How to Prevent Reinventing the Wheel? – Design Principles for Project Knowledge Management Systems

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Abstract. Today, many companies still struggle in documenting and reusing the knowledge gained by project teams. However, knowledge only creates value if it is applied. There exists a vast amount of research in the field of knowledge management focusing on documentation, storage and exchange of knowledge, but knowledge reuse is often omitted by researchers. The presented work aims to close this gap by developing a project knowledge management system enabling project teams to apply company-internal knowledge. We followed an action design research approach to explore meta-requirements in a case company, translate these requirements into design principles and test the design principles by evaluating an artifact of a project knowledge management system. By our work, the knowledge management research field can benefit since our design theory extends the existing body of knowledge. Furthermore, our research results are instantiated in a concrete artifact which can be directly transferred into practice.

Keywords: Project Knowledge Management System, Knowledge Reuse, Project Management, Action Design Research.

1 Introduction

A growing number of companies are organized in project-based structures [1] to translate their strategic targets into operative actions. Since projects are knowledge-intensive work [2], their management is not easy for several reasons. Most reasons are grounded in the definition of projects as *"… a temporary endeavor undertaken to create a unique product or service"* [3, p. 4]. Project teams are composed of different employees having different knowledge background and sets of skills. Because projects are of temporary nature, teams are set up for limited amount of time [4] resulting in members leaving the project within its duration. When leaving, they take their experiences with them, often without providing their key insights to a central knowledge base [5]. Another challenge of managing projects arises from the goal of creating unique products or services requiring a team having a broad field of expertise to cover the full range of required skills [1]. Consequently, knowledge produced and reused in one project many be valuable for another one. A special kind of projects is the information system (IS) project. IS projects have a high potential to benefit from

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previous project insights because a remarkable amount of IS project activities are similar to each other [6]. However, one reason why companies still struggle to perform IS projects in time and in budget is the lack of knowledge reuse. This results in repeating the same mistake, reinventing the wheel by finding already known solutions or performing redundant work [7].

In recent years many researchers examined the knowledge management (KM) field from different points of view like the supportive nature of modern technologies (e.g. [8-9]) or the role of social interactions (e.g. [5], [7]). Altogether, there exist vast amount of results in KM research. However, the knowledge reuse seems to be often omitted by researchers as valuable process phase of KM [10]. As Choi et al. [11] conclude in their work by stating *"… no matter how much knowledge is shared among team members, it cannot enhance team performance unless it is effectively applied."* [11, p. 866], we strongly belief that knowledge reuse is an important KM process phase being of interest for researchers and practitioners. Therefore, our overall research aims to answer the question on how KM activities in organizations can be structured in order to increase knowledge reuse across projects. Our research focuses on the social and technological subsystem of KM systems [12], since effective KM needs both appropriate technology and social interaction between individuals. While we will report on our research regarding the social subsystem of a project KM system in another article, the research presented in this article focuses on answering the following research question:

Which design principles of a project KM system increase individuals' intention to reuse existing, project-related knowledge?

The remainder of this paper is structured as follows: In subsequent section 2, we describe the methodology of our research and provide an overview on our research phases. Section 3 presents the first stage of our research focusing on the problem definition of knowledge reuse in a case company. In section 4, we present the mockup design of the project KM system grounded on our design principles. Section 5 discusses the evaluation of this design based on the feedback provided by experts of the case company. Section 6 summarizes our findings and discusses the limitations of our work.

2 Methodology

Our research aims to develop an artifact-based solution for increasing the reuse of project knowledge among various projects. Therefore, our work bases on the framework of Sein et al. [13] along the paradigm of design science research (DSR). In their work, the researchers call this form of DSR action design research (ADR) because it draws on action research (AR). The combination of both research approaches is intensively discussed by many researchers (e.g. [13-16]) since both research streams possess some advantages and disadvantages. Today, DSR is generally accepted in the IS discipline as a rigorous method. However, some critics argue that DSR results in an imbalance between rigor and relevance [13]. On the contrary, AR has a long tradition

in psychology and organizational science. AR is defined as *the "… combined generation of theory with changing the social system through the researcher acting on or in the social system"* [17, p. 586]. Unlike DSR, AR is strongly oriented toward collaboration between researchers and practitioners. Hence, AR addresses to solve current practical problems and to expand scientific knowledge simultaneously [18]. However, AR is often criticized for focusing too much on practical relevance on costs of methodological rigor. Often it is maligned as consultation projects [19] or *"… research with little action or action with little research …"* [20, p. 131]. By combing DSR and AR typical risks of both methods will be accommodated. A key advantage of the conjunction is an improved problem understanding and evaluation. In line with this view, the entire work follows the four stage model as presented by Sein et al. [13].

The **first stage** focuses on the identification and definition of the problem in a case company. Subsequently, we capture a set of meta-requirements [21] on a project KM system and deduce appropriate design principles enabling practitioners and researchers to create further artifacts that belong to the same kind of systems [13, 21-22]. The **second stage** bases on the planning and conduction of interventions. These interventions are concrete design decisions inferred from the design principles. The **third stage** aims to evaluate the effects of the interventions. We divide the evaluation stage in two cycles: (1) we evaluate the mockup design of our project KM system based on the feedback of some experts employed in the case company, and (2) we refine the design of the artifact based on the provided feedback, realize it within the case company and evaluate the system by studying users' intention to use it. Finally, the **fourth stage** serves for reflecting the research in terms of practical and theoretical contributions.

3 Stage 1: Problem Definition

The first stage of our research aims to get an overview on the awareness of challenges of project insights' reuse in companies and existing literature. We conducted an exploratory case study in a project-based company. Since IS projects seem to have a high potential to benefit from knowledge reuse [6], we focus on these projects. In the following subsections we describe our research activities within this first stage.

3.1 Case Company Selection

Given the focus on project knowledge reuse and the special characteristics of IS projects, we purposefully selected a financial service provider as the subject of our studies. Today, this sector heavily relies on IS to acquire, process and deliver information to all relevant users. These service-related systems are developed in IS projects [23]. Because of the high number of IS projects conducted in financial service companies, we expect a high demand on knowledge reuse to gain high organizational performance. We conducted our study in an IS service department of a large German financial service provider. To ensure anonymity of our research subject, we name the financial service provider "GeFiS" and its IS service department

"IS@GeFiS". Today, GeFiS operates in over 70 countries and employs more than 100.000 employees. IS@GeFiS is organized in a project-based structure and recently engages about 180 employees regularly supported by external consultants.

3.2 Exploratory Interview Study

To get an overview on the IS@GeFiS' issues with knowledge reuse among IS projects, we conducted an exploratory interview study. As a preparation and to triangulate gathered data, we started by studying some documents regarding project insights of IS@GeFiS. All in all, 31 documents were provided by the company. The documents include guidelines for the collection and documentation of project insights called lessons learned, some exemplarily lessons learned, and role descriptions of various professionals. In the document study we realized that the provided documents show considerable differences in their appearance and content. In our view, this is reasoned by a missing consistency of the lessons learned process and according instructions. Based on the result of our document analysis we defined some working assumptions forming the groundwork of our interview study.

The sampling of the interviewees was coordinated by some employees of IS@GeFiS. In order to prevent a selection bias, we briefed the employees how to deploy a good sample. In sum, 27 interviewees were selected (14 project managers, 8 technical specialists, 2 functional analysts, 2 professional development managers, 1 department head) reflecting the distribution of roles in the entire department. The selection of interviewees can be described to be a purposeful sampling [24]. At the beginning of an interview, we provided some information to the interviewees regarding anonymity, purpose of the research study, and use of gathered data [25]. The interviews lasted between 20 and 50 minutes. All interviews were conducted by two researchers – one conducting the interview and one taking notes. The questions addressed a wide range of KM topics to cover all aspects regarding both, the social and technological subsystem of a project KM system. Depending on the information needed, we extended the guideline with additional questions within the particular interview. The interviews were recorded and afterwards transcribed as text files. The records and transcripts are stored anonymously and cannot be traced back to the participants.

Although we had some working assumptions, we used the inductive coding approach for the data analysis instead of the deductive approach as described by Thomas [26]. While the deductive approach aims to test consistencies with prior assumptions or hypotheses, the inductive approach facilitates us to extract themes that are mentioned by the interviewees frequently, dominantly or significantly. To discover the company's knowledge reuse issues, inductive coding approach seemed to be most adequate. In order to increase internal validity [27-28] two researchers coded the interviews whereas one of the researchers was not involved in any other aspects of the project. After transcribing the interview recordings, we started to read the text files carefully. In the next phase, we identified specific text segments related to the research objective, marked all these segments and labeled them with codes using MaxQDA – a software application especially intended for qualitative data analysis.

As a result from this coding process, we developed 51 categories. If codes were clustered in more than one category, we discussed the findings and agreed on one of the categories. Furthermore, synonyms were resolved. Consequently, we reduced the amount of categories to 20. Finally, we searched for subtopics and established clear connections between subtopics and categories.

Table 1. Meta-requirements of the technological subsystem of project KM systems

Subtopic	*Meta-Requirement*		*Exemplarily Quote*
Access	MR1:	Full accessibility to project insight data base for all organization members	*"I was out of the project. At some time, 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:	Possibility to structure documents by indexing, categorizing and clustering	*"This actually happens quite informally, either you know someone working on a project. Then you talk with him/her having a coffee, lunch, and so on, or sometimes if you want to know something about a specific topic, then you ask: How was your experiences?"*
Structure	MR4:	Full accessibility to project insight data base for all organization members	*"Of course, it has to be structured and tagged so that you can pick key information to a certain topic."*
	MR5:	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 future similar projects."*
	MR6:	Including sufficient free space for additional explanations	*"… but I think every project is different. It should also contain a plenty of space to provide some free texts. Yes, of course, there are some aspects where I can tally: good, moderate, bad. But a lot of specifics of a project […] cannot be pre-structured."*
Feedback and Maintenance	MR7:	Provide feedback on documented project insights	*"… if anyone says to you: 'I read your lessons learned. Thank you for your presentation making the issue transparent for us […].' I think this kind of recognitions is incentive enough – or should be incentive enough."*
	MR8:	Ensured maintenance of project insight documents	*"It is a time exposure to maintain and manage it. I mean, information important in one project can later be invalid or outdated."*

Considering the codes related to the technological subsystem, we identified three main subtopics: (1) *access* to project insights, (2) *structure* of effective project insight documentation, and (3) *feedback* provision on and *maintenance* of documented project insights. Within these three categories, we derived eight meta-requirements (out of 13 meta-requirements for both, the social and technological subsystem). The meta-requirements and some exemplarily quotes are summarized in Table 1.

3.3 Results of the Interview Study

Building on the identified meta-requirements, we derived three design principles covering the technological issues of project KM. In doing so, we consulted literature published in the project KM field to interrelate the meta-requirements with the knowledge base of existing research. The mapping of the meta-requirements to design principles is discussed in the following subsections.

Access to Experts and Expertise

Access to project knowledge can take place via both, information technology and social interaction. From a technological point of view, there exist many applications to file project insights. This may be traditional storage bins such as repositories or databases or modern technologies like wikis or blogs. Both forms of technologies are coming with some advantages and disadvantages. Repositories, for example, possess hierarchical structures forcing users to file the documents in only one location. This in turn forces organizations to provide a strict categorization of documents. Such a categorization makes it difficult for employees to decide where to file, manage, locate and share specific documents like project insights [29]. Furthermore, many researchers (e.g. [4-5], [30]) realized that repositories are used by individuals only sporadically. The situation is exacerbated if documents contain lessons learned. Lessons learned, by definition, are essential experiences of a project team gained during the course of the project. However, such experiences are often characterized as tacit and bound to people involved in the problem-solving process [31]. Since tacit knowledge is difficult to externalize – if not even impossible – not every insight gained in a project can be captured in a repository [32]. Looking at more modern technologies like wikis, we observe some improvements in storing project insights. Wikis ease the knowledge documentation process in terms of authoring, sharing and finding the knowledge due to their included functionalities such as content-to-page-mapping, indexing, hyperlinking, duplicate removing, searching, and using the power of the crowd [33]. The usage of wikis in organizational settings, however, is still low [34]. Although these technologies possess some drawbacks, companies rely on the documentation of knowledge and insights for continuous organizational learning [35]. Hence, the implementation of an adequate central storage medium adapted to the needs of organizations and their employees is a vital necessity (**MR2**). The access of employees to this central storage technology, however, is inevitable (**MR1**).

Project insights may contain information perceived by individuals as very sensitive, especially when they have to fear negative consequences or misleading others [36]. Thus, people prefer to document their findings anonymously resulting in cutting off the documents from the experts. Because nearly all employees of large companies like GeFiS have some project-related experiences, the search for a specific expert will be like looking for the needle in a haystack. The provision of multiple channels for knowledge exchange is important for large-scale companies [37]. Hence, the technological subsystem of an effective project KM system should enable knowledge seekers to search for project insights via two ways: (1) direct search of documented (externalized) knowledge by browsing storage locations, and (2) indirect search of internalized knowledge by contacting experts (**MR3**).

Following our findings collected in the interview study and our literature review, we identified access to both, documented knowledge and knowledge that resides in individuals as a design principle (DP) of project KM systems. Therefore, we reword Markus' call for providing *"… access to the detailed resumes of every employee's experience and area of expertise in addition to documents…"* [38, p. 75] to our first design principle, which is also formulated in this way by Petter and Vaishnavi [9].

DP1: *Ensure access to both experts and expertise.*

Structure of Project Insights

Although project reviews are mostly documented at the end of projects [39], the capturing of insights in documents takes place only seldom [31]. Even if insights are collected and codified, they are often not valuable for others since its documentation often lacks on structure, degree of granularity, or context information [40-41]. One reason for such ill-structured documents is the high complexity of projects itself resulting in individuals' struggle in codification of their project insights [9]. For an efficient project KM, however, organizations have to structure and store the insights in a way that other employees can also use them, even if they were not part of the project team. Here, structuring the insights means that experiences have to be expressed, codified and prepared for an easy sharing [41].

Besides the structuring of insights, it is also important to organize the codified documents in a way that they can be found when needed [41]. Thus, a format supporting hyperlinking, indexing and search mechanisms are needed (**MR4**). In literature, many formats are discussed for project reviews. Often they are called postmortems. They are used to reflect what happened in projects aiming to improve future working practices [40]. These reviews focus on learning from success and failure instead of evaluating the project and its team. In general, there are three main perspectives on capturing and sharing knowledge of projects: reflective, formal, and narrative perspective. While the reflective perspective has mainly a subjective note and the formal perspective is highly objective, the narrative perspective focuses on telling a story to appeal to emotions [42]. Narratives are an easy-to-share and easy-to-remember format containing high amount of knowledge in a semi-structured format [9]. Compared to

traditional postmortems they are easy-to-remember, but require a high effort in codification [40]. Thus, a well balanced mix of pre-structured documents to ease the documentation and retrieve lessons learned (**MR5**), and free-text fields to provide additional information (**MR6**) are needed. Resulting from the literature of existing research and the meta-requirements of our case study, we formulate our second design principle:

DP2: *Provide contextual and packaged information in structured documents.*

Feedback and Maintenance

Providing incentives to employees for knowledge contribution is also an important factor influencing their willingness to share and reuse knowledge [9]. While the provisioning of incentives for motivating employees is part of our social subsystem of a project KM system, we identified feedback as another important part of the technological and social subsystem. There are many studies on intrinsic and extrinsic mechanisms motivating employees to share knowledge (e.g. [43-44]). Nevertheless, most of them realize that *"[…] knowledge self-efficacy is an important antecedent to employee knowledge sharing attitudes and intentions."* [44, p. 145] Thus, providing useful feedback (**MR7**) improves self-efficacy of individuals and increases their willingness to share knowledge. Documenting project insights facilitates managers to provide structured feedback and hence increase the performance of project teams [40]. In addition to feedback which can be provided by managers, feedback of colleagues is also valuable for an increased knowledge reuse [45]. Consequently, providing feedback is also a powerful method to incentivize individuals for sharing their project knowledge with others.

As King et al. [46] realized the currency of knowledge is also a challenge companies need to cope with in order to implement effective KM strategies [46]. One modern possibility to maintain project insights with regard to their currency and usefulness (**MR8**) is the implementation of rating functionalities. While rating is often used as feedback mechanisms for example in social networks (e.g. Facebook, Twitter, etc.) or online markets (e.g. eBay, Amazon), it can also be used in order to assess the project insights. Less rated insights are maybe of less interest for other projects because they are either outdated or not valuable. The usage of rating functionalities in order to assess a product or service is highly discussed in the research area of online markets (see [47]). From the findings of the interviews and the literature study, we thus formulate the following, third design principle:

DP3: *Enable project insight maintenance based on feedback regarding usefulness and currency of project insights.*

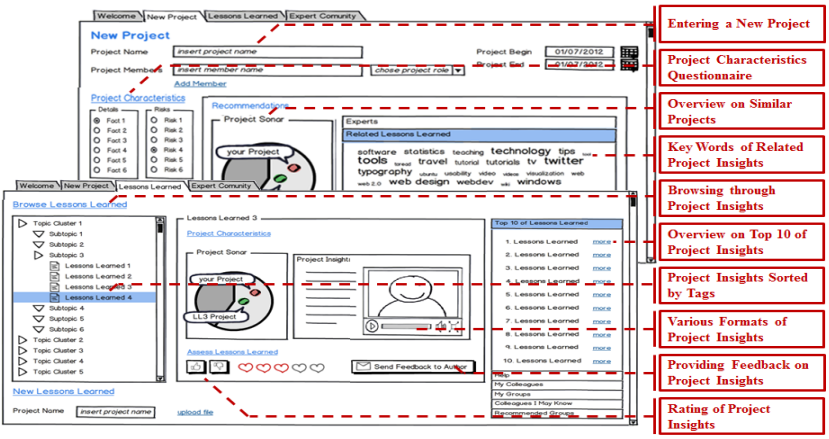

Fig. 1. Mockup design of project KM system

4 Stage 2 – Intervention

Based on the design principles DP1 to DP3, we designed an artifact of a project KM system. We translated our design principles into concrete design decisions again by consulting existing literature. Figure 1 presents two exemplarily mockups that include those functionalities that we perceive as adequate design decisions. Since most design decisions result from our discussed meta-requirements, we summarized the functionalities of the project KM system in Table 2.

Table 2. Design decisions 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 (CoP). By implementing communities, companies promote informal knowledge exchange which facilitates knowledge reuse. Examples of technological implementations can be social networks, forums or chat rooms.	[4], [36]
• **Search functionality:** Today, many platforms come with semantic search functionality. This enables users, to find unstructured information captured in various documents or other formats of knowledge documentation.	[49]
• **Hyperlinking and tagging:** Hyperlinking and tagging are mechanisms that ease the documentation, search and retrieval of knowledge. Each time a document is stored at the platform, individuals provide some key words or links to related documents. This enables the development of an information network which eases to explore project insights.	[32-33]
• **Access control:** By implementing user authentication and authorization mechanisms, users of 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 users of the project KM system or private only for the use of the project team members.	[50]

Table 2. (*continued*)

DP2: Provide contextual and packaged information in structured documents.	
• **Project characteristic questionnaire:** A questionnaire on project characteristics is a structured way to enable the provisioning project's contextual information. Such a 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 at a central database, a KMS can be enriched by a project overview. This overview 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 that project insights that relate to another project ease the search and retrieval of knowledge. Here, the rating mechanism can be used in order to display those project insights that were perceived as most useful for other users.	Interview study
• **Variety of formats:** Various projects possess varying complexity. Thus a fully standardization of project insight documentations is not feasible. The more complex a project, the more individuals should be able to include additional information, for example, by providing additional formats of documentation (e.g. photos, videos, etc.).	[9], [42]
DP3: Enable project insight maintenance based on feedback regarding usefulness and currency of project insights.	
• **Rating:** Rating products or services is intensively used in electronic markets. Rating mechanisms summarize the opinion of users and provide for potential users a brief overview on the product or service. By implementing the rating functionality in the project KM system, knowledge seekers get a quick overview on the usefulness and applicability of documented project insights	[47]
• **Feedback provisioning:** If individuals receive constructive feedback on their work, they are more willing to share their knowledge. By implementing mechanisms enabling project teams to assess the received expertise or the experts who provided the knowledge, continuous learning due to regular up-dates of existing, organizational knowledge can be facilitated.	[9], [40], [45]
• **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 not used anymore because they are and not useful anymore.	[46], [47]

In order to bundle the functionalities in one system, we decided to develop the project KM system as an integrated platform. We perceive the platform design as appropriate, since platforms are defined as 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."* [48, p. 676] The ease of extensibility is the key advantage of platforms resulting in the possibility of continuously improving the system by adding or removing modules.

5 Stage 3 – Evaluation

The resulting mockup design is evaluated via a workshop series within the case company. The **first workshop** aimed to get feedback from key decision makers of IS@GeFiS. Thus, we invited the department's head, one Professional Development Manager and one Project Manager as participants to the workshop. The entire session lasted 60 minutes and consisted of three parts: First, we presented the key findings of our interview study and literature review. We engaged the attention of department's management on typically challenges of knowledge reuse within IS@GeFiS. In the second part, we presented the meta-requirements, the resulting design principles and the mockup design of the project KM system we perceive as being effective in IS@GeFiS. After presenting the results and the mockup design, we opened a discussion round as the final part. Each participant was asked to provide feedback on the design. In order to motivate the participants to discuss the design very open, we decided to refrain from recording the session. Instead, the researchers took notes and collected these notes in a research field work journal. The key result of this first session can be summarized by one statement of the department's head: *"The design seems to be a good one. However, I think it makes more sense to evaluate the design by asking those people who will be supposed to use the system."*

In consequence of the workshop's key finding, we conducted a **second workshop** session aiming to get feedback from key players in IS@GeFiS' projects. In sum, we invited 10 participants possessing various roles within the department. However, only five participants were able to attend the workshop session. The workshop lasted 90 minutes. This workshop consisted of two parts: First, the presentation of the mockup design by one researcher. Second, we have obtained the participants' feedback on the design of the mockups. In order to get a structured feedback, we asked the participants to assess the design along the dimensions strengths, weaknesses, opportunities and threats (called SWOT-analysis). Finally, the participants were asked to brainstorm on key functionalities and their effect on an active knowledge reuse culture within the department. In order to motivate an open discussion, we decided once again to refrain from recording the statements. However, we took a photo protocol and summarized the key findings in our research field work journal. The key findings of the second workshop are displayed in Figure 3.

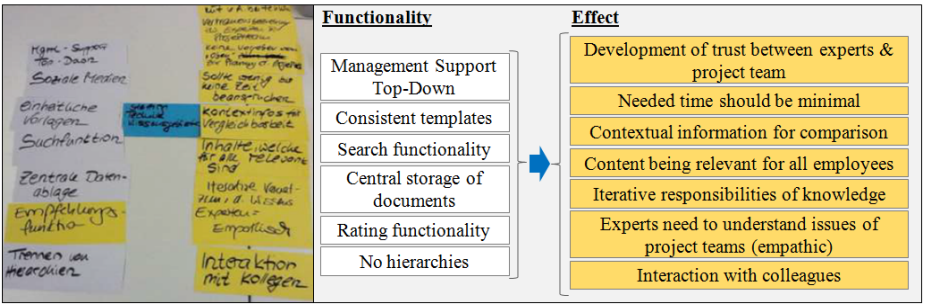

Fig. 2. Photo and translated results of workshop session 2

The left side of Figure 2 displays the photo documentation of the brainstorming session. Since the workshop is done in German, we present at the right side of Figure 3 a translation of the key results. At the end of the workshop, we collected five key points as feedback. The feedback of all workshop sessions and an overview on the sessions is provided in Table 3.

Since the participants of the second workshop were mainly project managers, we decided to conduct a **third workshop** session with project team members. Therefore, we invited eight project team members possessing different roles within a project. In coordination with some employees of IS@GeFiS we purposefully selected the participants of this third workshop. We selected employees as participants who were known for their attitude towards project in-sights. Thus, the group of participants consisted of some employees being skeptics of project insights collection methods and some having a positive attitude towards knowledge reuse. The third session lasted 60 minutes. After the presentation of the mockup design, the participants were asked to provide their feedback in an open feedback round. After a brief discussion, all participants agreed to implement at least the key functionalities of the mockup design in order to decide whether it is useful or not. Since the organization is already using a platform similar to Microsoft's SharePoint, the implementation of the functionalities seemed to be feasible with low effort.

Table 3. Evaluation of mockup design in three workshops

Workshop 1: Open Feedback	
Participants:	1 Head of IS@GeFiS, 1 Professional Development Manager, 1 Project Manager
Key Results:	• For better feedback ask those persons who are supposed to use the system
Workshop 2: **SWOT-Analysis**	
Participants:	1 Professional Development Manager, 1 Project Manager
Key Results:	• Documentation of the project insights requires a methodological toolbox as support • Templates would help to create consistent project insights • Project characteristics questionnaire needs some examples to support employees • Project comparison using the project characteristics questionnaire is still difficult • System needs some free text fields in order to include insights that are specialties
Workshop 3: **Open Feedback**	
Participants:	1 Professional Development Manager, 3 Project Manager, 4 Project Team Members
Key Results:	• Mockup design needs to be implemented in order to decide whether it will be used • Use of a platform that is already implemented and deployed within the company • Platform includes already functionalities like social networking, rating, document management, etc.

Based on the results of all three workshops, we are actually realizing the design within the case company. Figure 3 presents two exemplarily screenshots of the implementation.

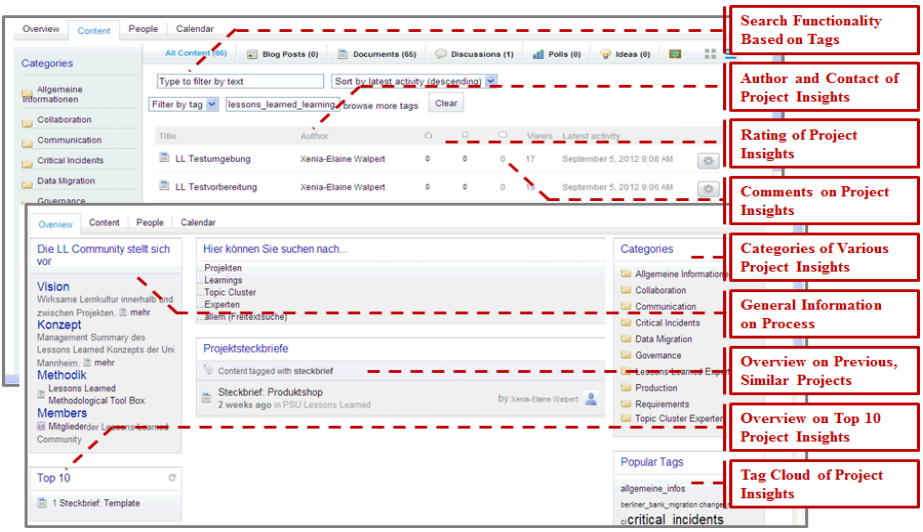

Fig. 3. Screenshots of implemented project KM system

6 Conclusion

The research presented in this paper presents our work on developing a project KM system. We provide a comprehensive overview on the entire process of our work beginning with the definition of problems related to knowledge reuse in a case company until the development of a project KM artifact within the company and its evaluation. The evaluation of our mockup design gave us first indication that the instantiation of a project KM system may increase knowledge reuse within and among projects. In particular, our work highlights the importance of providing individuals' access to both, experts and expertise. Many studies (e.g. [4-5], [9]) demonstrate that individuals prefer bilateral communications instead of writing down their project experiences in documents. Direct communication possesses advantages like the possibility of providing contextual information, foundation of trust between knowledge provider and knowledge seeker, or fast response to questions. In order to increase organizational learning, however, companies rely on the externalization of such experiences. While the project KM system presented in this article also provides some mechanisms for direct communication with experts (e.g. social networking sites, forums, chats), the design principles and decisions mainly focus on the externalization of knowledge, its storage, retrieval and reuse. Within our research we realized the importance of considering all phases of the KM process in order to encourage the reuse of existing project knowledge. The design principles as well as the derived design decisions therefore address all these phases: First, templates and the project characteristics questionnaire aim to ease and partially standardize the knowledge documentation phase. Second, implementing the project KM system as an integrated platform containing document management functionalities ensures the central storage of project insights. Third, functionalities like tagging, hyperlinking, search, and over-

view on projects and its characteristics enable employees to find project insights being most appropriate for their current issue. Fourth, knowledge reuse is fostered by the implementation of feedback and rating mechanisms, which enables the maintenance of documented project insights.

We are aware that our research has some limitations. First, our research bases on the results of studies within one company. Such single case studies are exposed by limited generalizability. Since the aim of our research is to develop (instead of testing) a design theory, we cope with the limited generalizability by conducting an in-depth analysis of issues with project knowledge reuse by performing a significant number of interviews with employees of varying roles. Second, the evaluation conducted to validate the design principles actually only bases on feedback provided by some experts of the case company. Therefore, we implement the project KM system within the case company and plan to conduct longitudinal user study. For this purpose, we decided to perform a quantitative user study based on unified theory of acceptance and use of technology (UTAUT) as described by Venkatesh et al. [51]. Third, our research described in this article focuses only on the technological subsystem of a project KM system. In order to achieve an active knowledge reuse in companies, the implementation of design principles regarding the social subsystem is also necessary. Thus, more research on the development of a process model as well as the definition of various roles in the knowledge reuse process is also needed.

Although, our research has some limitations, we perceive the presented work as valuable for both, researchers and practitioners. Since our design principles extend the existing body of knowledge on project knowledge reuse, researchers may build their work on our findings. Additional work is needed, for example, in testing the design theory by translating the design principles in other design decisions or in different contextual backgrounds. Furthermore, practitioners may benefit from our research, since we provide a set of activities that will increase the reuse of project knowledge and thus, may increase the performance of projects within companies.

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