The role of information technology in bridging the knowing-doing gap: an exploratory case study on knowledge application

Thilo Haamann and Dirk Basten

Thilo Haamann and Dirk Basten are both based at the Department of Information Systems and Systems Development, University of Cologne, Cologne, Germany.

Abstract

Purpose – *Organisations that systematically manage their knowledge based on processes of creating, storing, transferring and applying knowledge are likely to achieve both performance improvements and competitive advantages. However, companies often succeed in the first three processes only, while neglecting knowledge application. The phenomenon of employees not relying on existing knowledge when solving specific problems is referred to as knowing-doing gap. While the existence of this gap is well acknowledged, the purpose of this study is to advance the understanding how respective barriers of knowledge application can be overcome, in particular concerning the role of information technology (IT).*

Design/methodology/approach – *This study applies a case study design, thereby relying on various data sources, such as interviews, documents, field notes, observations and demonstrations. The analysis follows established guidelines for thematic analysis.*

Findings – *An understanding of knowledge application as a three-step process is derived. The set of knowledge application barriers, identified practices to overcome the barriers and yielded themes that explain the role of IT in bridging the knowing-doing gap are complemented.*

Research limitations/implications – *The role of IT in bridging the knowing-doing gap and contributing to the general understanding of the knowing-doing gap by also considering practices concerning the people and process dimensions is illuminated. While IT plays a central role in applying knowledge, successfully overcoming the knowing-doing gap requires organisational practices at the people and processes dimensions that are aligned with the IT. The set of barriers of knowledge application at the individual, group and organisational levels is complemented.*

Practical implications – *The practices to bridge the knowing-doing gap at the intersection of the people, processes and technology dimensions are identified. Specifically, the role of IT in overcoming barriers to knowledge application is explored.*

Originality/value – *This thematic analysis yields a theoretical explanation for knowledge application as a three-step process and suggests practices to bridge the knowing-doing gap for each step. Furthermore, four major themes that explain the role of IT for this process in depth are derived.*

Keywords *Knowledge management, Qualitative research, Practices, Knowledge application*

Paper type *Research paper*

1. Introduction

Knowledge management (KM) is the planning, organisation, motivation and control of *people*, *processes* and *technology* that organisations use for effective asset utilisation (King, 2009). One common definition in information systems research describes KM as a systematic process of acquiring, organising and communicating tacit (i.e. personalised, typically related to and derived from experience) and explicit (i.e. articulated, codified, and communicated) knowledge so that other people can use this knowledge to work more

Received 19 January 2018
Revised 15 April 2018
3 June 2018
5 August 2018
Accepted 13 August 2018

efficiently (Alavi and Leidner, 1999). KM thus consists of at least four sub-processes, namely, the creation (i.e. development of new or enhancement of existing knowledge), storage (i.e. the process of converting knowledge into an explicit form), transfer (i.e. exchange of knowledge between organisational units) and application of knowledge. These processes must not be considered independent steps but an “interconnected and intertwined set of activities” (Alavi and Leidner, 2001, p. 116).

Considering the growing intensity of knowledge in today’s competitive environments (Anand *et al*., 2007), companies[1] intensify their KM efforts due to its critical role in organisational performance (Setia and Patel, 2013) – particularly when conducting cross-functional projects (Newell and Edelman, 2008). The respective knowledge-based view recognises knowledge as the key resource underlying value creation and guiding decision-making in organisations (Grant, 1996; Spender, 1996). According to this view, “knowledge is fundamental to both improving efficiency and innovating, the two basic processes that enable organisations to compete” (Newell, 2015, p. 2). The success of an organisation thus relies on its ability to provide value for customers by leveraging knowledge of its employees (Kang *et al*., 2007).

As research implies that accumulating knowledge is beneficial (Reus *et al*., 2009), organisations substantially introduce organisational KM initiatives. However, the implementation of KM remains a significant organisational challenge (Lane *et al*., 2006; Roberts *et al*., 2012; Tohidinia and Mosakhani, 2010; Zahra and George, 2002) because KM outcomes are seldom predictable (Haas and Hansen, 2007; Setia and Patel, 2013) and KM initiatives frequently fail to realise the expected return on investment (Zyngier and Burstein, 2012). Many KM initiatives are challenged by drawbacks related to the continuous realisation of benefits (Chua and Lam, 2005; Kulkarni *et al*., 2006) because of a prevailing lack of understanding of how to manage knowledge (McIver *et al*., 2013).

Despite this shortcoming in the understanding how companies should manage knowledge, companies heavily invest in technologies to support their KM initiatives (Butler and Murphy, 2007; Davison *et al*., 2013; Setia and Patel, 2013; Young *et al*., 2012). While critical voices have been raised concerning information technology’s (IT) enabling role for KM (Hislop, 2002; McDermott, 1999), others emphasise IT’s importance to KM success (Argote *et al*., 2003; Gray and Durcikova, 2005/2006; Newell and Galliers, 2006). One reason for this differentiated picture can be found in organisation’s focus on investing in IT to support the processes of creating, storing and transferring knowledge (Basten *et al*., 2015; Huber, 2001; Lin and Huang, 2008; Young *et al*., 2012). Considerably less attention has been paid to the application[2] of knowledge (Davenport and Völpel, 2001), which involves the elicitation and application of existing knowledge with regard to an unsolved problem (Alavi and Tiwana, 2002; Červenka, 2012; Holzner and Marx, 1979). Considering KM from the perspective of knowledge contributors and knowledge seekers (Bock *et al*., 2006; Watson and Hewett, 2006), knowledge application is a knowledge seeker’s final step of the attempt to solve problems and competitive advantages are only achieved if knowledge seekers actually apply the discovered knowledge (Bierly *et al*., 2009; Choi *et al*., 2010; Grant, 1996). Performance predominantly depends on how well knowledge can be converted into concrete actions, not on the existence of the knowledge itself (Alavi and Leidner, 2001; Penrose, 2009). As a result, knowledge application can be considered as the most crucial KM process[3]. The phenomenon of not applying prevalent knowledge (i.e. the lack of doing) is referred to as knowing-doing gap (Pfeffer and Sutton, 2000). With organisations failing to apply knowledge, investments in KM and related IT are likely to be misguided.

Our objective in this study thus is to explain how IT helps individuals in overcoming barriers of knowledge application and how IT needs to be aligned with the organisations’ people and processes. In our context, a barrier refers to an actuality which hinders a knowledge seeker to apply existing knowledge in his/her problem-solving activity and thus increases the knowing-doing gap.

The remainder of this paper is structured as follows. At the beginning, we provide an overview of previous research on knowledge application in organisations and the knowing-doing gap. We then describe our research approach by characterising its context and explaining our research design in terms of data collection and data analysis. Subsequently, we present our results in three parts. First, we provide insights into the three steps in the process of knowledge application. Second, we describe instances of the knowing-doing gap, that is, how barriers affect individuals in the process of knowledge application. Third, we explain how practices concerning the people, process and technology dimensions help mitigate the barriers of the knowing-doing gap (henceforth referred to as practices; see Alavi and Leidner, 2001). Finally, we illuminate the role of IT regarding the knowing-doing gap in particular. We discuss our study's findings by offering implications for researchers and practitioners, and delineating threats to validity. Our paper ends with a short conclusion.

2. Knowing-doing gap

The knowing-doing gap (also referred to as applicability gap; cf. Mitchell, 1993) is defined as the challenge of converting existing knowledge into concrete actions (Pfeffer and Sutton, 2000). Accordingly, people tend to invest more time in creating new knowledge than in thinking about ways to use existing knowledge in their daily work (Blanchard *et al.*, 2007). A potential explanation for the existence of the knowing-doing gap is individuals' specific personalities and experiences (Pfeffer and Sutton, 2000). However, some companies such as consultancies can convert existing knowledge into action despite constant staff turnover. Differences between companies are perceived to result from established (knowledge) management practices, not from having employees with different knowledge. Although no simple practices to avoid the knowing-doing gap have been developed, research has shown that knowledge acquired by learning-by-doing is more readily applied than knowledge acquired by reading, listening and thinking (Pfeffer and Sutton, 2000). For a deeper understanding of the phenomenon of the knowing-doing gap and reasons for performance differences among companies, a first step is gaining insights into origins of the knowing-doing gap by analysing extant research. Here, a synthesis of barriers that lead to the emergence and reinforcement of the knowing-doing gap (Davenport and Prusak, 2000; Pfeffer and Sutton, 2000) is fundamental. Such barriers include both problems concerning knowledge application and reasons for employees' failure to apply existing organisational knowledge (Appendix 1).

Barriers of knowledge application affect individuals in their process of knowledge application origin from causes that can be found in the individual, group and organisational level. One issue can be found in the organisational culture (e.g. lack of trust on individual level, insufficient mutual understanding on group level and culture of fear on organisational level). Furthermore, it becomes evident that lack of resources on individual level contributes to the knowing-doing gap (i.e. information overload, lack of follow-up and lack of time or opportunity). Finally, organisational matters such as use of old methods, inappropriate evaluation systems and inflexibility of organisational ties show the complexity of barriers of knowledge application.

Alavi and Leidner (2001) emphasise the criticality of knowledge application for enhanced organisational performance and shift researchers' attention to explain how to encourage knowledge application and to identify organisational practices that can bridge barriers of knowledge application. While selected contributions address problems pertaining to knowledge application by identifying barriers that establish the knowing-doing gap (Alavi and Tiwana, 2002; Blanchard *et al.*, 2007; Davenport and Prusak, 2000; Pfeffer and Sutton, 2000; Richards and Busch, 2013; Stenmark and Lindgren, 2006), few works actually focus on how to overcome the knowing-doing gap. Despite longstanding awareness of the phenomenon, research lacks an in-depth understanding of how to mitigate barriers of knowledge application that lead to the knowing-doing gap (Alavi and Leidner, 2001; Noonan, 2012). Most publications incidentally describe this phenomenon to draw attention to the challenge of knowledge transfer between academics and practitioners (Rynes *et al.*, 2001), to describe the gap between theory and practice (Delisle and Olson, 2004), to emphasise the importance of learning by doing (Lee and Lim, 2015), to promote the knowledge-based view of firms (Lengnick-Hall and Griffith, 2011) or to expose the negative impact of the knowing-doing gap (Doherty *et al.*, 2012). In addition, these works are limited to educational contexts (Sparks, 2009) or abstract strategies rather than concrete practices (Joyner, 2015). However, such practices are highly relevant to the question of why knowledge seekers do not apply the knowledge that they have gained in the knowledge seeking process.

Considering both the high investments (Setia and Patel, 2013) and the inconsistent role (cf. Argote *et al.*, 2003; Gray and Durcikova, 2005/2006; Hislop, 2002; McDermott, 1999; Newell and Galliers, 2006) that researchers attribute to IT in the KM context, it is apparent that research on the role of IT in bridging barriers to knowledge applications is scarce. We find research on the knowing-doing gap in IT contexts (Richards and Busch, 2013), empirical support for the positive influence of IT on knowledge application (Choi *et al.*, 2010) and recommendations for IT that help organisations to know what they know (Stenmark and Lindgren, 2006). However, there is lack of insights into how IT helps to overcome barriers to knowledge application. In research, an agreement exists that deeper insights are required – in particular concerning the role of IT for bridging the knowing-doing gap (Alavi and Leidner, 2001; Blanchard *et al.*, 2007; Choi *et al.*, 2010; Richards and Busch, 2013; Stenmark and Lindgren, 2006). While using IT for managing knowledge in general and applying knowledge in particular, the differentiation between explicit and tacit knowledge needs to be considered (Basten *et al.*, 2017). Explicit knowledge can be articulated, codified and communicated and is seen as information (Alavi and Leidner, 2001; Oğuz and Şengün, 2011). However, it should not be presumed that all knowledge is explicit (Rugg *et al.*, 2002); rather most knowledge is tacit (Polanyi, 1966), that is, this type of knowledge is personalised and typically related to and derived from experience. It is deeply rooted in action, commitment and involvement and thus difficult to formalise or communicate. In line with the distinction between explicit and tacit knowledge, two types of IT for managing knowledge can be distinguished: machine-oriented and human-oriented (Alavi and Leidner, 2001; Hansen *et al.*, 1999). While the former has a technical focus and is suitable for codifying knowledge (i.e. explicit knowledge), the latter enables and fosters collaboration, thereby supporting the personalisation strategy (i.e. tacit knowledge).

3. Research approach

3.1 Research design

By following methodological guidelines (Dubé and Paré, 2003; Eisenhardt, 1989; Yin, 2002), this paper is based on exploratory case study research. Table I summarises the definitions of our key constructs. While we used the former three definitions to establish a common understanding during data collection (i.e. the company visits in general and the interviews in particular), the latter three were used during data analysis both to differentiate between the different types of practices (i.e. the dimensions of people, processes, and technology) and to identify interrelations between these dimensions regarding the process of knowledge application.

Our study adopts a multiple-case design that enables a comprehensive examination of the knowledge application process and generalisation of the results. Individuals working in a software development context and seeking to solve problems are the cases in this research, while our embedded units of analysis (Yin, 2002) are the knowing-doing gap that employees face in knowledge-application situations. For sampling the employees, we chose small- and medium-sized companies[4] focusing in the software development

Table I Definitions of key constructs

Key construct	*Definition*	*Reference*
Knowledge management	Planning, organisation, motivation and control of people, processes and technology that organisations put in place for the effective knowledge utilisation	King (2009)
Knowledge application	Elicitation and utilisation of existing knowledge regarding an unsolved problem	Alavi and Tiwana (2002); Červenka (2012); Holzner and Marx (1979)
Knowing-doing gap	Phenomenon of employees not converting existing knowledge into concrete actions when facing unsolved problems	Alavi and Leidner (2001), Pfeffer and Sutton (2000)
People	Employees engaged in KM	–
Processes	"series of actions or steps taken to achieve a particular end" (Oxford Dictionary) related to KM	–
Information technology	"Technologies for information processing, including software, hardware, communications technologies and related services"	Gartner (2016)

industry. The software development industry is considered as "knowledge-based" (Davenport and Prusak, 2000, p. 14) and software development is viewed as a highly volatile, knowledge-intensive process (Desouza *et al.*, 2006; Rus and Lindvall, 2002). Because small- and medium-sized businesses are likely to use less structured KM processes, probability of identifying the knowing-doing gap is greater in that context. The definition of the European Commission indicates that small- and medium-sized companies have 10-249 employees and an annual turnover in the range of EUR 2 to 50m (European Union, 2014). In three instances, we selected development departments within larger companies. Here, we ensured that the number of employees of these departments is consistent with the above definition. However, because a complete allocation of turnover in these contexts is very difficult, we omitted the criterion of annual turnover. Although we acknowledge that development departments within larger companies might threaten validity, the three departments considered in our study serve as independent service providers for either their organisation itself or external organisations and therefore their operations are comparable to those of SMEs.

We considered employees from five software developing companies and performed several on-site visits. To ease the understanding of the context in which the individuals work, Table II provides key figures for each company and we describe the companies, their domains and their KM processes below. Each company uses a different set of KM systems, which are listed in Appendix 2.

Company A is part of a larger international enterprise group known for standard computer-aided engineering solutions supporting the planning and management of switch boxes in plant manufacturing. We had the opportunity to investigate the R&D department, which is part of the composite company that is fully responsible for the development of the software product. The development of solutions is primarily guided by the traditional V-model but has experienced a change triggered by the introduction of agile methodologies approximately five years ago. In terms of existing KM processes, Company A hosts a biweekly developer meeting that typically consists of one or more lectures on current development topics along

Table II Characteristics of companies

Characteristic	*Company A*	*Company B*	*Company C*	*Company D*	*Company E*
# Employees	60	30	35	200	240
Turnover (in million EUR)	2,200 (company composite)	> 1	> 15	140 (overall company)	340 (overall company)
Team size	10-12	<5	4-6	10-15	5-30
Levels of hierarchy	5	2-3	3	4	3

reports on training programs and conferences. Because some projects are carried out following the Scrum methodology project, meetings are held regularly (Daily Scrum, Sprint Planning, Sprint Review, etc.).

Acting as an independent IT service provider in the fields of software development and IT consulting, Company B is primarily involved in the professional development of cross-industry application software. Their products rely on technologies such as Java, PHP and Microsoft C# tailored to client needs. Based on client preferences, their projects are conducted using Scrum, following either the waterfall approach or hybrid modes. Originating from in-house training, voluntary lectures are conducted bimonthly. These events are open to external audiences and are intended to introduce development technologies or methods. In addition, daily project meetings are held. New employees are eased into their respective roles by being given welcome packages that include information about the company.

As part of a larger enterprise group but acting as an independent subsidiary, Company C is an IT company specialising in the insurance industry, providing consultancy services and standard software solutions. Relying on both Scrum and test-driven development, it primarily develops solutions for inventory management, product systems and sales and service systems. So-called TechTalks, which holds technology-related lectures, are held once a month. New employees are provided with a mentor for their first year. Because of the adoption of agile development methods, daily project meetings are also convened. In addition, the company meets once a year for a summer festival with lectures on current topics, including corporate strategy and workshops for project retrospectives.

Company D is positioned as the independent IT service provider for a German insurance corporation. The observed department is mainly responsible for developing application management and individual software solutions for inventory carrying systems, partner systems and collections and disbursement. Because of the company's long history, most projects involve traditional approaches (such as waterfall), which are suitable for insurance companies' working style. The organisation is heavily reliant on communities of practice, which are regularly initiated by the department's management.

As an independent subsidiary, Company E is the full-service IT provider for one of Germany's largest insurance groups. Its core business includes the development of individual software and the management of stable and cost-effective systems to provide sustainable applications. Many current projects are related to a central platform for the insurance group's sales force. This company's development projects typically follow a sequential approach that is best characterised as the waterfall approach. Software development is supported by tools for requirements management, project management and issue tracking. Company E is similar to Company D in terms of communities of practice. While in Company D, such groups of expertise are prompted by management, employees at Company E voluntarily meet at irregular intervals. Topics include relevant programming languages such as Java. In some cases, executives establish groups to discuss selected topics, questions, and problems. Employees also hold TechTalks on issues related to their personal expertise, and training is one aspect of their pre-defined career paths.

3.2 Data collection

The data pertinent to this investigation were collected in the period from the beginning of August to the end of November 2014, are purely qualitative in nature and are sourced from interviews, field notes, documents, participation and demonstrations (Table III). Both authors were engaged in data collection. The first author collected data at Companies A, B, C and D and the second author collected data at Company E. This allocation primarily results from the time availability and geographical closeness of the authors at the time of data collection.

Table III	Number of on-site visits/interviews and data collection methods applied					
	# Visits	*# Interviews*	*Field notes*	*Documents*	*Participation*	*Demonstrations*
Purpose	Personal contact to employees to reduce inter-personal distance	Transcripts as the main source of insights into employees' approaches to solving problems	Minutes of observations and conversations to preserve additional insights gained during visits	Source for triangulation of data from interviews and field notes	Insights into actually lived knowledge exchange practices	Insights into the actual use of KM systems
Company						
A	1	3	Yes	No	No	Yes
B	2	2	Yes	Yes	Yes	No
C	2	4	Yes	No	No	No
D	5	6	Yes	Yes	No	Yes
E	2	5	Yes	Yes	No	Yes

We took extensive field notes during all company visits[5], which typically took all day. These notes result from observations, conversations outside of the formal interviews, and statements made by interviewees before or after the interview recordings. Using a major strength of case study research, we combined the various data sources. Although our findings are predominantly informed by the insights from the semi-structured interviews and our field notes, we used documents and the insights from both our observations and the presentations to triangulate among the different data sources. As our case study database, we used MAXQDA 12 (www.maxqda.com).

Owing to the focus on employees and the knowing-doing gap, semi-structured interviews with 20 employees from different hierarchical levels served as our primary data source. Because of the semi-structured character of the interviews, we were able to respond to the participants' explicit and implicit assumptions (Flick, 2006). In both preparing and conducting the interviews, we followed the guidelines for qualitative interviews proposed by Myers and Newman (2007). We had limited influence over the interviewee selection because it was predominantly the contact persons who made that decision. Although researcher bias could thus be prevented, each company was informed about the roles that would be most appropriate for our purpose. The final interviewee selection took place with mutual agreement. We were able to interview employees with different work responsibilities such as developers, architects, and executives. In conducting the interviews, we paid attention to the different roles' perspectives. Table IV provides an overview of the interviewees' characteristics, such as education and currently held role, duration of employment by the company, time in current role and years of experience in software development. Prior to our first company visit, we developed an interview guideline that followed common recommendations (Flick, 2006; King and Horrocks, 2010). In addition, we conducted two test interviews both to identify any problems with the content of the questions and to test the sequence of the interview process. The pilot interviews led to a few adjustments of the interview structure. Although some questions varied depending on whether we interviewed executives or developers, the general interview guide was structured in five main parts (Appendix 3).

With the respondents' permission, we audio-recorded the interviews. Only one respondent expressed concerns about recording (D3), and in this case, the interviewer took written notes of the central portions of the interview. The recorded portions of the interview sessions lasted between 39 and 91 min (61 min on average), and the interviews overall lasted between 48 and 100 min. The variance in the duration of the interviews results from the diverging numbers of barriers or practices mentioned by the interviewees during their interviews. We transcribed the recorded interviews (23 transcript pages on average) to

Table IV Interviewee characteristics (to ensure anonymity, we omitted gender information)

Interviewee	*Education*	*Domain*	*Role*	*Time at company (years)*	*Experience in role (years)*	*Development experience (years)*
A1	Engineering graduate	Mechanical engineering	Development Lead	20	12	12
A2	Diploma	Mathematics, computer science	Department Head	22	13	30
A3	Engineering graduate	Electrical engineering	Developer	16	16	21
B1	Diploma	Information systems	Developer, Project Manager	4	2-3	12
B2	Diploma	Information systems	Chief Executive Officer, Co-founder	15	15	16
C1	Diploma	Information systems	Managing Partner, Co-founder	20	2	30
C2	Diploma	Computer science	Developer	2	2	10
C3	Master	Information systems	Developer	1.5	1.5	1.5
C4	Diploma	Computer science	Developer	8	8	13
D1	State examination	Financial computer science	Head of Organisational Development	22	2	6
D2	Bachelor	Scientific programming	Developer	9	9	13
D3	Apprenticeship	Mathematics and technical assistant	Developer	24	8	24
D4	Diploma	Geography	Developer	17	13	17
D5	Apprenticeship	Mathematics and technical assistant	Product Manager	20	20	33
D6	Diploma	Business administration	Head of Application Development	20	2	5
E1	State examination	Teacher	Group Leadership Sales Force Platform	27	15	27
E2	Diploma	Computer science	Software Deployment	17	2	24
E3	Diploma	Electrical engineering	Configuration and Quality Management	14	5	19
E4	Diploma	Computer science	Collaboration Expert	13	2	13
E5	PhD	Computer science	IT Architect	3	2	13

facilitate data analysis. In case of interview D3, the handwritten notes were converted into digital form because the participant had not agreed to audio recording. In addition, we transcribed our field notes and incorporated them as a separate document.

After each interview, we reflected on problems that were encountered during the interviews and added a few questions to the manual. Although this procedure reduces the comparability of the interviews, this flexible design allowed us to consider newly emerged topics in later interviews.

3.3 Data analysis

In accordance with Miles and Huberman (1994), our data collection and data analysis overlapped. Thus, we continuously improved our data collection by iteratively reflecting on the previously collected data.

First, considering knowledge application as a knowledge seeker's final step in the attempt to solve problems (Bierly *et al.*, 2009; Choi *et al.*, 2010; Grant, 1996), we sought to gain an understanding of the respondents' general approach to problem solving (see fourth part of our interview guide in Appendix 3). We analysed the individuals' different explanation of their personal approach to solve problems by identifying the procedural steps taken in this endeavour. In generalising from the identified processes, we derived a knowledge application process that consists of three steps.

Second, we conducted a thematic analysis (Braun and Clarke, 2006; Fereday and Muir-Cochrane, 2006). Thematic analysis is a qualitative research method that is used to identify, analyse and report patterns within data. Because it is based on carefully reading and re-reading data (Rice and Ezzy, 1999), it can be described as the "search for themes that emerge as being important" (Fereday and Muir-Cochrane, 2006, p. 82). Therefore, thematic analysis is suitable for the exploratory nature of our case study. One of the method's benefits is its flexibility, which results from its applicability across a range of theoretical and epistemological approaches (Braun and Clarke, 2006). In applying thematic analysis to our data, we followed the six-step approach suggested by Braun and Clarke (2006):

1. familiarising ourselves with the data;
2. generating initial codes;
3. searching for themes;
4. reviewing themes;
5. defining and naming themes; and
6. producing the report (see Table V for an overview of the steps taken in our analysis).

1. For familiarising ourselves with the raw data, we repeatedly read the interview transcripts, documents and field notes. For better understanding, the authors also shared the impressions that they gathered during the on-site observations and demonstrations. Thus,

Table V Steps of thematic analysis

No.	*Step*	*Description*
1	Familiarising with the data	Readings of interview transcripts, documents and field notes
2	Generating initial codes	Data-driven coding in a team of two researchers
3	Searching for themes	Inductive identification of patterns in the coded data regarding IT's role for companies in overcoming knowledge application barriers
4	Reviewing themes	Checks and adaptions of themes to improve the fit to codes and the entire data set
5	Defining and naming themes	Identifying core idea and in turn the label for each theme
6	Producing the report	Writing the analysis and results of the data analysis

we gained a comprehensive understanding of KM and knowledge application at the case companies.

2. We coded the transcripts using our case study database software. We followed the recommendation of Miles and Huberman (1994) and involved both authors in the coding process to increase its clarity and enable reliability checks. While one author conducted data-driven coding, the other attempted to find alternative explanations by acting as the "resident devil's advocate" (Eisenhardt, 1989). The first authors coded data from Companies A, B and C, whereas the second author acted as the "resident devil's advocate" (Eisenhardt, 1989). For the data from Companies D and E, the authors switched roles. We generated the initial codes by coding our data for all semantic content related to:

- barriers to knowledge application; and
- practices to overcome barriers to knowledge application.

While Table VI provides exemplary codes and codings, Appendix 4 shows our entire coding scheme and respective codings.

3. Searching for themes, we looked for subjects that "capture [...] something important about the data in relation to the research question and represent [...] some level of patterned response or meaning within the data set" (Braun and Clarke, 2006, p. 82). The search for themes can be guided by either theory or data. Because the literature provides a set of barriers to knowledge application, we used those barriers as the basis for our search for themes concerning barriers. However, we continuously extended the list by considering additional barriers (Appendix 1) and grouped those barriers into themes at the individual, group and organisational levels. Because of our research question, we paid specific attention to uncover misalignment between people, processes and technology (Leavitt, 1965) which is commonly used while studying KM (Edwards, 2011). Misfits between the dimensions are likely to cause the lack of knowledge application in organisations (Alavi and Tiwana, 2002; Blanchard *et al.*, 2007; Davenport and Prusak, 2000; Pfeffer and Sutton, 2000; Richards and Busch, 2013; Stenmark and Lindgren, 2006). We differentiate between practices to overcome the knowing-doing gap that are related to IT and those that are not related to IT. We searched for themes in an inductive manner, that is, we established themes that were data-driven and did not attempt to fit the codes into an existing frame. Based on the codes *Step-by-step Instructions* and *Code Reuse*, for instance, we concluded that IT-enabled simplifications help overcome the knowing-doing gap. While the second author searched for themes, the first acted as the "resident devil's advocate" (Eisenhardt, 1989) and attempted to find alternative assignments. All themes are included in our coding scheme in Appendix 4.

4. In reviewing the themes, we checked whether they fit in relation to the codes and the entire data set. This check resulted in shifting codes from one theme to another. While the themes for people and processes were derived straight-forward, themes related to IT needed to be adapted since we discovered two different types of insights into the role of IT for bridging the knowing-doing gap. On the one hand, we extracted two practices that help to overcome barriers of knowledge application (see *search tools* and *automation* in our

Table VI Exemplary codings

Coding	*Data extract*	*Code*
Barrier	"The main problem commonly is to understand the developer's idea. One seems to know how it works, builds something and then notes that some part is missing or that it cannot be done that way" (A3)	Application too complex
Practice	"If it is a problem, where you have a clear sequence of steps and do not need to think much along, then you do it that way. That can be found in the wiki, which is perfectly adequate" (D3)	Step-by-step instructions

result section). On the other hand, we obtained insights in the role of IT in the broader organisational context (see the four themes in our discussion). Here, we adapted themes by moving *Reduction of Complexity* from the theme *Central IT Platform* to the theme *Simplifications through IT*. Furthermore, we moved *Wiki—Degeneration* from the theme *Social Effects of IT* to the theme *Central IT Platform* because this code is closely related to the concept of having a single IT system for KM. The authors conjointly performed the step of reviewing the themes.

5. The definition and naming of the themes was straightforward. This information represents one important building block of *6. our final results*.

4. Results

Taking an abstract view, three steps of knowledge application emerged from the interviewees' description of how they proceed to solve problems: Problem analysis, identification of source and search and appraisal and decision. Figure 1 summarises this process of knowledge application.

As work in software development is typically problem-oriented (A3), the first step is the analysis of the problem to be solved. Here, it is decisive to structure the problem ("First: thinking"; A1) and to find out what is required for developing the solution:

> In general: I have a problem that I want to solve [. . .]. Usually, I then first try to find out: Can I solve it myself or do I need external information? (C2)

Concerning the second step, potential sources of knowledge include corporate databases, such as Wikis, colleagues (e.g. experts or the person handling a topic last), the internet (i.e. commonly Google queries for technical issues) and sources such as documentation, reference books and congresses. The choice of a knowledge source depends on the specific problem situation (A1, B2, C2, C3):

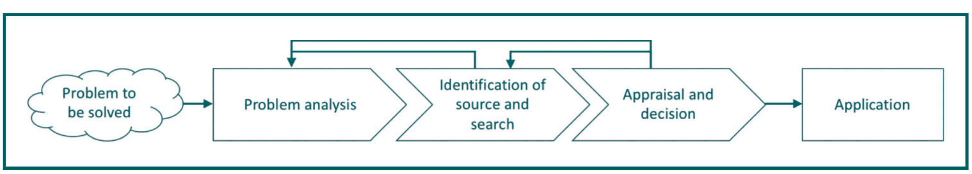
> [The choice of a knowledge source] depends on the type of a problem. In the context of a software development process, you face different problems – from the conceptual to the architectural and concrete implementation work. (B2)

In the final step, individuals need to decide whether to apply the identified knowledge based on its appraisal. Even if knowledge is obtained for the problem to be solved, it is important to appraise whether this knowledge really helps to solve the problem:

> You talk to a colleague and have the feeling during the conversation, or because of previous conversations, that this is not a trustworthy source. Although you have already gained knowledge [. . .], you either re-validate it or reject it directly. If you have validated it, you might use it afterwards. (D2)

Iterations of the process might occur if an employee observes that the search is inconclusive or the knowledge obtained is inadequate to solve the problem. In the following, we first describe instances of the knowing-doing gap concerning each of the three steps.

Figure 1 The knowledge application process



4.1 Instances of the knowing-doing gap

Based on our analysis, it appears that in each process step, different reasons lead to the knowing-doing gap while employees solve problems at hand (Figure 2). The differentiation between the process steps thus helps to better understand the existence of the knowing-doing gap and to design IT to account for challenges in each step of applying knowledge.

4.1.1 Problem analysis. Knowledge application is hindered by several reasons that prevent employees from analysing problems and thus leading to the knowing-doing gap. For instance, a *Culture of Fear* discourages employees from searching for existing knowledge:

> I claim that we have a culture of fear. The question is: What can I admit that I do not know? Should I admit that I do not know something at all? Am I allowed to do that? Or will that bother my next performance assessment? (D2)

Other instances of the knowing-doing gap result from the *Use of Old Methods*. If the majority of developers inside an organisation is always sticking to the common way of approaching problems, new employees are not going to rethink a solution as one of the interviewees describes:

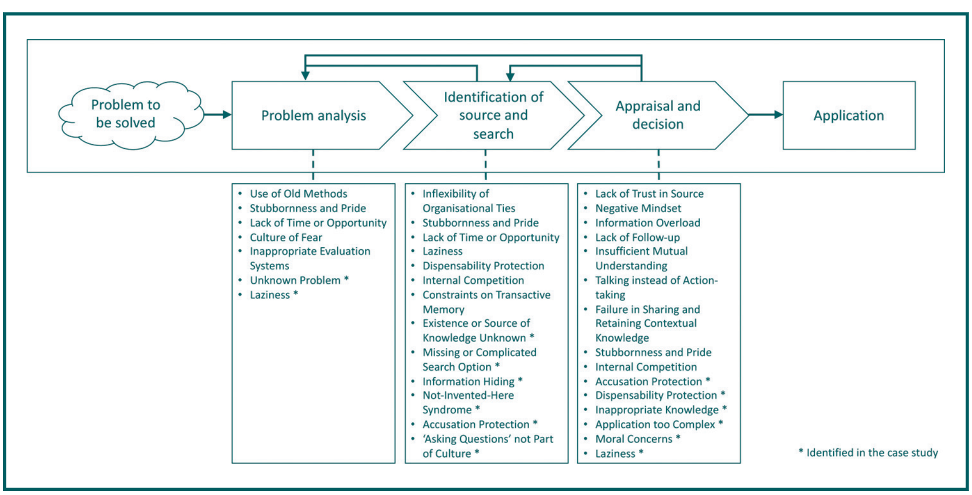
> Often, it is not about arrogance, but the timidity to question decisions made in the past. When I consider technologies, people say: ‘We will do it this way now. That is the way how it is done. We have always done it like that.’ [. . .] Often there is fear of changing established procedures, although the changes would be required to apply new knowledge and new technology. (D4)

The analysis of a problem can also be hindered if colleagues, who have addressed a similar problem before, are no longer aware of the situation and in turn are unable to offer support from the outset for the *Unknown Problem*:

> The people who regularly program in the environment [. . .] have the problem in the beginning, work on the problem, and then the problem is solved. Half a year later, someone else faces the same issue, but the others do not even remember the problem. (D5)

4.1.2 Identification of source and search. A central issue concerns the knowing-doing gap that occurs if the *Existence or Source of Knowledge is Unknown*. Employees might believe that no knowledge for solving the problem at hand exists within the organisation and are trying to solve it on their own without even spending a second for search (D6):

Figure 2 Barriers to the process of knowledge application



> It is important [. . .] to know that there is information on this topic [. . .], but you cannot always ensure it, I suggest. Eventually, I would not even get the idea to look for information, but I would say that is a completely new problem and that nobody has thought about it yet. (C2)

This barrier becomes more severe with a growing company size because not all employees are connected through their formal or informal networks (B1). If the source of knowledge is not known, another barrier to search for knowledge is a *Missing or Complicated Search Option*. If the employees are not provided with a suitable search option, they will immediately direct their focus on solving the problem on their own:

> However, we do not have the option for a central search [. . .]. Rather, I must start this process, depending on the topic, three to five times. (D2)

While the missing or complicated search option is a barrier regarding IT, an instance of the knowing-doing gap concerning colleagues as knowledge source concerns *Stubbornness and Pride*:

> You should get the mental attitude that you are not a single fighter. You do not have to find a solution by hook or by crook. Rather, you need to find a balance between developing a fast solution and programming using the basic technique with a lot of work. (A3)

4.1.3 Appraisal and decision. Concerning appraisal of the identified knowledge and the decision to apply it, *Lack of Trust in Source* can here be decisive. Humans tend to evaluate the suitability of knowledge based on their prior personal experience with the source. In case of a negative experience with the knowledge creator, they ultimately tend to neglect the existence of the solution. Another reason is described by the following developer pointing out the accurateness of the knowledge asset:

> Knowledge transfer is based on transport, and everyone conveys and transports in his own way. If this concerns a few sources [. . .] the most adventurous stories are the result. [. . .] He has a certain knowledge in his field, but not in other areas, and he only conveys the knowledge from his point of view. Either one can work with this knowledge fragment, with which one can actually start something, or one must question whether the knowledge transfer chain has delivered something quite different than was meant. (A1)

Even if knowledge passes the employees' first reliability check and the source is acknowledged, the knowing-doing gap might emerge because of *Inappropriate Knowledge*:

> I now remember a concrete situation. [. . .] Something did not work out and I just looked at the wiki. I found the pages of some colleagues, but found some hint, which I thought was not coherent. [. . .] I received an answer, but that did not help me either. The problem was then solved in a different way. (E2)

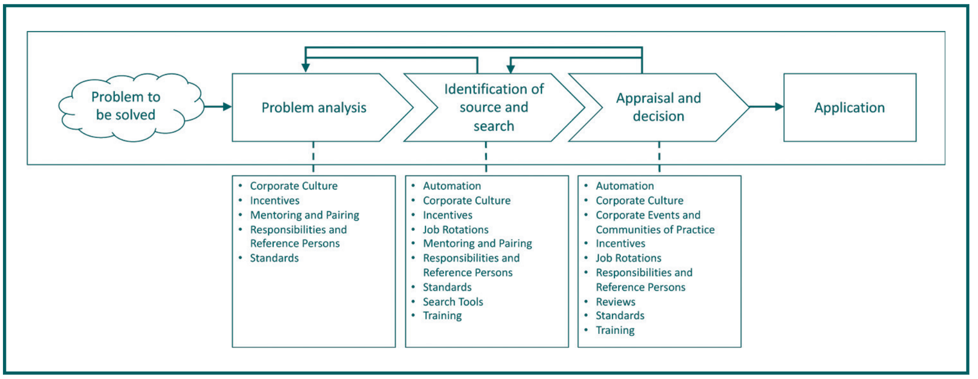
Another situation is concerned with too many ideas that prevent employees from applying knowledge due to *Information Overload*:

> I can remember that – in case of the one or the other junior employee – knowledge was not applied. This happened less due to ignorance but rather due to the fact that a lot of information was given. [. . .] If you start working here and are a good software developer, you still have to learn a lot. There are billions of suggestions for improvement [. . .] he is simply overstrained. (B2)

4.2 Bridging the knowing-doing gap

Figure 3 illustrates the steps of the knowledge-application process along the practices that help overcome barriers of knowledge application. In the following, we explain the interplay between practices and the barriers for each step.

Figure 3 Practices for bridging the knowing-doing gap in the process of knowledge application



4.2.1 Problem analysis. The knowing-doing gap might already appear in the first and initial step of knowledge application. If a developer with a problem at hand is generally not prepared to apply existing knowledge, a search for relevant sources is unlikely to happen. The knowing-doing gap thus results out of people-related reasons, which can only be addressed by exemplifying knowledge reuse throughout the organisation. Here, a *Corporate Culture* with a good corporate bond, collaborative work style and common understanding that one should use existing knowledge (A1) is a crucial practice. For instance, dealing with a wayward employee and introducing him to an open, knowledge-sharing culture is thereby a central task to reduce *Stubbornness and Pride*:

> I believe we all would try to make him feel comfortable, to get the information we need, and give him the information he needs. (C2)

Mistakes should not be punished as this increases fear of, for example, losing the job or being demoted, among employees and thus decreasing collaborative work (B1 and D3). The goal of achieving high-quality work needs to be aligned with the awareness that employees sometimes accomplish tasks in a suboptimal way (B1 and B2). If this understanding is made more explicit, *Culture of Fear* can be reduced. In addition, executives should cherish their employees and consider their suggestions as described by the following interviewee:

> You just have to appreciate it, I think. [...] It may simply be a conversation in which you ask a colleague about a particular topic and try to understand it, discuss it with him. (D6)

Discussions on improvements allow considering, for example, new technologies and approaches to reduce the barrier *Use of Old Methods*. Employees must be made aware of the benefits of knowledge application and should be given sufficient time and space (e.g. meeting places) for conducting KM processes (D3, D4, E1 and E4). The alleged additional efforts should be seen as an "*investment in the future*" (D3). Consequently, barriers concerning *Lack of Time or Opportunity* (B1) and *Inappropriate Evaluation Systems* (A1) are addressed. Besides these cultural practices concerning the people dimension, *Incentives* can also be used to improve lack of knowledge application. Examples include business trips, event vouchers (B1 and D1), participation in specific trainings (C1) and simple verbal recognition (C2). Having a reward in mind, employees might consider investing more effort to carefully analyse the problem instead of jumping straight to developing an own solution. However, other interviewees raised their concerns about using incentives for knowledge application, as these are viewed as counter-productive (B1, D4 and D6) and are thus more likely to apply to storing and transferring knowledge (D6):

> My motivation to accept knowledge of others is inherent. As a software developer, you need to apply the knowledge of others. [. . .] You cannot keep reinventing everything. [. . .] I need to enhance myself; I have to apply knowledge of others to get ahead. (C2)

It is thus important to strengthen developers' intrinsic motivation and to address their personality (D4, D6 and E3). Individuals enjoying their work are more likely to apply existing knowledge, as they are striving for perfection which can only be achieved while learning from other solutions (B1 and B2). When given more space, employees can pursue their own interests and realise respective projects. They can also be supported by *Mentoring* – a relationship between a high-level, experienced employee and a less experienced one (Mavrinac, 2005). This practice promotes application of knowledge, as inexperienced employees benefit from a direct contact to a senior colleague within the company (C1, C3 and D5). With the help of *Reference Persons* that can provide advice on a specific area, problems can be narrowed down, thus addressing the barrier *Unknown Problem* (C2). For instance, collaboration provides opportunities to directly discuss and narrow the scope of problems (C3).

These results indicate that practices concerning the people dimension are predominant in reducing barriers during problem analysis. Organisations also need to consider underlying technology and processes. In this regard, all studied companies use a wiki for knowledge storage. As a general rule, companies simplify the use of technologies for developers with fewer technical skills by relying on fewer and carefully selected technologies. This also applies to the technology used for communication. If no standardised solution is implemented, employees might be less reluctant to use additional technologies that limit interoperability throughout the organisation. Thus, *stubborn*, *proud* or *lazy* employees are forced to comply with specific knowledge by, for instance, introducing guidelines (D4).

Concerning the process dimension, *Standards* might ensure that employees have sufficient time for solving a problem, thus addressing *Lack of Time or Opportunity*. Particularly, standards for knowledge retrieval support knowledge application (C4 and D1) by, for instance, explicitly stating that employees should contact their nearby colleagues or a specific contact within a team in case of facing a problem they cannot be solved unassisted (B2, C3):

> Stop searching after a specific amount of time and ask your colleagues for help. (D1)

As an option that conjointly addresses people, processes and technology, one company applies concepts of gamification (Deterding *et al.*, 2011) by using a leaderboard for quality enhancing tasks that are unpopular among developers (B1). Thus, *stubborn, proud or lazy* employees are more likely to follow guidelines (B1).

4.2.2 Identification of source and search. Similar to the first step, a *Corporate Culture* that fosters the transfer and application of knowledge contributes to active searches for existing knowledge that can be applied to prevalent problems. When employees need access to specific knowledge, companies [. . .]:

> [. . .] should not count on knowledge simply being created and transferred. Instead, you need to raise awareness among the staff. (D5)

Knowing a company supports knowledge application helps to reduce employees' fear of becoming obsolete when applying extant knowledge (*Dispensability Protection*). Interaction among all employees including executives should be characterised by trust (B2, D5) and equality (C1, C3, D3) to reduce *Internal Competition* and *Information Hiding* among employees:

> "Meanwhile, there is trust and we are aware that in some parts he is better than me and vice versa." (B2) – "It must always be possible to ask technical questions, from both sides. Even

> though the one asking me a question is not sympathetic, I should still provide him with an answer". (D5)

Executives need to make goals and strategies transparent, to create a positive atmosphere (A1), as well as to promote and set examples of knowledge application (D1, D2 and D4). They thus suggest that employees cooperate with other organisational units to reduce the *Not-Invented-Here Syndrome* (E1). *Incentives* can thereby help to engage *lazy, stubborn or pride* employees (B1) and also reduce the barrier *Asking Questions not Part of Culture* (B1, C3, C4 and E1). Consequently, employees should not be liable for mistakes incorporated in the knowledge provided by others (*Accusation Protection*).

Automation of operations is also a feasible approach to rapid application of existing knowledge (A3, D1, D2 and E5). If knowledge is designated as an accepted standard or provided as automated procedures, developers are facing smaller hurdles to find and use a solution for their problem at hand. Thus, the barrier *Lack of Time or Opportunity* can be reduced. Here, *Standards* as practice concerning the process dimension can support the automation. When responsibilities are clearly defined, reference persons can serve as sources for knowledge accuracy confirmation (A3), thus taking the responsibility from employees and reducing the barrier *Accusation Protection*.

A central barrier to identifying sources of knowledge and searching for knowledge that is unlikely to be overcome by corporate culture is the problem of *Existence or Source of Knowledge being Unknown*. Definition and active communication of *Responsibilities and Reference Persons* for specific topics are most frequently mentioned practices intended to promote application of tacit knowledge. Because of this practice, employees are aware of colleagues to be contacted in case of unsolved problems:

> If there is a question about the product, employees know that they should call me or the head of product development, as we can answer all questions. It is thus not necessary to go around seven places. (C1)

Practices that help to overcome this barrier can be found for people, process and technology dimensions. Concerning the latter, *Search Tools* are critical for employees when striving to identify knowledge. In particular, IT can help to mitigate barriers such as *Lack of Time or Opportunity* if developers are provided with reliable *Search Tools to* reduce the time spent on searching. However, employees first need to be aware of the different databases. However, if several tools need to be considered, knowledge application might not occur (*Missing or Complicated Search Option*):

> Well, you can, of course, give him the information sources. However, when he invokes only three out of five of those sources, he still might not find the decisive factor. (D1)

Without corresponding practices concerning the process dimension, search tools provide limited value only. Making employees familiar with search tools can, for instance, be accomplished by means of *Training* (C1). Also, *Mentoring and Pairing* concerning the people dimension supports the identification of knowledge sources. Mentoring promotes application of knowledge because inexperienced employees benefit from a direct contact within the company when facing a problem (C1, C3 and D5). Pairing of employees from different departments can be considered to foster knowledge application (D3 and E2). By urging collaboration, employees can directly solve problems and obtain knowledge from other employees (*Existence or Source of Knowledge Unknown*). Forming pairs across departments contributes to strengthening the transactive memory (*Constraints on Transactive Memory*) and organisational binding (*Inflexibility of Organisational Ties*) (D3).

In addition, *Job Rotations* can help to make employees familiar with different branches of a company and the respective IT systems. Using job rotations, employees change their work areas at irregular intervals to ensure that they gain experience in different knowledge domains (e.g. technologies) and project roles. Employees benefit from contact with different organisational units, which in turn forms the transactive memory (*Constraints on Transactive Memory*) (B2). The practice helps to build knowledge redundancies and supports the staff in identifying relevant knowledge sources (*Existence or Source of Knowledge Unknown*). Employees make contact with different colleagues, thus increasing team stability and enabling knowledge exchange (C1). Consequently, they may be more inclined to apply knowledge of other organisational units, thus reducing the *Not-Invented-Here Syndrome*.

4.2.3 Appraisal and decision. Concerning the people dimensions, a *Corporate Culture* and *Incentives* form the foundation to foster employees' decisions to apply knowledge. Interaction among employees should be characterised by trust (B2 and D5) and equality (C1, C3 and D3) to reduce *Internal Competition* among employees. In addition, work appreciation (C2 and D6) has a positive impact on intrinsic motivation. This might motivate employees to perform better, which in turn reduces the barrier *Dispensability Protection*. Then, employees are more inclined to apply existing knowledge for products and services instead of just talking about it (*Talking instead of Action-taking*). Here, *Corporate Events and Communities of Practice* as process practices support reducing the barrier:

> Communities are not only an option for discussions, but to work things out and support the development base. Development of guidelines can, of course, take place outside this meeting. (D4)

Similarly, owing to such exchanges, employees might give up their *Negative Mindset* due to becoming familiar with the benefits of a new technology. *Job Rotations* as a process practice help to overcome the knowing-doing gap that results from different company contexts as well. A common culture and practice that fosters the exchange among employees (i.e. *Corporate Events and Communities of Practice* and *Job Rotations*) will in turn reduce the likeliness of *Insufficient Mutual Understanding* and *Failure in Sharing and Retaining Contextual Knowledge*:

> Through such an exchange or by taking people's hand you reduce fear and inhibitions, to ask for information: 'Do I do this right? How should I improve it?' [. . .] I believe that way you get to know a lot of different people, so that you have exchange. (C3)

In case *Standards* and *Reviews* are available and explained in *Training*, *Stubbornness and Pride*, as well as the barrier *Lack of Follow-Up*, can be reduced. If a corporate culture and practices concerning the people dimension do not suffice to reduce barriers to knowledge application, a combination with process and technology practices is required. *Reference Persons* can indicate relevant knowledge and thus help employees facing *Information Overload*. In addition, reference persons serve as sources for knowledge accuracy confirmation (A3), thus taking the responsibility from employees and reducing the barrier *Accusation Protection*. Reference persons are also to be contacted if explicit knowledge in repositories is out-dated or ambiguous (D5). As a result, they can directly adapt content and reduce *Inappropriate Knowledge*. Having responsibilities clearly defined eases knowledge application in distributed teams:

> Across different project sides, the key players are those that typically discuss specific topics. Consequently, colleagues contact their key player first to obtain necessary information. (C1)

For communicating and managing reference persons, an expert catalogue can be used (B1 and B2). When requiring complex knowledge, employees can contact experts and thus reduce the barrier *Application too Complex*.

In some cases, *Automation* of operations is a feasible approach to rapid application of existing knowledge (A3, D1, D2 and E5). Automated functions help when employees have *Lack of Trust in Source*, as all data are centrally deployed and cannot be traced to individual contributors. In addition, responsibility is clearly defined, thus addressing

Accusation Protection. Two of the companies use so-called basic service, such as standardised features provided to all programmers, which ideally takes over part of the work with little effort:

> It is useful; you do not have to read or do anything. The obstacles are relatively low and the benefits are high. (A1)

Accordingly, significant amount of information is combined in a single service, in turn reducing the barrier *Information Overload*. In this context, it is important that employees are able to apply such service in a straightforward fashion and to provide an overview of the features offered (D2). Simple integration of the services contributes to reducing the barrier *Application too Complex*.

Finally, *Inappropriate Knowledge* is unlikely to be overcome by practices regarding the people and technology dimension and instead requires a combination of process practices. Here, it is particularly helpful, if *Reference Persons* guide employees towards reviewed *Standards*. In a department of company D, quality gates are used for this purpose (D4). Thus, development can continue only if quality of completed work meets pre-defined criteria. In this context, wrong or out-dated content in the KM system can be uncovered and resolved, in turn addressing the barrier *Inappropriate Knowledge*. While *Reviews* are seen as supportive, *Standards* are also associated with negative aspects:

> "If something is obligatory, it is no fun" (D4) – "Do not define standards [. . .] people work here and people have preferences and if you disregard these, I think, you make a big mistake" (E4) – "Too many processes and excessive formalisation lead people in the wrong direction". (B1)

Because software development is a creative process and creative people are reluctant to accept restrictions, standards are seen as a threat (D6). On the other hand, in some situations and activities, specific guidelines are desirable. These include hints or tasks to apply specific knowledge (B2). Thus, employees' *Laziness* or *Stubbornness and Pride*, as well as *Moral Concerns*, can be reduced. Moreover, *Accusation Protection* is less of a problem.

4.3 The role of information technology for bridging the knowing-doing gap

We describe not only how IT helps overcome the knowing-doing gap but also the benefits and shortcomings that accompany the use of IT for knowledge application. Rather than considering the three process steps, we here address the general role of IT for barriers of knowledge application. The four themes that emerged from our data analysis include simplifications through IT, the social effects of IT, the central IT platform and communication. It becomes apparent that both types of knowledge (i.e. explicit and tacit) are reflected in the themes. While the central IT platform and simplifications through IT have a focus on easing the handling of explicit knowledge, the social effects of IT and communication aim at the human-oriented design of IT for managing knowledge and thus tacit knowledge.

4.3.1 Simplifications through information technology. In many respects, IT helps employees both decrease their work and, ultimately, apply knowledge. First, IT enables companies to provide everyone with descriptions of their procedures (i.e. explicit knowledge), that is, IT can help solve problems through a structured approach, in which steps are to be followed and the employee is not required to do very much solving on his or her own (B1 and C3):

> We use [the wiki] for our internal processes [. . .] It really includes step-by-step instructions. When you are not capable, this is excellent. (C4)

Next, IT reduces the barrier of *Lack of Time or Opportunity* and *Information Overload*. Often step-by-step instructions are less domain-specific:

> Commonly, it is less concerned with technical knowledge, but these are just organisational matters. For instance, everything that has to do with personnel management. [Or] if I have lost my password, how do I reset it?. (E3)

In the event of the need for knowledge about why something is done and how it relates to the broader context, knowledgeable colleagues are preferable. The more specific a problem, the less helpful the knowledge provided by a repository:

> Let us presume that I need internal resources to solve this problem. Even then it highly depends. Of course, I take a look at the wiki, if I have a hunch that I can find something there. In most cases, this is not the case. Unless I wonder about general programming guidelines such as 'I dislike the code; what is the best way to improve it?. (C2)

In other cases, additional insights are required from colleagues. Employees also perceive concurrent versions systems as helpful for applying knowledge:

> Of course, there is already much knowledge. You can thus acquire certain solutions from other projects. If you remember that we have implemented a mass e-mail service, then you just use the version control system to view the code directly. (B1)

Accordingly, previous knowledge can be applied when implementing a feature that someone else has already built in a different context (C2), ultimately avoiding the *Use of Old Methods*.

In addition to providing examples and instruction, IT helps reduce complexity in knowledge by illustrating interrelations, that is, it reduces the barrier *Application too Complex* (E3). Compared to file systems, in which documents are simply stored, KM systems such as wikis help reveal coherences:

> The wiki documents very complex structures. It shows which actions exist for which functions in a tabular way. You quickly find a point of reference to find what you are looking for. (A3)

In addition to knowledge structures, IT helps both to structure professional relations among employees and to identify colleagues who possess relevant knowledge. An expert catalogue, also referred to as skills management, summarises information such as fields of expertise, previous projects and previous roles for each employee; this catalogue can be used as a search index (C4). The expert catalogue helps to reduce *Lack of Trust in Source*, as the creator's legitimacy can be verified by his work history and experience and prevents situations in which the *Existence or Source of Knowledge is Unknown*. In some cases, automation of operations is a feasible approach to the rapid application of existing knowledge (A3, D1, D2 and E5). It thus reduces *Lack of Time or Opportunity* and overcomes the barrier *Application too Complex*. Furthermore, automation prevents employees from making mistakes because automated functions have already been used and tested several times. Accordingly, the barriers of *Dispensability Protection*, *Lack of Trust in Source* and *Accusation Protection* are reduced. Two of the case companies use so-called basic service such as standardised features provided to all programmers, which ideally take over part of the work with little effort. In this context, it is important that employees have the ability both to apply such a service in a straightforward fashion and to provide an overview of the features offered (D2).

4.3.2 Social effects of information technology. The use of IT for KM in general and knowledge application in particular has both positive and negative effects on employees' social structure. In particular, the barriers of *Culture of Fear*, *Insufficient Mutual Understanding*, and *Stubbornness and Pride* are relevant in this regard. Social dissonance can be avoided if knowledge is not personally acquired. Some people respond uncomprehendingly to inquiries:

> I simply do not ask certain people because they react in a way that make me feel goofy. In some cases, that might be right, but let us presume that most people who work here are not stupid. (D2)

By providing repositories from which to apply knowledge, IT provides anonymity that helps prevent social dissonances. More specifically, anonymity can help overcome the problem of *Accusation Protection*. On the other hand, IT can lead to social dissonance. First, employees do not want to provide naked, documented knowledge that others already have. Such knowledge might be shared and explained within a department, but not in a wiki. Next, the option to evaluate knowledge entries gets lost, which would help assess the applicability of the knowledge provided (E1, E5) thus again enforcing the barrier *Lack of Trust in Source*. Second, employees extensively contributing to a wiki might be questioned why they have so much time to document their knowledge (D4). Their behaviour indicates that they have too little work to do. Such criticism lessens their KM engagement. Finally, employees lose control over their knowledge (D4), which leads to a situation described by one interviewee:

> She documents everything. She is really good in documenting. She shares some things, but she does not make them public; instead, she distributes them among her narrowest circle of colleagues [...] However, she would never provide the knowledge in a wiki. (D4)

Personally sharing knowledge with colleagues only does not reveal the author. Employees might prefer this form of *Information Hiding* to avoid *Internal Competition*. In general, the social effects of IT thus predominantly cover the human-oriented design of IT for managing knowledge.

4.3.3 Central information technology platform. Another theme refers to the use of a central IT solution. Although none of the case companies relies on a single tool, many respondents describe encountering problems as the result of the use of several tools. Knowledge application is commonly impeded because employees are unable to retrieve knowledge (E3):

> You believe that the current arrangements for the classifications of staff [...] should be in the wiki. You take a look and you cannot find them because they probably were sent by e-mail. (C1)

Consequently, employees have low expectations concerning the knowledge to be applied:

> If I find knowledge—internally documented by us—that is a success on its own. I do not expect it to provide a perfect answer to my question. (E4)

A list of all tools available at a company can be used to prevent employees from being unaware of potential sources of knowledge application. However, if time is insufficient to consider all tools, knowledge application still might not occur:

> Well, you can, of course, give him the information sources. However, when he invokes only three out of five of those sources, he still might not find the decisive factor. (D1)

This shortcoming contributes to the barrier *Existence or Source of Knowledge Unknown*. In addition, a comprehensive list of information sources is typically unavailable:

> "Rather, there is trial and error [...] They guess where something could be. Then they look there. Then they know that a database for guidelines exists [...] If they still do not achieve the objective, they know someone who might know something [...] That is the strategy that is commonly applied here." (D1) –"Our people say that we store awful lot here. Knowing exactly where to find it [i.e., in which system], that is the problem". (E1)

This observation corresponds to the barrier *Missing or Complicated Search Option*. One approach to preventing such problems is the use of a central IT platform. Although one of the case companies relies on a single system for KM, some of the teams' experiences indicate that a focal point is important. More concretely, respondents from all companies describe the benefits that result from using a wiki as a single KM system:

> "Apart from a direct contact, [the wiki] is the first place to go to retrieve information." (A3) – "We have a separate page for new employees with hints to follow and reference persons to contact concerning general issues." (C3) – "If a question concerns, for instance, common project work or my personal role, I simply use the wiki". (E3)

Employees find information in the wiki "that really helps them" (D4). The wiki is seen as superior "simply because the search is easiest" (E1). Other systems such as concurrent-version systems do not provide that option (E1). What is required is a database "that is clearly structured, that masters everything that a modern wiki offers" (D2). Thus, it is possible to avoid both the problem of a *Missing or Complicated Search Option* and the barrier of *Information Overload*.

Despite the benefits that wikis offer, a central IT platform can reinforce barriers to knowledge application:

> The wiki constantly puffs up and has been in use for quite a long time [. . .] Thus, that many things are outdated. (C3)

Accordingly, employees might be confronted with *Information Overload* or *Inappropriate Knowledge*. In addition, reference persons for specific topics might not be easy to find:

> That [information] is in the wiki, but not at a central point. You get it with time. On certain subjects, you always see the same name. (C2)

Another common problem is the lack of guidelines for using the wiki (E3). Projects are documented in diverse ways because everyone documents at their convenience and in their own style. As a result, the wiki is perceived as a "large application that stores data in a pretty unstructured way" (D5). The manner in which knowledge is documented is often perceived as not intuitive (B1). This might contribute to the barrier in which *Existence or Source of Knowledge is Unknown*. Keywords for storing knowledge need to be carefully selected and need to match those used by others to retrieve that knowledge. Otherwise, the barrier of *Missing or Complicated Search Option* is unlikely to be resolved. The problems that hinder the application of knowledge from wikis might prevent employees from using the system at all (D5). Guidelines can help provide clear structure that eases knowledge retrieval. Nevertheless, adhering to the guidelines can require an extensive effort:

> "As long as there is a meaningful information, [it is stored] directly in the wiki. Each employee has access, that is, when we see somehow that something is wrong or outdated, then it should be revised immediately." (C3) – Categories are essential in this regard: "I must admit, for me, it keeps me alive". (D2)

The categories contribute to the general requirement that the system be searchable:

> Ultimately the dictionary, documentation, tagging, search – the things to recycle – need to be kept as simple as possible [. . .] if I need to invest more than half an hour to obtain a solution, I do it myself. (D2)

4.3.4 Communication. In addition to the support provided by internal IT, knowledge application can be enabled by external sources. Examples include search engines such as Google and forums. These practices offer increasingly detailed information:

> "And that, for instance, is something that we could never represent in an internal knowledge management system because we then would have to copy technical reports for APIs [. . .] That is nonsense. Insofar, it is de facto Google as a search engine that finally gets knowledge into their heads." (B2) – "the developers now and then go online to see whether someone responded to an inquiry". (E1)

Internet forums have a larger user base than the companies themselves:

> For this, the mass is simply too low. On the Internet, I do not give up that quickly. When I search the Internet, I assume that someone had the exact same problem before and I just have to keep looking. I do not believe that this is the case here. Here, if I find something, in whatever medium, that somehow fits, I expect that I must help myself to transfer that knowledge to my specific problem. Personally, I also find recipes for professionals much better than recipes for beginners because they are more compact and easier to read. (E4)

Although the internet provides detailed support for solving diverse problems, a company setting can create limits:

> It is somewhat limited, and on the Internet you do not find much [current information] for the versions used in our company. You find something, but it does not always fit our solutions because we often use older versions. (D5)

Ideally, a company's search engine would cover internal knowledge bases that automatically include Google results if internal sources do not provide a solution (B2). This type of integrated solution would likely overcome the barrier *Existence or Source of Knowledge Unknown*. Employees also rely on IT for improved communication, particularly when working in distributed teams. The quality of meetings can be improved when everyone is directly involved. Accordingly, advanced forms of communication help overcome *Insufficient Mutual Understanding* and *Failure in Sharing and Retaining Contextual Knowledge*:

> "Videoconferencing is ever better than just phones [...] The tool support, that is all right. Additionally, area meetings are distributed via videoconference." (C4) "WebEx enables meetings, where you conjointly take a look at a PowerPoint or program, while being at distributed locations [...] That helps for some parts; that you move closer together". (A2)

5. Discussion

While Table VII summarises our findings, we in the following provide general implications for researchers and practitioners, and finally acknowledge our study's threats to validity.

5.1 Implications for researchers

One of our themes suggests that using a central IT system helps reduce several barriers of the knowing-doing gap. Because of this suggestion, our research implies the need to conduct a quantitative field study to address that relationship. Similarly, researchers should dig deeper into the theme of IT's social effects. Although our study proposes features that IT systems should include to help overcome social dissonance, analyses of its concrete effects are subject to further research.

The identified practices that help reduce the barriers of the knowing-doing gap beyond IT at the people and process dimensions demonstrate the variety of strategies that can and

Table VII Central findings

Finding	*Central insight*
Knowledge application	A three-step process consisting of problem analysis, identification of source and search, and appraisal and decision (Figure 1)
Barriers of knowledge application	A variety of barriers – mostly at the individual level – prevents employees from applying knowledge (Appendix 1)
Bridging the knowing-doing gap	The alignment of IT with organisations' people and processes is crucial to foster knowledge application
Role of IT	Four themes characterise the IT's role for knowledge application: simplifications through IT, the social effects of IT, the central IT platform and communication (Section 4.3)

should be applied to foster knowledge application. In particular, interviewees deemed the most important practice as establishing a *Corporate Culture* to promote knowledge application. A corporate culture for KM is a culture that not only understands and values both knowledge and its management but also requires a balanced environment of power, control and trust (Baskerville and Dulipovici, 2006). This balance is essential for people applying other colleagues' knowledge and sharing their own knowledge, which in turn is critical to making knowledge available for application. Because knowledge supports actions such as solving a problem (Goldkuhl, 2006), it is important for organisations to establish a culture that fosters employee interactions. Otherwise, solving problems remains an activity in the mind of an individual who does not consider the information that is available in the organisation. If employees comprehend this relevance, the knowledge culture, which is generally seen as an enabler of effective KM (Sutton, 2001), can help reduce the barrier *Information Hiding*. This phenomenon can occur in three different forms: playing dumb (i.e. feigning ignorance), evasive hiding (i.e. providing incorrect or incomplete information) and rationalising hiding (i.e. justifying one's unwillingness to share knowledge) (Connelly and Zweig, 2014; Connelly *et al.*, 2012). As one of the respondents (D3) explained, which is in line with the previous literature (Cress *et al.*, 2005), one reason for this behaviour is the fear of losing one's status or pre-eminence (D3), which can be reduced by increasing perceived trust, establishing a climate of knowledge sharing and rewarding knowledge sharing (Connelly *et al.*, 2012).

Given the insight that executives do not perceive the knowing-doing gap as a relevant issue, the control dimension in the interplay of power, control and trust is particularly likely to be neglected. As an example of the control mechanism, some respondents mentioned the use of appropriate *Incentives*. Similarly, Markus (2001) and Sambamurthy and Subramani (2005) saw incentives as a solution to the lack of knowledge application. Nevertheless, the use of incentives is a practice that must be carefully considered. Several interviewees raised concerns about incentives to foster knowledge application because incentives are more likely to be effective for the processes of knowledge storage and transfer and thus leading to accumulation of knowledge but not directly the subsequent application. The use of incentives for knowledge application is deemed counterproductive and is expected to fail. In this context, extrinsic incentives, particularly monetary bonuses, can be disadvantageous (Huber, 2001; Sambamurthy and Subramani, 2005).

Finally, our results show that the majority of barriers can be found at the individual level (Appendix 1). In this regard, our study contradicts previous research suggesting that the knowing-doing gap does not primarily originate at the individual level (Pfeffer and Sutton, 2000). At least in the professional context of software development, the individual is likely to be decisive when determining whether to apply knowledge. Instead of addressing barriers in a general way for an entire organisation, it would be promising to address barriers in manner that is customised to individuals' characteristics. Consequently, practices to reduce the knowing-doing gap should focus on reducing barriers that are relevant to individuals' reluctance to apply existing knowledge. Such barriers might result from the characteristics of corporate culture, which is regarded as one of the greatest obstacles to effective KM (Alavi and Leidner, 2001; Bock *et al.*, 2006; Gold *et al.*, 2001). By repeatedly referring to *Corporate Culture* as the practice of reducing barriers of the knowing-doing gap, particularly at the individual level, our respondents agreed with the view that "[m]anaging knowledge is managing people; managing people is managing knowledge" (Davenport and Völpel, 2001, p. 218).

5.2 Implications for practitioners

While our study provides guidance on practices concerning people, processes and technology, we focus our practical implications on three aspects that we consider critical:

the relevance of the knowing-doing gap in practice, the role of IT in reducing the knowing-doing gap and practices concerning the people and process dimensions.

First, our study provides evidence for the existence of the knowing-doing gap in the software development context. Accordingly, we create awareness of the problems that result from employees who do not apply existing knowledge. The data gathered as a part of this study also reveal that the perception of the knowing-doing gap depends on the hierarchy level. Although software developers reported that they often experience situations in which existing knowledge is not applied, executives seem unaware of this problem. Consequently, it is unlikely that executives will actively promote knowledge application. Instead, executives seem to believe that knowledge application is a direct consequence of well-established processes concerning knowledge creation, storage, and transfer. Therefore, executives should work to reduce the knowing-doing gap.

Based on this study's insights into the importance of centralised IT for knowledge application, organisations should attempt to consolidate their landscapes of IT systems that are used to support KM. This type of consolidation contributes to easing both the identification of relevant knowledge and the standardisation of the evaluation of knowledge that helps in overcoming barriers such as employees' *stubbornness and pride*. By relying on fewer technologies, companies simplify the use of those technologies for people with fewer technical skills. This also applies to the technology used for communication. If no standardised solution is implemented, employees might be less reluctant to use additional technologies that limit interoperability throughout the organisation.

Finally, our results show that knowledge application is impeded by individual, group-related and organisational barriers. To ensure that employees translate existing knowledge into products and services, companies should apply a combination of practices concerning technology, people, and processes instead of focusing on single practices. Therefore, it is essential for companies to develop a comprehensive strategy to overcome the barriers of the knowing-doing gap. When combining practices, however, it must be noted that some practices affect the outcomes of others. For instance, *Incentives* are applied to provide employees with greater freedom. When applied in combination with *Reviews*, however, the outcome is restricted freedom.

5.3 Threats to validity

Following a positivistic case study approach (Yin, 2002), we discuss the following validity criteria for the assessment of exploratory case studies: construct validity, internal validity, external validity and reliability. To ensure construct validity, it is necessary to identify correct operational practices for the concepts under investigation. To satisfy with this criterion, we relied on multiple sources of evidence (different interviewees, the use of documents and KM systems), established a chain of evidence, and spent time on site to assess the plausibility of our analysis.

To ensure internal validity, we carefully analysed the relations between the identified practices and barriers to closing the knowing-doing gap. When producing this mapping, one researcher conducted data-driven coding based on insights from our case companies while the other tried to find alternative explanations. The evidence converged to the results presented in this paper, on which both authors agreed.

With respect to external validity, it is critical to define the domain to which the case study findings can be generalised. Industry-specific methods such as pair programming or refactoring are used; these methods cannot be used in other industries without some restrictions. However, insights into the centrality of IT and practices such as Corporate Culture and Corporate Events and Communities of Practice are likely to be transferrable to other domains because they do not rely on industry-specific methods. Moreover, researchers agree on the importance of theoretical saturation (Glaser and Strauss, 1967;

Strauss and Corbin, 1990) or "point of redundancy" (Lincoln and Guba, 1985, p. 235) regarding the emerging constructs, that is, the point at which no new findings are discovered. During our cross-case analysis, no new findings emerged from the interviews conducted at Company E. Therefore, we are confident that we have reached saturation. As suggested by Eisenhardt (1989), we accordingly did not add further cases.

The purpose of the reliability criterion is to ensure that "if a later investigator followed the same procedures as described by an earlier investigator and conducted the same case study all over again, the later investigator should arrive at the same findings and conclusions" (Yin, 2002, p. 45). Although we acknowledge the complexity of KM in general and the knowing-doing gap in particular, which is subject to interpretation, we are confident that our work complies with this criterion because of the detailed description of our data analysis and the close attention on inter-subjectivity in our coding process.

6. Conclusion

This study is among the few publications to address practices to overcome the barriers of the knowing-doing gap in a professional context. Our primary contribution is to illuminate the role of IT in bridging the knowing-doing gap. Second, our study contributes to the general understanding of the knowing-doing gap by also considering practices concerning the people and process dimensions. While IT plays a central role in applying knowledge, successfully overcoming the knowing-doing gap requires organisational practices at the people and processes dimensions that are aligned with the IT, in particular to enable the application of tacit knowledge. Third, we derived an understanding of knowledge application as a three-step process. Finally, we contribute to the stream of literature focussing on the identification of the barriers of the knowing-doing gap. We complement the set of barriers at the individual, group, and organisational levels. Although this set can provide useful guidance in understanding the reasons behind evident lack of knowledge application, our results suggest that the individual level of barriers is in particular need of being addressed.

We identified three major steps that individuals take in the process of knowledge application and our thematic analysis yields a theoretical explanation for practices that help to bridge the knowing-doing gap in each step. As in-depth insight, we provide four major themes that explain the role of IT in this process: simplification, centrality, social effects and communication. Although previous research has addressed the role of IT for KM in general (Alavi and Leidner, 2001) and selected KM processes in particular (Hislop, 2002), our study is the first to address the role of IT in knowledge application. We thereby contribute to an improved understanding of the role of IT in the knowledge context, which has attracted both supporters (Argote *et al.*, 2003; Gray and Durcikova, 2005/2006; Newell and Galliers, 2006) and critics (Hislop, 2002; McDermott, 1999). Our study suggests that IT plays an important role in knowledge application. It becomes evident that IT is a key determinant for providing knowledge that employees transform into action. Instead of using a set of systems, the majority of respondents favour a single system (i.e. a wiki) that covers both internal and external knowledge sources. The variety of knowledge required to solve prevalent problems can only be addressed by the variety of knowledge that can be found both in company-specific (i.e. an internal KM system) and external (e.g. Google and forums) knowledge. In addition to benefits of a technical nature (i.e. simplifications, knowledge retrieval and communication), our study suggests the potential offered by IT with regard to the barriers anchored in organisations' social structures.

In addition to IT, practices concerning the people and process dimensions are required to bridge the knowing-doing gap. In particular, a knowledge culture is an essential element in organisations to enable successful knowledge application in problem-solving situations. Focusing on practices concerning the people and processes dimensions aligned with organisations' IT appears to be the most promising approach. In contrast to the findings reported in previous literature, our results indicate that the knowing-doing gap is a phenomenon that originates primarily at the individual level, not the organisational level. While we create awareness of the knowing-doing gap and guide organisations towards a centralised IT solution, our study suggests several directions for future research that analyse the effects of the centrality theme, focus on the barrier to knowledge application at the individual level and carefully examine the interplay between incentives and reviews in the light of knowledge application.

Notes

1. Within this research, we interchangeably use the terms *company* and *organisation*.
2. Terms used synonymously to denote this process are *application*, *use* and *utilisation* of knowledge (Holzner and Marx, 1979; Song *et al.*, 2005).
3. We note that situations might exist in which development of new knowledge is more suitable than using existing knowledge. In developing new products, for instance, it can be beneficial to detach from previous patterns of solving problems. Yet, in this study, we focus on situations in which employees search for existing knowledge to solve problems, but, in the end, do not apply the knowledge.
4. We refer to companies as both single companies and organisational units that serve as independent service providers to the overall organisation or external organisations and thus act as autonomous entities.
5. Because all interviews were conducted on-site (i.e. at the case companies), the number of site visits is predominantly determined by the number of interviews.
6. The concept of transactive memory describes the knowledge of a group of individuals and their awareness of knowledge other colleagues possess (Wegner, 1987). Thus, other employees serve as external storage and the employees have access to external knowledge. This collective knowledge is greater than the sum of the knowledge individuals possess. A sound TM has a positive influence on knowledge application (Choi *et al.*, 2010), allows individuals to pool their tacit knowledge, promotes solutions to common tasks, and facilitates the search for knowledge to solve a problem (Alavi and Tiwana, 2002).
7. Reuse of existing methods can also be seen as application of organisational knowledge. However, this approach prevents organisational learning and performance improvements, thus leading to the knowing-doing gap.

References

Alavi, M. and Leidner, D.E. (1999), "Knowledge management systems: emerging views and practices from the field", in IEEE Computer Society Press (ed.), *Proceedings of the 32nd Annual HI International Conference on System Sciences*.

Alavi, M. and Leidner, D.E. (2001), "Review: knowledge management and knowledge management systems: conceptual foundations and research issues", *MIS Quarterly*, Vol. 25 No. 1, pp. 107-136.

Alavi, M. and Tiwana, A. (2002), "Knowledge integration in virtual teams: the potential role of KMS", *Journal of the American Society for Information Science and Technology*, Vol. 53 No. 12, pp. 1029-1037.

Anand, N., Gardner, H.K. and Morris, T. (2007), "Knowledge-based innovation: emergence and embedding of new practice areas in management consulting firms", *Academy of Management Journal*, Vol. 50 No. 2, pp. 406-428.

Argote, L., Mcevily, B. and Reagans, R. (2003), "Managing knowledge in organizations: an integrative framework and review of emerging themes", *Management Science*, Vol. 49 No. 4, pp. 571-582.

Baskerville, R. and Dulipovici, A. (2006), "The theoretical foundations of knowledge management", *Knowledge Management Research & Practice*, Vol. 4 No. 2, pp. 83-105.

Basten, D., Michalik, B. and Yigit, M. (2015), "How knowledge management systems support organisational knowledge creation – an in-depth case study", in Society, I. EEE C. (ed.), *Proceedings of the 48th HI International Conference on System Sciences*.

Basten, D., Schneider, L. and Pankratz, O. (2017), "Codifcation, personalisation, or in between? Exploring knowledge characteristics to guide knowledge management system design", *Journal of Information & Knowledge Management*, Vol. 16 No. 4, pp. 1-46.

Bierly, P.E., Damanpour, F. and Santoro, M.D. (2009), "The application of external knowledge: organizational conditions for exploration and exploitation", *Journal of Management Studies*, Vol. 46 No. 3, pp. 481-509.

Blanchard, K.H., Meyer, P.J. and Ruhe, D. (2007), *Know Can Do!: Put Your Know-How into Action*, Berrett-Koehler Publishers, San Francisco, CA.

Bock, G.-W., Kankanhalli, A. and Sharma, S. (2006), "Are norms enough? The role of collaborative norms in promoting organizational knowledge seeking", *European Journal of Information Systems*, Vol. 15 No. 4, pp. 357-367.

Bordia, P, Irmer, B.E. and Abusah, D. (2006), "Differences in sharing knowledge interpersonally and via databases: the role of evaluation apprehension and perceived benefits", *European Journal of Work and Organizational Psychology*, Vol. 15 No. 3, pp. 262-280. doi: 10.1080/13594320500417784.

Braun, V. and Clarke, V. (2006), "Using thematic analysis in psychology", *Qualitative Research in Psychology*, Vol. 3 No. 2, pp. 77-101.

Butler, T. and Murphy, C. (2007), "Understanding the design of information technologies for knowledge management in organizations: a pragmatic perspective", *Information Systems Journal*, Vol. 17 No. 2, pp. 143-163.

Červenka, M. (2012), "Organizational influence on effectivity of knowledge application by knowledge workers: an attention-based approach", *Economics and Management*, Vol. 17 No. 2, pp. 719-725.

Choi, S.Y., Lee, H. and Yoo, Y. (2010), "The impact of information technology and transactive memory systems on knowledge sharing, application, and team performance: a field study", *MIS Quarterly*, Vol. 34 No. 4, pp. 855-870.

Chua, A. and Lam, W. (2005), "Why KM projects fail: a multi-case analysis", *Journal of Knowledge Management*, Vol. 9 No. 3, pp. 6-17.

Connelly, C.E. and Zweig, D. (2014), "How perpetrators and targets construe knowledge hiding in organizations", *European Journal of Work and Organizational Psychology*, Vol. 24 No. 3, pp. 1-11.

Connelly, C.E., Zweig, D., Webster, J. and Trougakos, J.P. (2012), "Knowledge hiding in organizations", *Journal of Organizational Behavior*, Vol. 33 No. 1, pp. 64-88.

Cress, U., Barquero, B., Buder, J. and Hesse, F.W. (2005), "Social dilemma in knowledge communication via shared databases", in Bromme, R., Hesse, F.W. and Spada, H. (Eds), *Barriers and Biases in Computer-Mediated Knowledge Communication*, Springer-Verlag, New York, NY.

Davenport, T.H. and Prusak, L. (2000), *Working Knowledge: How Organizations Manage What They Know*, Harvard Business School Press, Boston.

Davenport, T.H. and Völpel, S.C. (2001), "The rise of knowledge towards attention management", *Journal of Knowledge Management*, Vol. 5 No. 3, pp. 212-222.

Davison, R.M., Ou, C.X.J. and Martinsons, M.G. (2013), "Information technology to support informal knowledge sharing", *Information Systems Journal*, Vol. 23 No. 1, pp. 89-109.

Delisle, C.L. and Olson, D. (2004), "Would the real project management language please stand up?", *International Journal of Project Management*, Vol. 22 No. 4.

Desouza, K.C., Awazu, Y. and Baloh, P. (2006), "Managing knowledge in global software development efforts: issues and practices", *IEEE Software*, Vol. 23 No. 5, pp. 30-37.

Deterding, S, Dixon, D, Khaled, R. and Nacke, L. (2011), "From game design elements to gamefulness: defining 'gamifaction'", in ACM (Ed.), *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, pp. 9-15.

Doherty, N.F., Ashurst, C. and Peppard, J. (2012), "Factors affecting the successful realisation of benefits from systems development projects: findings from three case studies", *Journal of Information Technology*, Vol. 27 No. 1, pp. 1-16.

Dubé, L. and Paré, G. (2003), "Rigor in information systems positivist case research: current practices, trends, and recommendations", *MIS Quarterly*, Vol. 27 No. 4, pp. 597-635.

Edwards, J. (2011), "A process view of knowledge management: it ain't what you do, it's the way that you do it", *Electronic Journal of Knowledge Management*, Vol. 9 No. 4, pp. 297-306.

Eisenhardt, K.M. (1989), "Building theories from case study research", *Academy of Management Review*, Vol. 14 No. 4, pp. 532-550.

European Union (2014), "What is an SME?", available at: http://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition/index_en.htm (accessed 22 November 2014),

Fereday, J. and Muir-Cochrane, E. (2006), "Demonstrating rigor using thematic analysis: a hybrid approach of inductive and deductive coding and theme development", *International Journal of Qualitative Methods*, Vol. 5 No. 1, pp. 80-92.

Flick, U. (2006), *An Introduction to Qualitative Research*, SAGE Publications, Thousand Oaks, CA.

Gartner (2016), "IT glossary", available at: www.gartner.com/it-glossary/it-information-technology/ (accessed 8 June 2016)

Glaser, B.G. and Strauss, A.L. (1967), *The Discovery of Grounded Theory. Strategies for Qualitative Research*, Aldine Publishing, Chicago.

Gold, A.H., Malhotra, A. and Segars, A.H. (2001), "Knowledge management: an organizational capabilities perspective", *Journal of Management Information Systems*, Vol. 18 No. 1, pp. 185-214.

Goldkuhl, G. (2006), "Practice theory vs practical theory: combining referential and functional pragmatism", in *Panel Paper to the 4th International Conference on Action in Language, Organisations and Information Systems*, *Borås*, 1-2 November.

Grant, R.M. (1996), "Toward a knowledge-based theory of the firm", *Strategic Management Journal*, Vol. 17 No. S2, pp. 109-122.

Gray, P.H. and Durcikova, A. (2005/2006), "The role of knowledge repositories in technical support environments: speed versus learning in user performance", *Journal of Management Information Systems*, Vol. 22 No. 3, pp. 159-190.

Haas, M.R. and Hansen, M.T. (2007), "Different knowledge, different benefits: toward a productivity perspective on knowledge sharing in organizations", *Strategic Management Journal*, Vol. 28 No. 11, pp. 1133-1153.

Hansen, M., Nohria, N. and Tierney, T. (1999), "What's your strategy for managing knowledge?", *Harvard Business Review*, Vol. 77 No. 2, pp. 106-116.

Hislop, D. (2002), "Mission impossible? Communicating and sharing knowledge via information technology", *Journal of Information Technology*, Vol. 17 No. 3, pp. 165-177.

Holzner, B. and Marx, J.H. (1979), *Knowledge Application. The Knowledge System in Society*, Allyn and Bacon, Boston.

Huber, G.P. (2001), "Transfer of knowledge in knowledge management systems: unexplored issues and suggested studies", *European Journal of Information Systems*, Vol. 10 No. 2, pp. 72-79.

Joyner, F.F. (2015), "Bridging the knowing/doing gap to create high engagement work cultures", *Journal of Applied Business Research*, Vol. 31 No. 3, pp. 1131-1148.

Kang, S.-C., Morris, S.S. and Snell, S.A. (2007), "Relational archetypes, organizational learning, and value creation: extending the human resource architecture", *Academy of Management Review*, Vol. 32 No. 1, pp. 236-256.

King, W.R. (2009), "Knowledge management and organizational learning", in King, W.R. (Ed.), *Knowledge Management and Organizational Learning*, Springer, Dordrecht, New York, NY.

King, N. and Horrocks, C. (2010), *Interviews in Qualitative Research*, SAGE, Los Angeles.

Kulkarni, U.R., Ravindran, S. and Freeze, R. (2006), "A knowledge management success model: theoretical development and empirical validation", *Journal of Management Information Systems*, Vol. 23 No. 3, pp. 309-347.

Krauss, R.M. and Fussell, S. R. (2014), "Mutual knowledge and communicative effectiveness", In Galegher, J, Kraut, R.E. and Egido, C. (Eds.), *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work*, Taylor and Francis, Hoboken, pp. 111-146.

Lane, P.J., Koka, B.R. and Pathak, S. (2006), "The reification of absorptive capacity: a critical review and rejuvenation of the construct", *Academy of Management Review*, Vol. 31 No. 4, pp. 833-863.

Leavitt, H.J. (1965), "Applied organizational change in industry: structural, technical and humanistic approaches", in March, J.G. (Ed.), *Handbook of Organizations*, Rand McNally & Co, Chicago.

Lee, S.H.A. and Lim, T.-M. (2015), "A study on the perception of POKM as the organizational knowledge sharing enabler", *VINE,* Vol. 45 No. 2, pp. 292-318.

Lengnick-Hall, C.A. and Griffith, R.J. (2011), "Evidence-based versus tinkerable knowledge as strategic assets: a new perspective on the interplay between innovation and application", *Journal of Engineering and Technology Management*, Vol. 28 No. 3, pp. 147-167.

Lin, T.-C. and Huang, C.-C. (2008), "Understanding knowledge management system usage antecedents: an integration of social cognitive theory and task technology fit", *Information & Management*, Vol. 45 No. 6, pp. 410-417.

Lincoln, Y.S. and Guba, E.G. (1985), *Naturalistic Inquiry*, Sage, Newbury Park.

Mavrinac, M.A. (2005), "Transformational leadership: peer mentoring as a values-based learning process", *Portal: Libraries and the Academy*, Vol. 5 No. 3, pp. 391-404. doi: 10.1353/pla.2005.0037.

McDermott, R. (1999), "Why information technology inspired but cannot deliver knowledge management", *California Management Review*, Vol. 41 No. 4, pp. 103-117.

Markus, L.M. (2001), "Toward a theory of knowledge reuse: types of knowledge reuse situations and factors in reuse success", *Journal of Management Information Systems*, Vol. 18 No. 1, pp. 57-94.

Mciver, D., Lengnick-Hall, C.A., Lengnick-Hall, M.L. and Ramachandran, I. (2013), "Understanding work and knowledge management from a knowledge-in-practice perspective", *Academy of Management Review*, Vol. 38 No. 4, pp. 597-620.

Miles, M.B. and Huberman, A.M. (1994), *Qualitative Data Analysis*, Sage, Thousand Oaks, CA.

Mitchell, C.T. (1993), *Redefining Designing: From Form to Experience*, Van Nostrand Reinhold, New York, NY.

Myers, M.D. and Newman, M. (2007), "The qualitative interview in IS research: examining the craft", *Information Organization*, Vol. 17 No. 1, pp. 2-26.

Newell, S. (2015), "Managing knowledge and managing knowledge work: what we know and what the future holds", *Journal of Information Technology*, Vol. 30 No. 1, pp. 1-17.

Newell, S. and Edelman, L.F. (2008), "Developing a dynamic project learning and cross-project learning capability: synthesizing two perspectives", *Information Systems Journal*, Vol. 18 No. 6, pp. 567-591.

Newell, S. and Galliers, R.D. (2006), "Facilitating - or inhibiting - knowing in practice", *European Journal of Information Systems*, Vol. 15 No. 5, pp. 441-445.

Noonan, P. (2012), "Breaking through the barriers of time: how to find time to support struggling students", *The Collaborative Administrator: Working Together as a Professional Learning Community*, Solution Tree, Bloomington.

Oğuz, F. and Şengün, A.E. (2011), "Mystery of the unknown: revisiting tacit knowledge in the organizational literature", *Journal of Knowledge Management*, Vol. 15 No. 3, pp. 445-461.

Penrose, E.T. (2009), *The Theory of the Growth of the Firm (4th ed.)*, Oxford University Press, Oxford; New York.

Pfeffer, J. and Sutton, R.I. (2000), *The Knowing-Doing Gap: How Smart Companies Turn Knowledge into Action*, Harvard Business School Press, Boston, MA.

Polanyi, M. (1966), *The Tacit Dimension*, University of Chicago Press, Chicago, London.

Reus, T.H., Ranft, A.L., Lamont, B.T. and Adams, G.L. (2009), "An interpretive systems view of knowledge investments", *Academy of Management Review*, Vol. 34 No. 3, pp. 382-400.

Rice, P. and Ezzy, D. (1999), *Qualitative Research Methods: A Health Focus*, Oxford University Press, Melbourne.

Richards, D. and Busch, P. (2013), "Knowing-doing gaps in ICT: gender and culture", *VINE: The Journal of Information and Knowledge Management Systems*, Vol. 43 No. 3, pp. 264-295.

Roberts, N., Galluch, P.S., Dinger, M. and Grover, V. (2012), "Absorptive capacity and information systems research: review, synthesis, and directions for future research", *MIS Quarterly*, Vol. 36 No. 2, pp. 625-6A6.

Rugg, G., Eva, M., Mahmood, A., Rehman, N., Andrews, S. and Davies, S. (2002), "Eliciting information about organizational culture via laddering", *Information Systems Journal*, Vol. 12 No. 3, pp. 215-229.

Rus, I. and Lindvall, M. (2002), "Knowledge management in software engineering", *IEEE Software*, Vol. 19 No. 3, pp. 26-38.

Rynes, S.L., Bartunek, J.M. and Daft, R.L. (2001), "Across the great divide: knowledge creation and transfer between practitioners and academics", *Academy of Management Journal*, Vol. 44 No. 2, pp. 340-355.

Sambamurthy, V. and Subramani, M. (2005), "Special issue on information technologies and knowledge management", *Management Information Systems Quarterly*, Vol. 29 No. 2, pp. 1-7.

Setia, P. and Patel, P.C. (2013), "How information systems help create OM capabilities: consequents and antecedents of operational absorptive capacity", *Journal of Operations Management*, Vol. 31 No. 6, pp. 409-431.

Shaw, M.L.G. and Gaines, B.R. (1989), "Comparing conceptual structures: consensus, conflict, correspondence and contrast", *Knowledge Acquisition*, Vol. 1 No. 4, pp. 341-363.

Song, M., Van Der Bij, H. and Weggeman, M. (2005), "Determinants of the level of knowledge application: a knowledge-based and information-processing perspective", *Journal of Product Innovation Management*, Vol. 22 No. 5, pp. 430-444.

Sparks, D. (2009), "Reach for the heart as well as the mind: leaders can take action to close the knowing-doing gap", *Journal of Staff Development*, Vol. 30 No. 1, pp. 48-54.

Spender, J.-C. (1996), "Making knowledge the basis of a dynamic theory of the firm", *Strategic Management Journal*, Vol. 17 No. S2, pp. 45-62.

Stenmark, D. and Lindgren, R. (2006), "System support for knowledge work: bridging the knowing-doing gap", *International Journal of Knowledge Management*, Vol. 2 No. 2, pp. 46-68.

Strauss, A.L. and Corbin, J.M. (1990), *Basics of Qualitative Research. Techniques and Procedures for Developing Grounded Theory*, SAGE Publications, Newbury Park.

Sutton, D.C. (2001), "What is knowledge and can it be managed?", *European Journal of Information Systems*, Vol. 10 No. 2, pp. 80-88.

Tohidinia, Z. and Mosakhani, M. (2010), "Knowledge sharing behaviour and its predictors", *Industrial Management & Data Systems*, Vol. 110 No. 4, pp. 611-631.

Watson, S. and Hewett, K. (2006), "A multi-theoretical model of knowledge transfer in organizations: determinants of knowledge contribution and knowledge reuse", *Journal of Management Studies*, Vol. 43 No. 2, pp. 141-173.

Wegner, D.M. (1987), "Transactive memory: a contemporary analysis of the group mind", In Mullen, B. and Goethals, G.R. (Eds.), *Theories of Group Behavior*, Springer-Verlag, New York, pp. 185-208.

Yin, R.K. (2002), *Case Study Research: Design and Methods*, Sage Publisher, Thousand Oaks, CA.

Young, M.-L., Kuo, F.-Y. and Myers, M.D. (2012), "To share or not to share: a critical research perspective on knowledge management systems", *European Journal of Information Systems*, Vol. 21 No. 5, pp. 496-511.

Zahra, S.A. and George, G. (2002), "Absorptive capacity: a review, reconceptualization, and extension", *Academy of Management Review*, Vol. 27 No. 2, pp. 185-203.

Zyngier, S. and Burstein, F. (2012), "Knowledge management governance: the road to continuous benefits realization", *Journal of Information Technology*, Vol. 27 No. 2, pp. 140-155.

Appendix 1. Barriers of knowledge application

Table AI provides an overview of barriers of knowledge application both identified in literature and our multiple-case study. While literature provides selected barriers to knowledge application, a comprehensive overview is missing yet. In our synthesis, we identified barriers as described in both the literature and our respondents. In aggregating the barriers, we paid attention to avoid potential semantic ambiguities. Following Shaw and Gaines (1989), we considered between four possible semantic constellations: consensus (same terminology for same concepts), correspondence (different terminology for same concepts), conflict (same terminology for different concepts) and contrast (different terminology for different concepts) and discussed ambiguities. In line with previous research, we differentiate barriers originating at individual, group and organisational level.

Table AI Barriers inherent in the knowing-doing gap as described in literature, as well as identified in our multiple-case study (differentiated in column references)

Barrier	*Description*	*References*
Individual		
Information overload	Employees are often exposed to significant amounts of information. Instead of focusing on the implementation of their knowledge, they tend to augment it. This leads them to feel overwhelmed and to forget newly acquired knowledge.	Blanchard *et al.* (2007)
Lack of trust in source	Typically, employees do not have sufficient time to evaluate all available information in detail to identify useful knowledge. Instead, they evaluate knowledge based on a subjective assessment of the source's trustworthiness. Knowledge is rejected if the source is not considered trustworthy.	Davenport and Prusak (2000)
Negative mindset	Due to a negative mindset, employees filter information (e.g. acquired by reading or listening) and only a small part remains in personal memory. Thus, existing knowledge is only partially applied to solve new problems.	Blanchard *et al.* (2007)
Lack of follow-up	In case of employees gaining new knowledge (even with training), it is necessary to think about a plan for knowledge post-processing. Without such a plan, it is likely to return to daily work applying old practices.	Blanchard *et al.* (2007)
Stubbornness and pride	Individual behaviours are characterised by stubbornness and pride. Thus, employees do not rely on existing knowledge and prefer to use their own solutions.	Davenport and Prusak (2000)
Lack of time or opportunity	Individuals do not have the time or ability to deal with existing knowledge. As a result, they turn to their own solution.	Davenport and Prusak (2000)
Existence or source of knowledge unknown	Employees are not aware of the existence of either the knowledge or its source (KM system or colleague). When trying to solve a problem, employees do not start searching or stop searching without any useful results.	Multiple-case study
Inappropriate knowledge	The knowledge that employees find cannot be applied to their problem since it is wrong or outdated. Consequently, they have to start searching again or stop searching without any meaningful results.	Multiple-case study
Application too complex	Useful knowledge is too complex or too detailed to be applied. Instead of relying on existing knowledge, employees try to solve the problem on their own since they perceive their way to be less time-consuming.	Multiple-case study
Information hiding	Employees deliberately withhold knowledge from colleagues. Consequently, employees searching for knowledge are not granted access. Information hiding results from or is intensified by Internal Competition (Bordia *et al.*, 2006) and Culture of Fear. However, since information hiding may also be a consequence of a personal attitude (Connelly *et al.*, 2012; Connelly and Zweig, 2014), we consider it as a separate barrier on individual level.	Multiple-case study
Unknown problem	Employees are unaware of the actual problem due to its novelty or complexity. As a result, there is no indication how to search for existing knowledge and the employees themselves solve the problem.	Multiple-case study
Laziness	Individuals reject knowledge of others, or are not interested in searching for a better solution, since they do not want to deal with it.	Multiple-case study

(*continued*)

Table AI

Barrier	*Description*	*References*
Accusation protection	To avoid being blamed for problems resulting from applying knowledge of others, employees ignore existing knowledge. This barrier might result from Culture of Fear or Internal Competition.	Multiple-case study
Dispensability protection	By applying existing knowledge, employees worry that they might appear obsolete. As a result, they tend to ignore it during their problem-solving activity.	Multiple-case study
Moral concerns	Employees have concerns regarding application of existing knowledge, as it contradicts their moral values.	Multiple-case study
Group		
Constraints on transactive memory[6]	If the transactive memory of a group of employees is insufficient, the search for relevant knowledge is aggravated. Furthermore, employees might not be aware of the existence of knowledge, and thus knowledge application cannot take place.	Alavi and Tiwana (2002)
Insufficient mutual understanding	Mutual understanding between individuals in groups facilitates their understanding and interpretation of the communicated knowledge. This understanding is formed primarily through exchanges with other individuals and joint problem-solving within teams. Lack of mutual understanding (e.g. in virtual teams) complicates the interpretation of the communicated knowledge.	Alavi and Tiwana (2002), Krauss and Fussell (2014)
Failure in sharing and retaining contextual knowledge	Typically, contextual knowledge, such as access to information or the physical design of the organisation, is established by observations and shared experience. Lack of contextual knowledge leads to misunderstandings, as well as misinterpretations, and complicates the application of knowledge.	Alavi and Tiwana (2002)
Inflexibility of organisational ties	In case of independent organisational units or virtual teams, only weak organisational commitment exists. As a result, knowledge is unevenly transferred within teams and some employees are less knowledgeable than others. Thus, application of the entire team's knowledge will be more difficult.	Alavi and Tiwana (2002)
Not-invented-here syndrome	An organisational unit reduces the communication with other units and rejects their knowledge, as they are keen to create proprietary, internal knowledge base.	Multiple-case study
Organisation		
Talking instead of action-taking	A sole decision does not lead to the implementation of organisational knowledge. People, for instance, tend to confuse the establishment of plans with their actual implementation. While conducting meetings, drafting reports or formulating a corporate philosophy is valuable, such measures do not lead directly to a change in the company.	Pfeffer and Sutton (2000)
Use of old methods[7]	Companies often fail to make efficient use of existing knowledge for performance improvements if employees only rely on precedents or standardised procedures. Consequently, employees solely rely on old methods for solving novel problems, even if these are inappropriate in the specific situation. A reflection of current practices does not take place and is unlikely to be accepted by the organisation.	Pfeffer and Sutton (2000)
Culture of fear	Companies fail to transform their existing knowledge into action when the culture is characterised by fear and mistrust. Employees are afraid of job losses, pay cuts or demotions. Due to this fear, they are prevented from presenting suggestions for improvement, as they have to admit that certain things do not work.	Pfeffer and Sutton (2000), Davenport and Prusak (2000)
Inappropriate evaluation systems	Through the specification of evaluation criteria, the focus of the work employees perform is on meeting these criteria. Other value-adding activities are neglected since they do not contribute to the performance evaluation of the employee. When the focus is solely on short-term (e.g. financial) goals, the use of rating systems prevents the application of knowledge.	Pfeffer and Sutton (2000)
Internal competition	Knowledge is a source of differentiation between employees. Employees tend to keep their knowledge to themselves to maintain their status as experts. Relying on the knowledge of others is thus akin to a confession of inferiority and inability.	Pfeffer and Sutton (2000)
Missing or complicated search option	Employees lack adequate means for conducting effective search; thus, knowledge cannot be intuitively identified.	Multiple-case study
"Asking questions" not part of culture	Corporate culture forbids asking questions. Employees that ask questions are punished, since this discloses ignorance and weaknesses.	Multiple-case study

Appendix 2. KM systems in use at case companies

Table AII KM systems in use at case companies

Case A	*Case B*	*Case C*	*Case D*	*Case E*
Wiki Blog Documentation database	Wiki Mailing list Project management	Wiki Version management Issue and ticket management	Wiki Intranet Software for application documentation	Wiki Intranet Forum
Forum	Dependency management	Corporate short message service	Database for standards	Version Management
Intranet SharePoint	Version management		Lotus Notes database Forum	Project management Issue and ticket management
Ticket management			Issue and ticket management	Database for standards
Version management			Defect and test management Version management	Requirements management tool

Appendix 3. Interview guide

The interview guide was jointly developed by the authors of this paper based on an intensive literature research on KM, the knowing-doing gap and problem-solving in general. During two independent test interviews, we checked the suitability of the chosen questions, as well as the sequence of the interview. Based on these insights we adapted the interview guide. The final version followed the structure described below. The first part was devoted to introducing the interviewer, explaining the study purpose and outlining the course of the interview. Moreover, we ensured that respondents shared our understanding of the difference between knowledge transfer and knowledge application.

The second part contained questions about the respondents' background to set the data in context with their professional experience.

- Which is your highest degree of education? Which subject?
- What position do you hold in your company?
- What is your main task in your company?
- How long have you been working for your company and in your role?
- How many years of experience do you have in the software development industry?

  Part three addressed the clarification of key concepts and the collection of KM processes and systems in use.

1. What do you understand by KM and what does it mean for you and your company?
2. If we now only consider knowledge application as the last process step: What significance can be attributed to knowledge application?
3. Does your company execute KM and has processes, procedures or standards (e.g. training) in place? Do you use KM systems? Since when? What benefits do you see in the KM systems? How do you think the KM systems are being used? Are there any guidelines for knowledge application existing in your company? Do your KM systems support you in the process of knowledge application?
4. What knowledge is typically used in software development? You are welcome to give examples of a typical knowledge asset.
   - Explicit: context-independent, articulated and communicable, facts, formulas, procedures, documents.
   - Implicit: personalised and context-dependent, in the experiences, values rooted in a person, is not easy to convey.

The fourth part identified the general approach to problem solving, along with situations in which the respondent has applied existing knowledge in his/her daily work and the potential role of IT in these situations (i.e. knowledge as support for action).

1. We are now looking at your personal experience with the application of knowledge: How do you basically solve a problem? Which sources do you use? E.g. self-solving, seek contact with experienced employees, look up in KM systems, literature, etc.
2. Are there any guidelines on how the employees work to solve problems in everyday work? Are there any defined processes? Is there a standard/guideline for the application of knowledge in your company? Any policies or processes?
   - Which policies/guidelines are existing?
   - Are the employees adhering to these guidelines? Why not?
   - Do you think there should be guidelines? Which ones?
3. Can you remember the last time you have applied existing knowledge from your company (knowledge from KM systems, from other employees)?
   - Which way did you come to the knowledge? And who or what was the source of knowledge?
   - Please describe what kind of knowledge you have used (e.g. explicit and implicit).
   - How did it help you to solve your present problem?
   - What difficulties did you have while applying this knowledge?

The final part addressed situations in which the respondent had intentionally not used existing knowledge. Moreover, the interviewees were asked to identify both hypothetical reasons for the non-use of knowledge and possible counteractions.

1. Previously, we talked about positive experiences with the application of knowledge. Now, we will talk about situations where you have not used knowledge. Was there already a situation in which you have deliberately not applied existing knowledge (e.g. from other employees, from KM systems, literature, etc.)? We are talking about situations where you have been aware of existing but have consciously decided not to apply this knowledge.
   - What reasons did you have to not apply this knowledge? What factor would have eased the application of the knowledge in this situation? Did you miss tools, processes, the possibility in general to find the relevant knowledge? What could you have done better in this situation?
   - Have you ever been in a different context noticing that existing knowledge has not been applied? Do you know the reasons for this situation? What factor would have eased the application of the knowledge in this situation?
   - Have you ever heard of other employee who consciously did not apply existing knowledge?
   - In your own opinion, what is the main reason for not applying existing knowledge? Are there any more reasons?
2. So far, we have discussed your own experiences and your concrete working situations in which you were confronted with the application of the knowledge. Now we would like to discuss with you together what problems might to exist to not apply knowledge in general and what action you think could be used to work around the problem.
   - What incentive mechanisms could you use to promote the knowledge application of employees? What guidelines can be in place?
   - Does your company offer training? Which measures support the knowledge application after the training?
   - Could you imagine a situation where you would not apply existing knowledge but rather solve the problem independently?

- What reasons could stop you from applying this knowledge? What would have made the application easier for you? Did you miss the existence of tools, processes, opportunities for looking for relevant knowledge?
- Problem of information overload: It is not possible to have an overview of all relevant and existing knowledge. How can the search be made more efficient?
- Which systems or processes support companies in the application of knowledge?
- What motivation do you have for searching for and applying existing knowledge (from other employees, from KM systems, literature, etc.)?
- Are there any processes or incentives to apply knowledge in your daily work? Do you think it makes sense to implement incentives?
- Do you wish your company would provide more specific guidelines for the application of knowledge?
- What difficulties do you see in the application of knowledge? Have you ever felt exposed to these difficulties? Can you imagine this situation? What could you do about this too fix the problem?

Appendix 4. Coding system

Table AIII Themes, codes and exemplary codings

Theme	*Code*	*Coding example*
Consequences of the knowing-doing gap		
Individual	Employees become indispensable	"Coding or applying something in a way that someone else does not understand makes me indispensable" (D4)
	Knowledge becomes outdated	"The wiki constantly puffs up and has been in use for quite a long time [. . .] Thus, that many things are outdated" (C3)
Group	Making mistakes	"We have to do everything pretty fast and probably do more harm than good" (D3)
Organisational	Ineffective KM	"The employer does not benefit from knowledge that is not applied" (E1)
	Unnecessary effort	"Through a cascade of questions, you keep the organisation busy. This is something you prefer to avoid. I ask you. And you let me know that you know something and then take a look yourself. Then, you remind yourself of someone who might know something else. Then, you have three or four people who are busy with the same issue" (D1)
The role of IT		
Simplifications through IT	Step-by-step instructions	"If it is a problem, where you have a clear sequence of steps and do not need to think much along, then you do it that way. That can be found in the wiki, which is perfectly adequate" (D3)
	Useful examples	"Insofar, I remembered that the wiki included examples that were written by a developer. I explicitly knew where to find them in order to directly get help with similar data structures" (B2)
	Code reuse	"Of course, there is already a lot of knowledge. You can thus acquire certain solutions from other projects. If you remember that we have once implemented a mass e-mail service, then you just use the version control system to directly view the code" (B1)
	Reduction of complexity	"The wiki documents very complex structures. It shows which actions exist for which functions in a tabular way. You quickly find a point of reference to find what you are looking for" (A3)
	Expert catalogue	"There is an approach called skills management [. . .] Its purpose is the generation of profiles, that you provide information about your projects and roles and skills" (C4)
	Automation through IT	"[A colleague] has written configurations that allows developers to automate by fingertips [. . .] that are automated extensions [. . .] where you can configure what should happen" (A1)

(*continued*)

Table AIII

Theme	*Code*	*Coding example*
Social effects of IT	Anonymity	"I simply do not ask certain people because they react in a way that make me feel goofy. In some cases, that might be right, but let us presume that most people who work here are not stupid" (D2)
	Social dissonance	"People that document a lot are given the devil's eye by management: 'Do you have nothing to do? Why do you have the time for so many posts?' [. . .], which is seen as negative. That can happen as well. Then, the people are rather reluctant" (D4)
	Evaluation	"The employee who wrote the article receives a notification. I actually use it [. . .] but you need to use it the right way. When I give my 'Like' to everything, that makes no sense" (A1)
	No control over knowledge	"She documents everything. She is really good in documenting. She shares some things, but she does not make them public; instead, she distributes them among her narrowest circle of colleagues [. . .] However, she would never provide the knowledge in a wiki" (D4)
Central IT platform	Lack of integrated IT systems	"Well, you can, of course, give him the information sources. However, when he invokes only three out of five of those sources, he still might not find the decisive factor" (D1)
	Wiki as integrated IT system	"As long as there is a meaningful information, [it is stored] directly in the wiki. Each employee has access, that is, when we see somehow that something is wrong or outdated, then it should be revised immediately" (C3)
	Wiki degeneration	"The wiki constantly puffs up and has been in use for quite a long time [. . .] Thus, that many things are outdated" (C3)
	Ineffective Search	"CVS is a system that does not allow to search, only to store. [In this regard], our intranet is also on a stone-age level" (E1)
Communication	Internet as knowledge source	"For this, the mass is simply too low. On the Internet, I do not give up that quickly. When I search the Internet, I assume that someone had the exact same problem before and I just have to keep looking. I do not believe that this is the case here. Here, if I find something, in whatever medium, that somehow fits, I expect that I must help myself to transfer that knowledge to my specific problem. Personally, I also find recipes for professionals much better than recipes for beginners because they are more compact and easier to read" (E4)
	Modern technology	"WebEx enables meetings, where you conjointly take a look at a PowerPoint or program, while being at distributed locations [. . .] That helps for some parts; that you move closer together" (A2)
Measures to overcome the knowing-doing gap on people, process and IT level		
People	Corporate culture	"It must always be possible to ask technical questions, from both sides. Even though the one asking me a question is not sympathetic, I should still provide him with an answer" (D5)
	Incentives	"My motivation for accepting others' knowledge is inherent. As a software developer, you need to apply others' knowledge. [. . .] You cannot keep reinventing everything. [. . .] I need to enhance myself; I have to apply knowledge of others to get ahead" (C2)
	Responsibilities and reference persons	"If there is a question about the product, employees know that they should call me or the head of product development, as we can answer all questions. It is thus not necessary to go around seven places." (C1)
	Mentoring	"[Mentors] typically know about the knowledge of others. Hence, the employee can ask the mentor and then consult other employees" (D5)
Process	Standards	"Do not define standards [. . .] people work here and people have preferences and if you disregard these, I think, you make a big mistake" (E4)
	Corporate events and communities of practice	"Our developer meeting is another support. We do this bi-weekly. It usually takes an hour and typically there is also a scheduled lecture. [. . .] The speaker is in most cases a developer as well" (A2)
	Reviews	"Therefore, we have these code reviews. You should be quite critical. In some parts, I have completed code reviews five times before finally closing them" (C3)

(*continued*)

Table AIII

Theme	*Code*	*Coding example*
	Training	"[Companies] should not count on knowledge simply being created and transferred. Instead, you need to raise awareness among the staff and include it in training programs" (D5)
	Job rotations	"We also do job rotations. Most recently, [. . .] a member of staff – an absolute PHP expert – should learn other programming languages. So, we say 'We have some adequate projects, where he can work himself into that topic [. . .] This is a job rotation because he learns – parallel to his current activities – new technologies, new programming patterns [. . .] But it does not make sense for a developer to sit at the welcome desk" (B2)
IT	Automation	"It is useful; you do not have to read or do anything. The obstacles are relatively low and the benefits are high." (A1)
	Search tools	"Well, you can, of course, give him the information sources. However, when he invokes only three out of five of those sources, he still might not find the decisive factor." (D1)

Corresponding author

Dirk Basten can be contacted at: dirk.basten@gmail.com

For instructions on how to order reprints of this article, please visit our website:
www.emeraldgrouppublishing.com/licensing/reprints.htm
Or contact us for further details: permissions@emeraldinsight.com