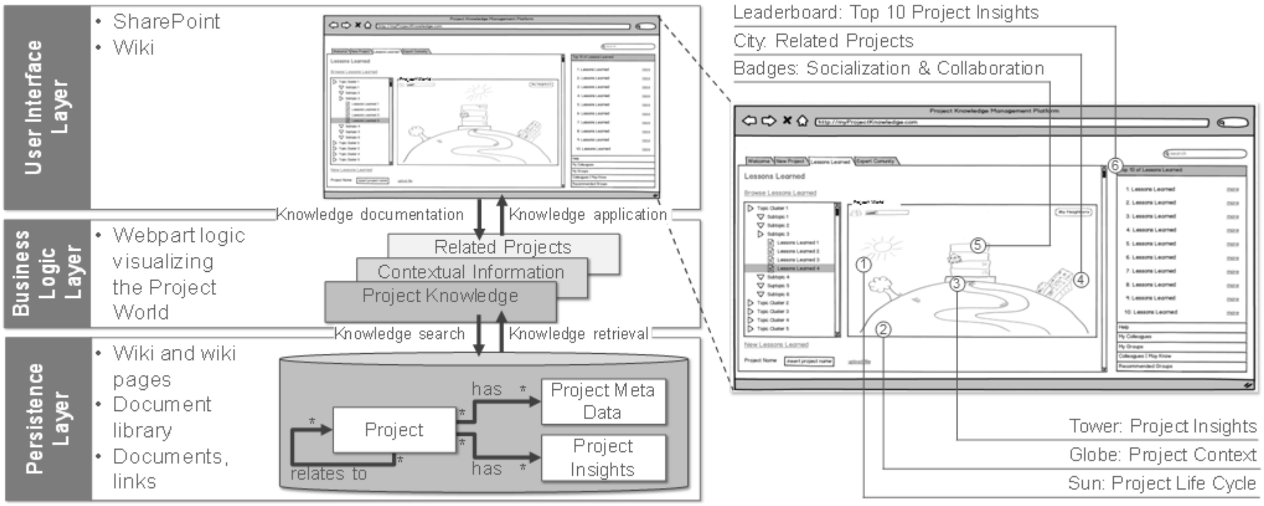

Figure 7. Architectural Design of Project World

5 Discussion of Results and Future Work

The existing literature on knowledge reuse and our exploratory interview study reveal that project teams tend to perceive the search for valuable knowledge as a waste of time and are less motivated to sift through databases. Instead, they prefer to directly contact experts and exchange their knowledge in bilateral communication. Thus, we derived six design principles that cover the case company's requirements. As a result, we designed Just KNow—a project KMS that comprises both a technical and a social subsystem. Further, the social subsystem comprises a PKI and a KCPMP. In a small survey, we asked 89 case company employees to assess the last lessons-learned session they had participated in. This survey revealed that more than 60 percent of the participants stated that the last-lessons learned session they had attended had employed a PKI. In addition, 36.3 percent of participants stated that the lessons learned session took place either at the start of or during the project rather than at project's end. Thus, the case company heavily used the PKI, and, in an increasing number of projects, lessons-learned sessions took place not only at a project's end but also at the start of and during the project. However, we had not implemented many of the technical subsystem's functionalities in either its original version nor as a gamified version. Nonetheless, the interview data and the PKI's success in the case company demonstrate that project teams need to support to document, store, transfer, and reuse project-related knowledge. In the pilot study, the participants acknowledged a high added value of employing a PKI as both method and topic expert. However, since the technical subsystem was still missing and, thus, could not support the PKI or project teams in retrieving valuable knowledge, the case company purely relied on the PKI and this individual's memory skills.

As a result, we still need to do quite some work to increase and support knowledge reuse in the case company. Currently, our research project is in the middle of the second ADR cycle. Because the implementation process for the KM technology has been slow and sluggish, we decided to conduct an ex post evaluation testing only the PKI's effect on project knowledge reuse in the case company. By applying the situated learning theory, we have begun to measure participants' satisfaction with the social interactions in lessons-learned sessions that employed a PKI and compared the results with groups that did not employ a PKI. In addition, we are studying which factors influence satisfaction with the social interaction. Based on situated learning theory, the results of the ex post evaluations will give us some insights into the PKI's effects on project knowledge reuse. Subsequently, we will prepare and push for the technical subsystem's redesign. When the technical subsystem is implemented, we plan to conduct another ex post evaluation. As the final step of the overall ADR project, we will consider our results and formulate a design theory (Gregor & Jones, 2007) for project KMS enabling knowledge reuse.

Although our ADR project is not yet complete, the current research results contribute to both research and practice. From a theoretical perspective, our research demonstrates that the universalized assumption that knowledge only needs to be documented, stored, and exchanged will result in its reuse needs to be revised. Many researchers have put much effort into supporting project teams to document, store, and exchange their knowledge. However, whether or not they are using the knowledge is only rarely tested or demonstrated. However, we have designed (and continue to design) a project KMS that will increase knowledge reuse by applying the situated learning theory to reason the effects of social interactions on learning and knowledge reuse. In addition, few studies "pursue[s] a novel holistic perspective by taking into account the embedded and multifaceted nature of knowledge and by omitting the predominant focus on knowledge sharing" (Dingel & Spiekermann, 2007, p. 521). By applying the socio-technical perspective (Bostrom & Heinen, 1977), we address this research gap. Owing to our application of the ADR approach in a case company, we extend the existing body of knowledge in the KM area since most DSR or AR projects tend to evaluate their artifacts either in an experimental setting in a synthetic environment or not at all (Peffers et al., 2012). By including the practitioners in the design process and implementing the interventions in a case company, we address the call by Peffers et al. (2012) "for more action research…or perhaps action design style research" (Peffers et al., 2012, p. 408). Thus, the ADR project enables researchers to redesign an artifact considering research rooted in theory and inspired by practice on the one hand. On the other hand, it also facilitates the evaluation in real settings, considering organizational conditions and changes, as Sein et al. (2011) suggests. As a result, both researchers and practitioners can interpret and apply the design principles. Still, we need further research to generalize the findings. However, since IS projects in companies are often very similar (Reich et al., 2008), we assume that the results can easily be adapted to different backgrounds and organizations. Thus, from a practical perspective, the step-by-step descriptions of the ADR project and its preliminary results can also guide practitioners on how to adapt the project KMS to their own environment and project knowledge issues. They will be able to improve their project-based learning. Thus, the artifact mutability supports practitioners since not all design principles or design decisions need to be implemented in order to address project-based learning in an organization. Rather, organizations can implement the design principles incrementally. Such a step-by-step approach enables organizations to prevent too many changes at a time, which may result in high perceived costs to potential users and, thus, in high reluctance concerning the intervention (Homans, 1958).

6 Acknowledgments

We thank the Senior Editor Jan vom Brocke and the entire team of reviewers who offered constructive feedback and inspiring ideas, which helped us to improve the papers. These colleagues bear no responsibility for any errors, omissions, or views expressed in the papers. We wrote this paper in the context of the research project WeChange (promotional reference 01HH11059), which is funded by the German Federal Ministry of Education and Research (BMBF).

References

Ackoff, R. L. (1989). From data to wisdom. *Journal of Applied Systems Analysis, 16*, 3-9.

Adenfelt, M., & Lagerström, K. (2006). Enabling knowledge creation and sharing in transnational projects. *International Journal of Project Management, 24*(3), 191-198.

Ajmal, M. M., & Koskinen, K. U. (2008). Knowledge transfer in project-based organizations: An organizational culture perspective. *Project Management Journal, 39*(1), 7-15.

Akscyn, R. M., McCracken, D. L., & Yoder, E. A. (1988). KMS: A distributed hypermedia system for managing knowledge in organizations. *Communications of the ACM, 31*(7), 820-835.

Alavi, M., & Leidner, D. E. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly*, *25*(1), 107-136.

Allee, V. (1997). The knowledge evolution: Expanding organizational intelligence. Boston: Butterworth-Heinemann.

Van Alstyne, M., & Brynjolfsson, E. (1996). Electronic communities: Global village or cyberbalkans? In *Proceedings of the 1996 International Conference on Information Systems* (pp. 80-98).

Arazy, O., Gellatly, I., Jang, S., & Patterson, R. (2009). Wiki deployment in corporate settings. *IEEE Technology and Society Magazine*, *28*(2), 57-64.

Ardichvili, A., Page, V., & Wentling, T. (2003). Motivation and barriers to participation in virtual knowledge-sharing communities of practice. *Journal of Knowledge Management, 7*(1), 64-77.

Bartsch, V., Ebers, M., & Maurer, I. (2012). Learning in project-based organizations: The role of project teams' social capital for overcoming barriers to learning. *International Journal of Project Management*, *31*(2), 239-251.

Baskerville, R., & Myers, M. D. (2004). Special issue on action research in information systems: Making IS research relevant to practice—foreword. *MIS Quarterly, 28*, 229-235.

Baskerville, R., Pries-Heje, J., & Venable, J. (2007). Soft design science research: Extending the boundaries of evaluation in design science research. In *Proceedings of the 2007 Conference on Design Science Research in Information Systems and Technologies* (pp. 18-38).

Bélanger, F., & Allport, C. D. (2008). Collaborative technologies in knowledge telework: An exploratory study. *Information Systems Journal*, *18*(1), 101-121.

Benbasat, I., Goldstein, D., & Mead, M. (1987). The case research strategy in studies of information systems. *MIS Quarterly*, *11*(3), 369-386.

Berztiss, A. T. (2002). Capability maturity for knowledge management. In *Proceedings of the 13th International Workshop on Database and Expert Systems Applications* (pp. 162-166).

Blessing, D., Goerk, M., & Bach, V. (2001). Management of customer and project knowledge: Solutions and experience at SAP. *Knowledge and Process Management*, *8*(2), 75-90.

Boh, W. F. (2007). Mechanisms for sharing knowledge in project-based organizations. *Information and Organization, 17*(1), 27-58.

Boland, R. J. J., Tenkasi, R. V, & Te'eni, D. (1994). Designing information technology to support distributed cognition. *Organization Science*, *5*(3), 456-475.

Bondarouk, T. V. (2006). Action-oriented group learning in the implementation of information technologies: Results from three case studies. *European Journal of Information Systems, 15*, 42-53.

Bostrom, R. P., & Heinen, J. S. (1977). MIS problems and failures: A socio-technical perspective. Part I: The causes. *MIS Quarterly, 1*(3), 17-32.

Bresnen, M., Edelman, L., Newell, S., Scarbrough, H., & Swan, J. (2003). Social practices and the management of knowledge in project environments. *International Journal of Project Management*, *21*(3), 157-166.

Butler, T., & Murphy, C. (2007). Understanding the design of information technologies for knowledge management in organizations: A pragmatic perspective. *Information Systems Journal*, *17*(2), 143-163.

Carrillo, P., Ruikar, K., & Fuller, P. (2013). When will we learn? Improving lessons learned practice in construction. *International Journal of Project Management, 31*(4), 567-578.

Chen, R.-S., & Hsiang, C.-H. (2007). A study on the critical success factors for corporations embarking on knowledge community-based e-learning. *Information Sciences*, *177*(2), 570-586.

Choi, S. Y., Lee, H., & Yoo, Y. (2010). The impact of information technology and transactive memory systems on knowledge sharing, application, and team performance: A field study. *MIS Quarterly*, *34*(4), 855-870.

Chou, D. C., & Lin, B. (2002). Development of Web-based knowledge management systems. *Human Systems Management*, *21*(3), 153-158.

Coyne, I. T. (1997). Sampling in qualitative research. Purposeful and theoretical sampling; merging or clear boundaries? *Journal of Advanced Nursing, 26*(3), 623-630.

Cramer, H., Zeynep, A., Holmquist, L. E., & Rost, M. (2011). Gamification and location-sharing: Some emerging social conflicts. In *Proceedings of the CHI 2011 Workshop on Gamification* (pp. 30-33).

Crossan, M. M., Lane, H. W., & White, R. E. (1999). An organizational learning framework: From intuition to institution. *The Academy of Management Review, 24*(3), 522-537.

Davenport, T. H., De Long, D. W., & Beers, M. C. (1998). Successful knowledge management projects. *Sloan Management Review, 39*(2), 43-57.

Davidson, E., & Lamb, R. (2000). Examining socio-technical networks in scientific academia/industry collaborations. In *Proceedings of the 2000 Americas Conference on Information Systems* (pp. 1625-1631).

Davison, R. M., Martinsons, M. G., & Kock, N. (2004). Principles of canonical action research*. Information Systems Journal*, *14*(1), 65-86.

Dellarocas, C. (2010). The digitization of word digitization feedback mouth: Promises and challenges of online feedback mechanisms. *Management Science*, *49*(10), 1407-1424.

Desouza, K. C., & Evaristo, J. R. (2004). Managing knowledge in distributed projects. *Communications of the ACM*, *47*(4), 87-91.

Desouza, K., Dingsoyr, T., & Awazu, Y. (2005). Experiences with conducting project postmortems: Reports vs. stories and practitioner perspective. In *Proceedings of the 2005 Hawaii International Conference on System Sciences.*

Deterding, S., Khaled, R., Nacke, L. E., & Dixon, D. (2011). Gamification: Towards a definition. In *Proceedings of the CHI 2011 Workshop on Gamification* (pp. 6-9).

Dickens, L., & Watkins, K. (1999). Action research: Rethinking Lewin. *Management Learning*, *30*(2), 127-140.

Dingel, K., & Spiekermann, S. (2007). Third generation knowledge management Systems—towards an augmented technology acceptance model. In *Proceedings of the 2007 Wirtschaftsinformatik Conference.*

Dourish, P., Edwards, W. K., LaMarca, A., Lamping, J., Petersen, K., Salisbury, M., Terry, D. B., & Thornton, J. (2000). Extending document management systems with user-specific active properties. *ACM Transactions on Information Systems*, *18*(2), 140-170.

Earl, M. (2001). Knowledge management strategies: Toward a taxonomy. *Journal of Management Information Systems*, *18*(1), 215-233.

Earl, M. J., & Scott, I. A. (1999). Opinion: What is a chief knowledge officer? *Sloan Management Review*, *40*(2), 29-38.

Eskerod, P., & Skriver, H. J. (2007). Organizational culture restraining in-house knowledge transfer between project managers—a case study. *Project Management Journal*, *38*(1), 110-122.

Firestone, J. M., & McElroy, M. W. (2003*). Key issues in knowledge management knowledge creation diffusion utilization*. Amsterdam: KMCI Press.

Garcia, B. C. (2009). Developing connectivity: A PKM path for higher education workplace learners. *Online Information Review, 33*(2), 276-297.

Geister, S. (2006). Effects of process feedback on motivation, satisfaction, and performance in virtual teams. *Small Group Research, 37*(5), 459-489.

Gregor, S., & Jones, D. (2007). The anatomy of a design theory. *Journal of the Association for Information Systems*, *8*(5), 313-335.

Hasan, H., & Pfaff, C. C. (2006). The wiki. In *Proceedings of the 20th Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction: Design, Activities, Artefacts and Environments* (pp. 377-380).

Herschel, R. (2000). Chief knowledge officer: Critical success factors for knowledge management. *The Executive's Journal*, *16*(4), 37-46.

Hevner, A. R. (2007). A three cycle view of design science research. *Scandinavian Journal of Information Systems*, *19*(2), 87-92.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, *28*(1), 75-105.

Homans, G. C. (1958). Social behavior as exchange. *American Journal of Sociology, 63*(6), 597-606.

Hsu, M.-H., Ju, T. L., Yen, C.-H., & Chang, C.-M. (2007). Knowledge sharing behavior in virtual communities: The relationship between trust, self-efficacy, and outcome expectations. *International Journal of Human-Computer Studies*, *65*(2), 153-169.

Huysman, M., & Wulf, V. (2005). The role of information technology in building and sustaining the relational base of communities. *The Information Society*, *21*(2), 81-89.

Hwang, Y. (2005). Investigating enterprise systems adoption: Uncertainty avoidance, intrinsic motivation, and the technology acceptance Model. *European Journal of Information Systems*, *14*(2), 150-161.

Jarvenpaa, S. L., & Leidner, D. E. (1999). Communication and trust in global virtual teams. *Organization Science*, *10*(6), 791-815.

Järvinen, P. (2007). Action research is similar to design science. *Quality & Quantity*, *41*(1), 37-54.

Julian, J. (2008). How project management office leaders facilitate cross-project learning and continuous improvement. *Project Management Journal*, *39*(3), 43-58.

Kankanhalli, A., Tan, B. C. Y., & Wei, K.-K. (2005). Contributing knowledge to electronic knowledge repositories: An empirical investigation. *MIS Quarterly*, *29*(1), 113-143.

Kasvi, J. J. J., Vartiainen, M., & Hailikari, M. (2003). Managing knowledge and knowledge competences in projects and project organisations. *International Journal of Project Management*, *21*(8), 571-582.

Kautz, K., & Hansen, B. (2008). Mapping knowledge flows. In P. A. Nielsen & K. Kautz (Eds.), Software processes & knowledge: Beyond conventional software process improvement (pp. 89-116). Frederiksberg : Software Innovation Publisher.

King, W. R., Marks, P. V., & McCoy, S. (2002). The most important issues in knowledge management. *Communications of the ACM, 45*(9), 93-97.

Kivrak, S., Arslan, G., Dikmen, I., & Birgonul, M. T. (2008). Capturing knowledge in construction projects: Knowledge platform for contractors. *Journal of Management in Engineering*, *24*(2), 87-95.

Kotnour, T. (2000). Organizational learning practices in the project management environment. *International Journal of Quality & Reliability Management, 17*(4/5), 393-406.

Laha, A. (2011). On challenges and opportunities of designing integrated IT platforms for supporting knowledge works in organizations. *The Journal for Decision Makers, 36*(3), 35-60.

Laschke, M., & Hassenzahl, M. (2011). Mayor or patron? The difference between a badge and a meaningful Story. In *Proceedings of the CHI 2011 Workshop on Gamification* (pp. 72-75).

Lee, J. J., & Hammer, J. (2011). Gamification in education: What, how, why bother? *Academic Exchange Quarterly*, *15*(2), 1-5.

Leseure, M. J., & Brookes, N. J. (2004). Knowledge management benchmarks for project management. *Journal of Knowledge Management, 8*(1), 103-116.

Lin, H.-F. (2007). Effects of extrinsic and intrinsic motivation on employee knowledge sharing intentions. *Journal of Information Science, 33*(2), 135-149.

Lind, M., & Persborn, M. (2000). Possibilities and risks with a knowledge broker in the knowledge transfer process. In *Proceedings of the 42nd Annual Conference of the Operational Research Society*.

Markus, M. L. (2001). Toward a theory of knowledge reuse: Types of knowledge reuse situations and factors in reuse success. *Journal of Management Information Systems*, *18*(1), 57-93.

Markus, M. L., Majchrzak, A., & Gasser, L. (2002). A design theory for systems that support emergent knowledge processes. *MIS Quarterly*, *26*(3), 179-212.

McKeen, J. D., & Staples, D. S. (2004). Knowledge managers: Who they are and what they do. In C.W. Holsapple (Ed.), *Handbook on knowledge management* (Vol. 1, pp. 21-41). Berlin: Springer.

Meloche, J. A., Hasan, H. M., Willis, D., Pfaff, C., & Qi, Y. (2009). Co-creating corporate knowledge with a wiki. *International Journal of Knowledge Management, 5*(2), 33-50.

Meyer, M. (2010). The rise of the knowledge broker. *Science Communication*, *32*(1), 118-127.

Morse, J., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods*, *1*(2), 13-22.

Myers, M. D. (2009). *Qualitative research in business & management*. Thousand Oaks, CA: Sage.

Myers, M. D., & Newman, M. (2007). The qualitative interview in IS research: Examining the craft. *Information and Organization, 17*(1), 2-26.

Nesheim, T., & Olsen, K. M. (2011). Knowledge communities in matrix-like organizations: Managing knowledge towards application. *Journal of Knowledge Management*, *15*(5), 836-850.

Newell, S. (2004). Enhancing cross-project learning. *Management*, *16*(1), 12-20.

Newell, S., & Edelman, L. F. (2008). Developing a dynamic project learning and cross-project learning capability: Synthesizing two perspectives. *Information Systems Journal*, *18*(6), 567-591.

Nielsen, L., & Madsen, S. (2006). Storytelling as method for sharing knowledge across IT projects. In *Proceedings of the 2006 Hawaii International Conference on System Sciences.*

Nonaka, I., & Konno, N. (1998). The Concept of “Ba”: Building a foundation for knowledge creation. *California Management Review, 40*(3), 40-54.

Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and leadership: A unified model of dynamic knowledge creation. *Long Range Planning*, *33*(1), 5-34.

Paharia, R. (2012). Gamification means amplifying intrinsic value. *Interactions*, *19*(4).

Palmisano, J. (2009). Motivating knowledge contribution in virtual communities of practice: Roots, progress and needs. In *Proceedings of the 2009 Americas Conference on Information Systems.*

Pan, S. L., & Scarbrough, H. (1999). Knowledge management in practice: An exploratory case study. *Technology Analysis & Strategic Management, 11*(3), 359-374.

Patel, N. V., & Ghoneim, A. (2011). Managing emergent knowledge through deferred action design principles: The case of ecommerce virtual teams. *Journal of Enterprise Information Management*, *24*(5), 424-439.

Paulzen, O., Doumi, M., Perc, P., & Cereijo-Roibas, A. (2002). A maturity model for quality improvement in knowledge management. In *Proceedings of the 2002 Australasian Conferences on Information Systems.*

Peffers, K., Rothenberger, M., Tuunanen, T., & Vaezi, R. (2012). Design science research evaluation. In K. Peffers, M. Rothenberger, & B. Kuechler (Eds.), *Design science research in information systems. Advances in theory and practice* (Vol. 7286, pp. 398-410). Berlin: Springer.

Peffers, K., Tuunanen, T., Rothenberger, M., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, *24*(3), 45-77.

Perott, A., Schader, N., Bruder, R., & Leonhardt, J. (2012). Development of a knowledge management system for complex domains. *Work*, 41, 2757-2764.

Petter, S., & Randolph, A. B. (2009). Developing soft skills to manage user expectations in IT projects: Knowledge reuse among IT project managers. *Project Management Journal*, *40*(4), 45-59.

Petter, S., & Vaishnavi, V. (2008). Facilitating experience reuse among software project managers. *Information Sciences, 178*(7), 1783-1802.

PMI. (2011). IEEE Guide—adoption of the project management institute (PMI(R)) standard: A guide to the project management body of knowledge (4th ed., pp. 1-508). *IEEE.*

Polanyi, M. (1966). *The tacit dimension*. Chicago: The University of Chicago Press.

Popov, B., Kiryakov, A., Ognyanoff, D., Manov, D., & Kirilov, A. (2004). KIM—a semantic platform for information extraction and retrieval. *Natural Language Engineering*, *10*(3-4), 375-392.

Reich, B. H., Gemino, A., & Sauer, C. (2008). Modeling the knowledge perspective of IT projects. *Project Management Journal*, *39*(1), 4-14.

Reich, B., & Wee, S. (2006). Searching for knowledge in the PMBOk guide. *Project Management Journal*, *37*(2), 11-26.

Riemer, K., Steinfield, C., & Vogel, D. (2009). eCollaboration: On the nature and emergence of communication and collaboration technologies. *Electronic Markets*, *19*(4), 181-188.

Salisbury, M., & Plass, J. (2001). A conceptual framework for a knowledge management system. *Human Resource Development International*, *4*(4), 451-464.

Schacht, S., & Maedche, A. (2013). How to prevent reinventing the wheel? Design principles for project knowledge management systems. In *Proceedings of the 2013 Conference on Design Science Research in Information Systems and Technologies* (Vol. 7939 LNCS, pp. 1-17).

Schacht, S., Morana, S., & Maedche, A. (2014). The project world—gamification in project knowledge management. In *Proceedings of the 2014 European Conference on Information Systems*.

Schindler, M., & Eppler, M. J. (2003). Harvesting project knowledge: A review of project learning methods and success factors. *International Journal of Project Management*, *21*(3), 219-228.

Schütt, P. (2003). The post Nonaka knowledge management. *Journal of Universal Computer Science*, *9*(6), 451-462.

Sein, M. K., Henfridsson, O., Purao, S., Rossi, M., & Lindgren, R. (2011). Action design research. *MIS Quarterly*, *35*(1), 37-56.

Serenko, A., Bontis, N., & Detlor, B. (2007). End-user adoption of animated interface agents in everyday work applications. *Behaviour & Information Technology*, *26*(2), 119-132.

Staples, D. S., & Webster, J. (2008). Exploring the effects of trust, task interdependence and virtualness on knowledge sharing in teams. *Information Systems Journal*, *18*(6), 617-640.

Stein, E. W., & Zwass, V. (1995). Actualizing organizational memory with information systems. *Information Systems Research, 6*(2), 85-117.

Sure, Y., Staab, S., & Studer, R. (2002). Methodology for development and employment of ontology based knowledge management applications. *ACM SIGMOD Record, 31*(4), 18-23.

Surridge, B., & Harris, B. (2007). Science-driven integrated river basin management: A mirage? *Interdisciplinary Science Reviews, 32*(3), 298-312.

Susman, G. I., & Evered, R. D. (1978). An assessment of the scientific merits of action research. *Administrative Science Quarterly, 23*(4), 582-603.

Sutton, D. (2001). What is knowledge and can it be managed? *European Journal of Information Systems, 10*(2), 80-88.

Swan, J., Scarbrough, H., & Newell, S. (2010). Why don't (or do) organizations learn from projects? *Management Learning, 41*(3), 325-344.

Tan, H. C., Carrillo, P. M., Anumba, C. J., Bouchlaghem, N., Kamara, J. M., & Udeaja, C. E. (2007). Development of a methodology for live capture and reuse of project knowledge in construction. *Journal of Management in Engineering, 23*(1), 18-26.

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation*, *27*(2), 237-246.

Tiwana, A., & Bush, A. (2005). Continuance in expertise-sharing networks: A social perspective. *IEEE Transactions on Engineering Management*, *52*(1), 85-101.

Tiwana, A., & Ramesh, B. (2001). A design knowledge management system to support collaborative information product evolution. *Decision Support Systems*, *31*(2), 241-262.

Tolone, W., Ahn, G.-J., Pai, T., & Hong, S.-P. (2005). Access control in collaborative systems. *ACM Computing Surveys*, *37*(1), 29-41.

Tuomi, I. (1999). Data is more than knowledge: Implications of the reversed knowledge hierarchy for knowledge management and organizational memory. *Journal of Management Information Systems*, *16*(3), 103-117.

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, *39*(2), 273-315.

Wagner, C. (2004). Wiki : A technology for conversational knowledge management and group collaboration. *Communications of the Association for Information Systems*, *13*(1), 265-289.

Wagner, C., & Bolloju, N. (2005). Supporting knowledge management in organizations with conversational technologies: Discussion forums, weblogs, and wikis. *Journal of Database Management*, *16*(2), 1-8.

Walls, J. G., Widmeyer, G. R., & El Sawy, O. A. (1992). Building an information system design theory for vigilant EIS. *Information Systems Research*, *3*(1), 36-59.

Wang, S., & Noe, R. A. (2010). Knowledge sharing: A review and directions for future research. *Human Resource Management Review*, *20*(2), 115-131.

Wattal, S., Racherla, P., & Mandviwalla, M. (2010). Network externalities and technology use: A quantitative analysis of intraorganizational blogs. *Journal of Management Information Systems*, *27*(1), 145-174.

Webster, B. J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *MIS Quarterly*, *26*(2), xiii-xxiii.

Wei, C.-P., Hu, P. J.-H., & Chen, H.-H. (2002). Design and evaluation of a knowledge management system. *IEEE Software*, *19*(3), 56-59.

Wong, K., & Aspinwall, E. (2006). Development of a knowledge management initiative and system: A case study. *Expert Systems with Applications*, *30*(4), 633-641.

Wu, J.-H. (2009). A design methodology for form-based knowledge reuse and representation. *Information & Management*, *46*(7), 365-375.

Yang, X., Hu, D., & Davison, R. M. (2010). How microblogging networks affect project success of open source software development. In *Proceedings of the 2010 International Conference on Information Systems*.

Zaheer, A., McEvily, B., & Perrone, V. (1998). Does trust matter? Exploring the effects of interorganizational and interpersonal trust on performance. *Organization Science*, *9*(2), 141-159.

Appendix

To overview existing KMS design research in the KM research community, we conducted a systematic literature review following the approach of Webster and Watson (2002). Thus, we considered three main research areas: (1) project management and organizational learning, (2) IS, and (3) computer science. After scanning the identified papers, we developed a concept matrix that clusters the different topics. Thus, we clustered the paper by (1) the KM school addressed, (2) the design approach applied, and (3) the reported research outcomes. Table A1 overviews the identified papers that discuss KM artifact design and how each paper relates to the clusters. Although Salisbury and Plass (2001) don't explicitly state to follow the DSR approach, we included the paper in Table A1 because the authors describe a user-centered and agile approach to design the KM artifact.

Table A1. Research Addressing KM Artifact Design

Source	**KM school**		**Design approach**		**Research outcomes**			
Markus et al. (2002)	**Technocratic**	**Socio-technical**	**DSR**	**AR**	**Requirements**	**Design principles**	**Implementation**	**Evaluation**
Stein & Zwass (1995)	X		X		X	X	X	
Akscyn et al. (1988)	X		X		X	X		
Blessing et al. (2001)	X						X	
Kivrak, Arslan, Dikmen, & Birgonul (2008)		X					X	
Wei et al. (2002)		X			X		X	
Sure, Staab, & Studer (2002)	X						X	X
Boland, Tenkasi, & Te'eni (1994)	X						X	
Laha (2011)		X					X	
Wong & Aspinwall (2006)		X	X		X	X	X	
Perott, Schader, Bruder, & Leonhardt (2012)		X					X	
Tiwana & Ramesh (2001)	X				X			
Salisbury & Plass (2001)	X					X		
Chou & Lin (2002)	X		(X)		X		X	X
Tan et al. (2007)	X				X			
Patel & Ghoneim (2011)		X			X	X		
Petter & Vaishnavi (2008)		X		X	X	X		
Butler & Murphy (2007)		X	X		X	X	X	X

About the Authors

Silvia Schacht is post-doctoral researcher at the Chair for Information Systems IV and Institute for Enterprise Systems, University of Mannheim. She received her PhD in Information Systems from the University of Mannheim in 2014. Her PhD focused on project knowledge management and methods to motivate knowledge sharing and reuse within project teams with a methodological emphasis on design science research. She is currently also researching the effects of gamification and persuasive information systems.

Stefan Morana is a PhD candidate at the Chair for Information Systems IV and Institute for Enterprise Systems, University of Mannheim. He holds both a Master and a Bachelor of Science in Computer Science from the University of Applied Sciences, Darmstadt. He also studied at the University of Wisconsin, Platteville, US. His current research interests and thesis focus on supporting users in their compliant execution of business processes by applying a design science research approach.

Alexander Maedche is a Professor and Chair in Information Systems IV at the Business School and Managing Director of the Institute for Enterprise Systems (InES) at the University of Mannheim. He earned his Doctorate from the University of Karlsruhe and then worked for three years as head of a research group that focused on knowledge-based systems. He has six years' industry experience in large-scale information systems in positions such as IT manager of the Bosch Group and vice president of product management at SAP AG. His research focuses on user-centered software development, effective use in information systems, and intelligent process-aware information systems. He has published more than 100 papers in journals and conferences, such as the *IEEE Intelligent Systems*, *AI Magazine*, *Information and Software Technology*, *Proceedings of the International Conference on Information Systems*, and *Proceedings of the Conference on Advanced Information Systems Engineering*.

JITTA is a Publication of the Association for Information Systems
ISSN: 1532-3416