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A Taxonomy of Information System Projects' Knowledge-sharing Mechanisms

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Abstract:

Despite its criticality to the success of information system (IS) projects, knowledge sharing among IS projects is generally ineffective compared to knowledge sharing in IS projects. Although several mechanisms for knowledge sharing exist in the literature, it is difficult to determine which mechanism one should use in a specific context. We lack work that concisely and comprehensively classifies these mechanisms. Based on a literature review, we extracted information from 33 studies and identified twelve mechanisms for sharing knowledge among IS projects. Then, we derived a taxonomy for these mechanisms, which extends previous research by both adapting existing mechanisms and complementing the set of dimensions used for their classification. The results help to systematically structure the fields of knowledge management and IS projects. Both research and practice can use this taxonomy to better understand knowledge in this domain and effectively adopt mechanisms for a particular application.

Keywords: Knowledge Sharing, Information System Projects, Taxonomy-development Method, Literature Review.

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1 Introduction

In response to the increasing competitive pressure that globalization generates, many organizations rely on information systems (IS) to implement projects for change. Consequently, global IS spending continues to increase (Pettey & Goasduff, 2013; Rivera & Goasduff, 2014). However, despite these investments, IS projects are notorious for their failures, and researchers emphasize the persistent challenges involved in successfully execute IS projects (Cerpa & Verner, 2009; Joosten, Basten, & Mellis, 2014; Keider, 1984; Keil, 1995; Pankratz & Basten, 2013; Yeo, 2002).

Prior studies indicate that IS projects' success depends on how well teams share knowledge (Slaughter & Kirsch, 2006; Staples & Webster, 2008). Knowledge sharing supports teams' decision making and contributes to team effectiveness (Staples & Webster, 2008). Organizational performance increases with the intensity of knowledge sharing among members of different work groups (Cummings, 2004). However, knowledge sharing among IS projects is ineffective compared to knowledge sharing in a single IS project team (Newell, Tansley, & Huang, 2004; von Zedtwitz, 2003) because team members rarely capture and transfer valuable knowledge obtained on IS projects to other projects (Petter & Randolph, 2009). The failure to acquire knowledge from other projects—both in and outside the organization— leads to the reinvention of solutions and repetition of past mistakes (Tiwana & Ramesh, 2001). Research presumes that an insufficient understanding of knowledge-sharing mechanisms causes ineffective inter-project knowledge sharing (Newell, Bresnen, Edelman, Scarbrough, & Swan, 2006). Although a plethora of research exists on various aspects of knowledge sharing among IS projects (Ghobadi, 2015; Pee, Kankanhalli, & Kim, 2010; Reich, 2007), few studies have considered the issue of which mechanisms one can apply in a particular context for effective knowledge sharing among IS projects. Thus, existing knowledge-sharing mechanisms lack a concise and comprehensive classification and structure that could reduce the uncertainty and heterogeneity about appropriately using these mechanisms in specific contexts. In particular, the dimensions used to structure knowledge-sharing mechanisms are presently limited to codification versus personalization (Hansen, Nohria, & Tierney, 1999) and individualization versus institutionalization (Boh, 2007). To address the identified research gap, we address the following research question:

> **RQ**: What mechanisms for knowledge sharing among IS projects can one apply in specific contexts?

We close the research gap to obtain an overall understanding of the existing mechanisms in the literature. We begin by identifying existing mechanisms for knowledge sharing among IS projects in the previous literature. We then develop a taxonomy that evokes and classifies the identified mechanisms. We predominantly contribute to the literature by identifying and classifying mechanisms for knowledge sharing among IS projects through developing an appropriate taxonomy. Classification is one of the most critical tasks in research not only for conceptualization but also for reasoning, data analysis, and other issues (Bailey, 1994; Paré, Trudel, Jaana, & Kitsiou, 2015). In the knowledge management and IS project domains, the classification task is a means to structure and organize knowledge and can help both researchers and practitioners to better understand these domains. Barki, Rivard, and Talbot (1988) summarize the benefits of developing and using classifications as follows:

- Classifications describe the field and help IS researchers understand and analyze the observed research domain.
- Classifications help IS researchers develop a common vocabulary and reduce the number of synonyms for specific terms.

Taxonomy is one possible form of classification and plays a significant role in research and practice (Nickerson, Varshney, & Muntermann, 2013; Paré et al., 2015). Specific features of taxonomy include its ability to structure different concepts and the relationships among them (Glass & Vessey, 1995; McKnight & Chervany, 2001). Furthermore, taxonomy helps one understand the differences among various research findings (Sabherwal & King, 1995). Terms such as framework or typology describe other classification. Although researchers sometimes use the term typology to describe the process of conceptually structuring different objects into multidimensional complex categories (Bailey, 1994; Doty & Glick, 1994), studies in the literature most commonly use the term taxonomy (Nickerson et al., 2013). Further, they use it as a synonym for terms such as typology or classification scheme (Gregor, 2006). One can consider a framework as a kind of holistic and concise description of an observed domain that covers its main elements, concepts, and principles. One can use a framework to visualize the relationships and interactions among its components and to provide guidance for implementation and application processes

(Weber, Wunram, Kemp, Pudlatz, & Bredehorst, 2002). A further refinement concerns whether the term taxonomy refers to a process or a product. Bailey (1994) argues that the term can refer to both: that it denotes the classification process itself and the product that results from the classification process. Thus, in this paper, we follow tradition and use the term taxonomy to describe the overall result (i.e., the product). In summary, our taxonomy adds to existing research by structuring and complementing the set of dimensions used by researchers to classify existing mechanisms for knowledge sharing.

This paper proceeds as follows. In Section 2, we overview existing streams of literature concerning knowledge-sharing mechanisms in IS projects. In Section 3, we describe our two-phase research approach of reviewing previous literature and developing the taxonomy. In Section 4, we present the results of the review and the taxonomy development. Finally, in Section 5, we summarize the paper and discuss our findings.

2 Knowledge Sharing among IS Projects

We adopt the definition of IS projects as temporary endeavors undertaken to design, develop, and implement an IS product, service, or process (Karlsen & Gottschalk, 2004). Such projects are difficult undertakings and possess certain features that differentiate them from other types of projects, such as those in the construction and pharmaceutical development fields. The main unique requirements for IS projects include team members with technical skills and continual technological upgrades and improvements (Snyder & Parth, 2006). IS projects are less transparent, lack appropriate data about previous experiences due to differences among IS projects, are more prone to technological changes, and need to address the complicated task of specifying user requirements (Pankratz & Basten, 2013, 2015). IS projects require specialized approaches that differ from those appropriate for other types of projects. In such projects, team members need to adequately share knowledge to increase the likelihood of IS project success (Cerpa & Verner, 2009; Keider, 1984; Keil, 1995; Pankratz & Basten, 2013; Yeo, 2002).

Knowledge sharing has attracted considerable attention (Eisenhardt & Santos, 2002) because it is essential to innovation, organizational learning, management of perceived challenges, increased productivity, and the exploration of emerging opportunities (Ghobadi, 2015; Mooradian, Renzl, & Matzler, 2006). We adopt the definition of knowledge sharing as providing or receiving task information, know-how, and feedback regarding a product or procedure (Hansen, 1999). Given this definition, we view knowledge sharing as not only a communication process involving a specific task but also a complex process that involves both explicit and tacit knowledge (Nonaka, 1991; Polanyi, 2009).

Although much research has examined various aspects of knowledge sharing in individual IS projects, few studies have addressed knowledge sharing and knowledge-sharing mechanisms among multiple IS projects. Researchers have defined IS projects' knowledge-sharing mechanisms in various ways. Such mechanisms constitute "methods, procedures, or processes involved in how knowledge sharing might occur" (Chai, Gregory, & Shi, 2003, p. 8) and refer to "the formal and informal mechanisms for sharing, integrating, interpreting and applying know-what, know-how, and know-why embedded in individuals and groups that will aid in the performance of project tasks" (Boh, 2007, p. 28).

Based on these definitions, we define IS projects' knowledge-sharing mechanisms as the formal and informal methods, procedures, or processes for sharing knowledge embedded in the individuals and groups that comprise a particular IS project with other IS projects. Among the few existing studies on this subject, Rech, Höcht, and Haas (2007) describe how a wiki framework acts as a knowledge-sharing platform for IS projects. Additionally, Petter and Vaishnavi (2008) provide a model for transferring experience among IS projects. Nevertheless, we need to carefully analyze and understand knowledge sharing in a broader context (Loebbecke, van Fenema, & Powell, 2016).

To date, research has differentiated between two dimensions of knowledge-sharing mechanisms: the codification-versus-personalization dimension (Hansen et al., 1999) and the individualization-versus-institutionalization dimension (Boh, 2007). According to the first dimension, which Hansen et al. (1999) introduced, individuals share codified knowledge through a codification mechanism whereby one extracts the knowledge from the person who developed it and then codifies it in databases or documents where different members of the organization can access and use it. In contrast, under the personalization mechanism, individuals share tacit knowledge that is closely tied to the individual who constructed primarily through direct person-to-person contact (Desouza & Evaristo, 2004). Therefore, the latter mechanism is often more ad hoc and informal. Boh (2007) introduced individualization versus institutionalization to describe the second dimension of knowledge-sharing mechanisms. The main difference between individualization and institutionalization relates to whether the mechanisms used to support knowledge sharing occur at the individual level or the collective level. Through individualized mechanisms, individuals or small groups share knowledge is among themselves. In contrast, institutionalized knowledge-sharing mechanisms enable one individual to share knowledge to many others. These mechanisms are structured as organizational routines.

Although certain studies have reported on mechanisms for knowledge sharing among projects, we lack an in-depth study of the appropriate mechanisms for particular contexts, and we lack work that concisely and comprehensively classifies these mechanisms. Based on previous research that applies contingency theory to IS projects (e.g., Pankratz & Basten, 2015), we suggest that the effectiveness of mechanisms for sharing knowledge depends on the context. According to contingency theory, no single way of managing and organizing fits best in all contexts (Hanisch & Wald, 2012; Taylor, 1911). Standards that provide generally acknowledged practices across a wide range of projects even suggest approaches to customized project management (Vom Brocke & Lippe, 2010). According to the PMBOK Guide, "good practice does not mean the knowledge described should always be applied uniformly to all projects" (Project Management Institute, 2004, p. 4). In addition to the dimensions we mention above, a taxonomy needs to account for factors that impact the context of IS projects in general (e.g., the role of culture) (Aman & Nicholson, 2009; Boden, Avram, Bannon, & Wulf, 2012).

3 Research Approach

3.1 Phase I: Literature Review

We reviewed the literature to synthesize existing mechanisms for knowledge sharing among IS projects. Conducting literature reviews is an elementary step of every research project to obtain an overview of the investigated research domain. Furthermore, a literature review allows one to summarize, compare, and critique recent research efforts in a structured manner (Tranfield, Denyer, & Smart, 2003; Webster & Watson, 2002). Because we focus on providing a structured overview of existing knowledge-sharing mechanisms and then integrate these mechanisms into an appropriate taxonomy, a literature review fits well with our objectives. We followed guidelines for systematically reviewing the literature (Kitchenham & Charters, 2007) that researchers in the information systems field have widely applied (Afzal, Torkar, & Feldt, 2009). According to these guidelines, in a literature review, one focuses on defining the following artefacts (Kitchenham & Charters, 2007):

a) The rationale for the review and the research questions that the review intends to answer.
b) The literature-search strategy, study-selection criteria, and quality-assessment procedures.
c) The data-extraction strategy and synthesis of the extracted data.

We reviewed the literature (a) to summarize existing mechanisms for knowledge sharing among IS projects. This rationale is important because it is the premise for developing the taxonomy (see our research question in Section 1).

We began our search strategy (b) by searching in the following electronic databases: EBSCOHost, ScienceDirect, IEEE Xplore, ProQuest and AISeL. We searched within titles, abstracts, and keywords by joining the terms knowledge, sharing, and IS projects and their synonyms. We performed both forward (via Google Scholar) and backward searches. We selected studies using a tollgate approach (Afzal et al., 2009).

After searching in all five databases, we obtained an initial set of 2,506 studies. We then excluded the following types of papers:

- Papers related to knowledge sharing among IS projects.
- Papers that did not describe any the mechanisms for knowledge sharing among IS projects.
- Pure discussion or literature review papers.
- Papers not in English.

As a result, 27 primary papers remained, though we subsequently added six more papers that we obtained through backward and forward searching. Figure 1 summarizes our selection process.

We employed a three-point Likert scale to assess the quality of the studies (Nidhra, Yanamadala, Afzal, & Torkar, 2013). The respective quality criteria (QC) were as follows:

(1) Is the topic the research paper addresses relevant to our literature review?

(2) Does the research paper describe mechanisms for knowledge sharing among IS projects at all?

(3) Does the research paper contain any case that describes how IS projects apply knowledge-sharing mechanisms?

(4) Does the research paper explain the context of knowledge sharing?

(5) If the paper met a criterion, we gave it a score of 1. If it partially satisfied a criterion, we gave it a score of 0.5. If it did not meet the criterion at all, we gave it a score of 0. We considered a paper as having high quality if scored above or equal to 3, medium if it scored between 3 and 1 or equal to 1, and low if it scored below 1. Because we scored all papers as medium or high quality (see Table 4 in Appendix A), we did not exclude any of them. We extracted two types of data (c) from the primary studies: general information and specific information. General information comprised publication venue, name of author, title of the paper, and name of the publication database. Specific information mostly included mechanisms for knowledge sharing among IS projects. Moreover, we extracted information about the characteristics of these mechanisms as specific information. Data synthesis entailed summarizing and combining the results of the selected primary studies (Kitchenham & Charters, 2007). Our synthesis is mainly descriptive. We compiled a concept matrix to synthesize the extracted information (Webster & Watson, 2002), which we present in Section 4.

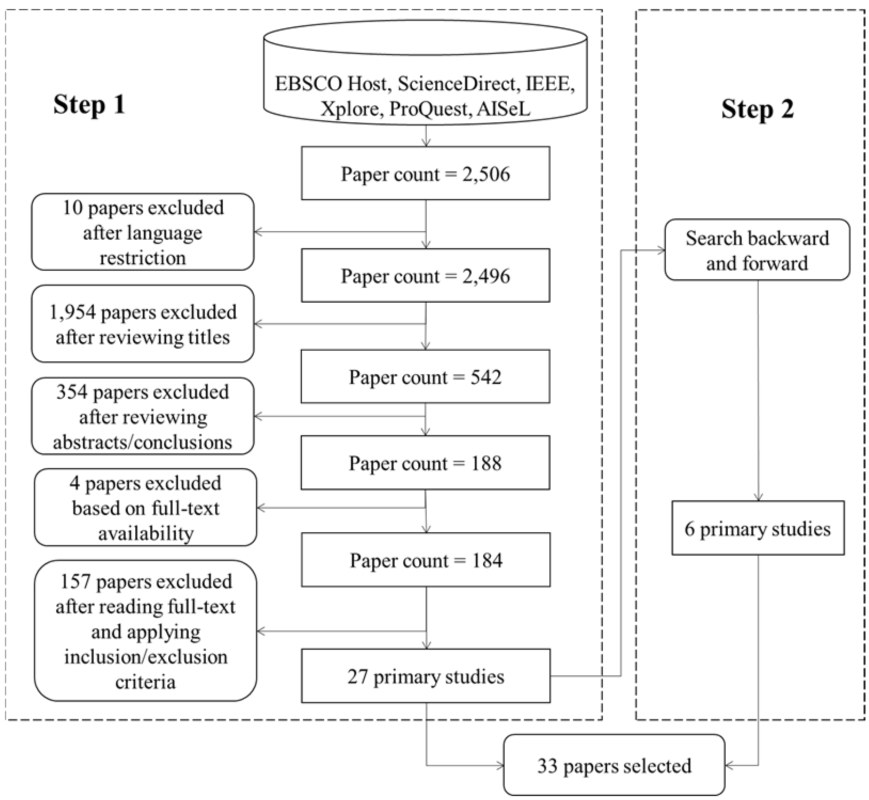

Figure 1. Two-step Filtering of Studies and Final Number of Primary Studies

3.2 Phase II: Taxonomy Development

Taxonomy plays an indisputable role in the development of a specific field not only because it systematically structures and organizes knowledge in this field but also because it can predict areas of future development (Glass & Vessey, 1995). According to Nickerson et al. (2013), a taxonomy is:

> *a set of n dimensions Di (i = 1, …, n) each consisting of ki (ki ≥ 2) mutually exclusive and collectively exhaustive characteristics Cij (j = 1, …, ki) such that each object under consideration has one and only one Cij for each Di.* (Nickerson et al., 2013).

Researchers in various disciplines (e.g., biology (Eldredege & Cracraft, 1980) and the social sciences (Bailey, 1994)) have proposed many methods to develop taxonomies. For the information systems field, Nickerson et al. (2013) propose a taxonomy-development method (see Figure 2) that has proven useful due to its simplicity, richness, completeness, and systematics (Nickerson, Varshney, Muntermann, & Isaac, 2009; Varshney, Nickerson, & Muntermann, 2013). This method combines the ideas and approaches of recent studies on taxonomy development by presenting a taxonomy-development method that suits both empirical and conceptual studies. Moreover, this method provides detailed guidance during the taxonomy-development process. Therefore, we follow this method for developing the taxonomy of mechanisms for knowledge sharing among IS projects.

The taxonomy development process starts with specifying a meta-characteristic, which derives from the users and purpose of the taxonomy and serves as a basis for the choice of characteristics (Nickerson et al., 2013). Next, one needs to determine both objective and subjective ending conditions. Subsequently, one identifies dimensions and corresponding characteristics through an empirical-to-conceptual or conceptual-to-empirical approach in iterative passes. One terminates the development process when all ending conditions (objective and subjective) are checked and found to be met.

One choose the meta-characteristic based on the taxonomy's purpose, which, in turn, should depend on the expected use of the taxonomy and should be defined by the taxonomy's eventual users (Nickerson et al., 2013). With respect to mechanisms for knowledge sharing among IS projects, researchers and leaders of IS projects constitute the taxonomy's users. This user group is interested in characteristics of the context in which knowledge is shared among IS projects. According to Dey (2001, p. 5), "context is any information that can be used to characterize the situation of an entity". This user group wants the ability to use the taxonomy to identify specific contexts in which individuals mainly use mechanisms. Specifically, the taxonomy's purpose is to distinguish among mechanisms for knowledge sharing among IS projects based on the context of the knowledge sharing. Such a taxonomy will help researchers and project leaders to decide which mechanisms one should choose in a particular context.

Based on that purpose, the meta-characteristic for our taxonomy-development process is the context of knowledge sharing among IS projects. In general, context includes who (identity), when (time), what (activity), and where (location) (Varshney, 2009). However, researchers have suggested that one could also employ additional constructs—such as how (process)—in cases that require a higher level of context richness and reliability (Varshney, 2009). Thus, we add "how" to the context because the process of sharing knowledge among IS projects is an important element of the knowledge-sharing context.

Nickerson et al.'s (2013) method is iterative and, thus, requires ending conditions to determine when to terminate the process. These conditions include both objective and subjective conditions. We define the following objective ending conditions for this taxonomy:

- We examined all selected objects.
- We merged no object with a similar object and split no object into multiple objects in the last iteration.
- We classified at least one object under every characteristic of every dimension.
- We added no new dimensions or characteristics in the last iteration.
- We merged or split no dimensions or characteristics in the last iteration.
- Every dimension was unique and not repeated.
- Every characteristic was unique in its dimension.
- Each combination of characteristics was unique and not repeated.

We adopt the following conditions as subjective ending conditions (Nickerson et al., 2013):

- **Conciseness:** a taxonomy should contain a limited number of dimensions, and each dimension should contain a limited number of characteristics. An objective criteria for this condition is that the number of dimensions should fall in the range of seven plus or minus two (Miller, 1956)
- **Robustness:** a useful taxonomy should include enough dimensions and characteristics to clearly differentiate the objects of interest.

- **Comprehensiveness:** a useful taxonomy should be comprehensive, which means that all descriptions should be complete. Complete descriptions imply that the taxonomy includes all dimensions of each object of interest.
- **Extendible:** a useful taxonomy should allow one to include additional dimensions and additional characteristics in a dimension when new types of objects appear.
- **Explanatory:** a useful taxonomy should contain dimensions and characteristics that provide helpful explanations of the nature of the objects under study or of future objects.

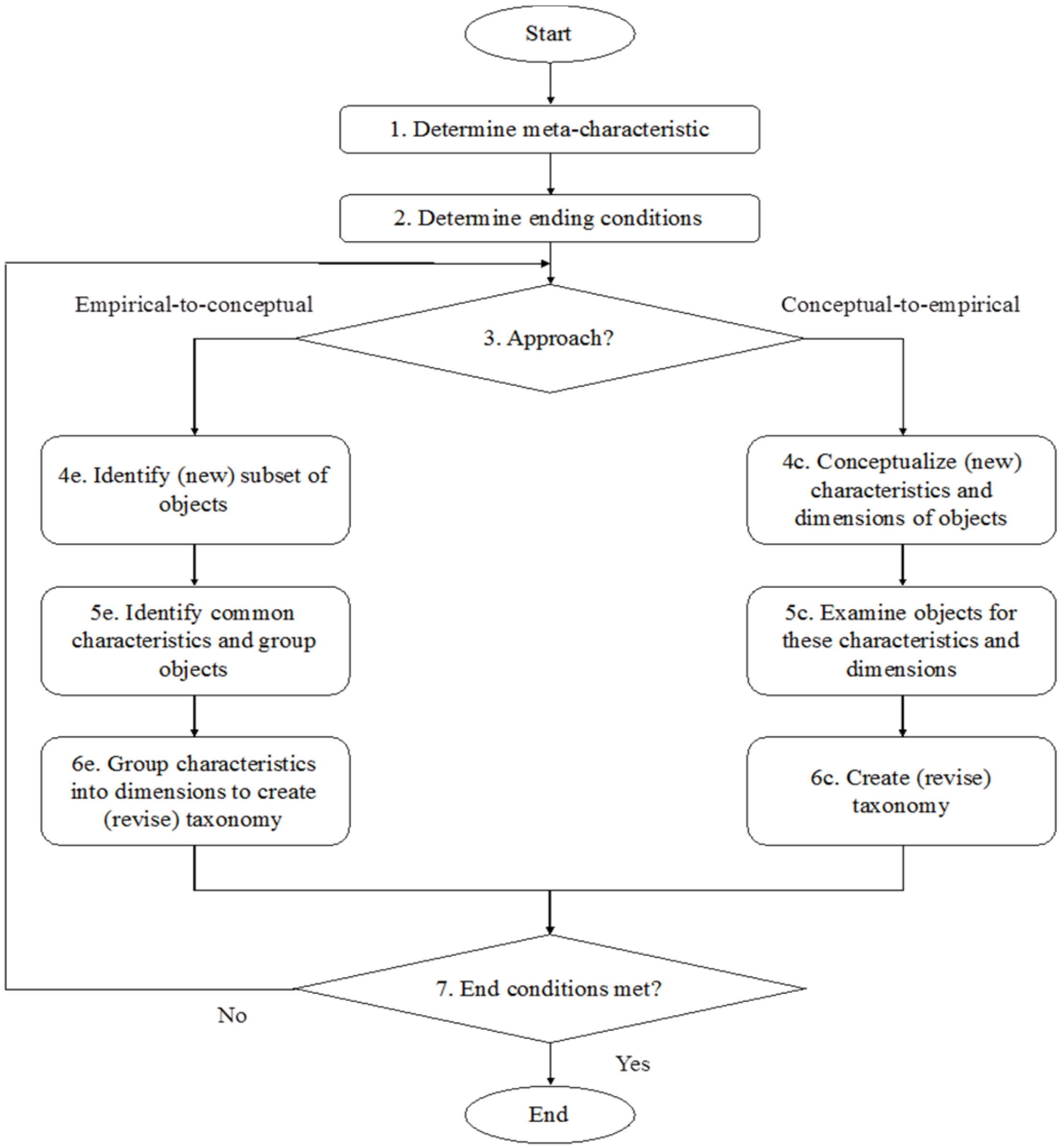

Figure 2. Flowchart of the Taxonomy-development Method (Nickerson et al., 2013)

Subsequently, one derives characteristics and dimensions in an iterative passes until the ending conditions are met. Step 3 can start with either an empirical-to-conceptual approach or a conceptual-to-empirical approach (Nickerson et al., 2013). What approach one chooses depends on the availability of data about the objects under investigation and the researchers' understanding of the domain. In the empirical-to-conceptual approach, one first identifies a subset of objects (Nickerson et al., 2013). These objects could be those that one knows well or a random sample. One needs to identify these objects' common characteristics, and these characteristics should be logical consequences of the meta-characteristic. Then, one can group characteristics into dimensions. In the conceptual-to-empirical approach, we start by conceptualizing the dimensions of the taxonomy without examining actual objects

(Nickerson et al., 2013). As in the empirical-to-conceptual approach, these dimensions should contain characteristics that are logical consequences of the meta-characteristic. Then, one can begin examining objects for these dimensions and characteristics. This process results in an initial taxonomy based on a conceptual-to-empirical approach. One should repeat the process until all ending conditions are satisfied. We present the detailed iterative process in Section 4.

4 Results

In this section, we describe the identified IS projects' knowledge-sharing mechanisms. Subsequently, we provide the results of the taxonomy development.

4.1 Results of Literature Review

Table 1 overviews the identified mechanisms for knowledge sharing among IS projects and the respective publications. We labeled the mechanisms that the identified studies explicitly described accordingly. We labeled mechanisms that the studies did not explicitly name in the literature despite their relevance with an appropriate descriptive code. We identified the studies and coded the results. Specifically, the second author performed the initial classification and the first and third attempted to identify alternatives by acting as the devil's advocates (Eisenhardt, 1989). We all subsequently discussed and evaluated the results. We describe the identified mechanisms below.

4.1.1 Communities of Practice

Communities of practice emerge from a work- or interest-related field (Kähkönen, 2004), and members join voluntarily. Such communities are usually connected, self-managed, and informal (Mestad, Myrdal, Dingsøyr, & Dybå, 2007). For example, Paasivaara and Lassenius (2014) describe how communities of practice took on various important roles in a large software development organization in Ericsson. Initially, these communities of practice offered a forum in which cross-project team members could discuss how to employ agile development practices. As the transformation progressed, communities of practice started to focus on organization-wide issues and to consider the organization as a whole. Rather than sharing knowledge between two IS project teams, communities of practice form networks that connect team members with people from multiple other IS project teams.

4.1.2 Creating a Senior Role

A key challenge for many organizations occurs when several IS projects for different clients run concurrently. In this context, people from different IS projects do not have a direct way to know about the work that other project teams conduct. To address this problem, organizations have introduced the mechanism of a senior role (Kotlarsky, Oshri, van Hillegersberg, & Kumar, 2007). One such senior role is an IS program manager. Program managers develop the overall program plan and monitor the process of the program to ensure that the program meets its overall goals, schedule, budget, and benefits. With respect to knowledge management, the program manager ensures that everyone in the program who needs important program knowledge can easily access it (Project Management Institute, 2013).

4.1.3 Cultural Mediators

Globally distributed software teams often have difficulties sharing knowledge among IS projects due to geographical distance, time zone differences, and cultural disparities. To address cultural differences, some software teams assign team leaders or appoint team members as cultural mediators in IS projects (Aman & Nicholson, 2009; Boden et al., 2012). Cultural mediators refer to people who can bridge two or more cultures and have domain knowledge (Boden et al., 2012). They can avoid most misunderstandings and conflicts that cultural differences cause and, thus, ensure efficient knowledge sharing.

4.1.4 Experience Factory

An experience factory is a separate organizational unit that supports several IS projects to reuse experience and collective learning (Basili & Caldiera, 1995; Hellström, Malmquist, & Mikaelsson, 2001; Schneider, von Hunnius, & Basil, 2002). Under this concept, the organization is divided into two distinct parts: the project organization, which develops specific software, and the experience factory, which supports software development by providing packaged experience (Basili & Caldiera, 1995; Basili & Seaman, 2002).

Table 1. Concept-author Matrix (Webster & Watson, 2002): IS Projects' Knowledge-sharing Mechanisms

Paper	Communities of practice	Creating a senior role	Cultural mediators	Experience factory	Knowledge broker	Knowledge repository	Mutual visits	Postmortem reviews	Regular face-to-face meetings	Storytelling	Use of collaboration tools	Writing an IS project management handbook
Aman & Nicholson (2009)			x			x	x				x	
Aurum, Daneshgar, & Ward (2008)	x					x						
Basili & Caldiera (1995)				x								
Basili & Seaman (2002)				x								
Betz, Oberweis, & Stephan (2014)						x	x		x		x	x
Bibbo, Michelich, Sprehe, & Lee (2012)						x						
Birk, Dingsøyr, & Stålhane (2002)								x				
Boden et al. (2012)			x			x	x		x		x	
Brössler (2006)					x	x						
Desouza, Dingsøyr, & Awazu (2005)								x				
Dingsøyr (2005)								x				
Ebert & De Man (2008)						x						
Hellström et al. (2001)				x	x							
Houdek, Schneider, & Wieser (1998)				x								
Jasimuddin (2007)											x	
Kähkönen (2004)	x											
Kjærgaard, Nielsen, & Kautz (2010)												x
Kotlarsky et al. (2007)		x				x	x		x		x	
Krogstie (2008)						x						
Licorish & MacDonell (2015)						x						
Mestad et al. (2007)	x					x						
Milovanović, Minović, Štavljanin, Savković, & Starčević (2012)						x						
Nielsen & Madsen (2006)										x		
Olsson, Conchúir, Ågerfalk, & Fitzgerald (2008)		x					x		x		x	
Oshri, van Fenema, & Kotlarsky (2008)						x	x		x		x	
Paasivaara & Lassenius (2014)	x					x						
Pawlowski & Robey (2004)					x							
Radziwill & Shelton (2004)						x						
Rech et al. (2007)						x						
Schneider, von Hunnius, & Basili (2002)				x								
Uittenbogaard (2013)										x		
Wende, King, & Schwabe (2014)										x		
Zaidman & Brock (2009)											x	

4.1.5 Knowledge Broker

A knowledge broker is an organizational role that facilitates the flow of information from those with knowledge and experience to those who need it for a particular purpose (Hellström et al., 2001; Pawlowski & Robey, 2004). Knowledge brokers should not be assigned to a single IS project but rather should have an independent position and adequate social skills and the trust of colleagues (Hellström et al., 2001).

4.1.6 Knowledge Repository

A knowledge repository is the mechanism that the identified studies mentioned most often. Organizations often use knowledge repositories to store information regarding project processes. One can store the process knowledge that an IS project generates at the end of the project and make it available for use in future IS projects (Licorish & MacDonell, 2015). Reuse of this knowledge can help one to capture, understand, and use the process developed in a project, save developer time and effort, and, thus, improve productivity.

4.1.7 Mutual Visits

To help geographically dispersed IS projects share knowledge among each other, project managers and developers of IS projects should regularly spend time at the sites of other IS projects. This mechanism is called mutual visits. Mutual visits offer a variety of advantages. For example, they can bridge knowledge gaps among IS projects (Boden et al., 2012; Kotlarsky et al., 2007) and enable mutual enculturation and, thereby, reduce cultural differences between cross-cultural project teams (Aman & Nicholson, 2009).

4.1.8 Postmortem Reviews

Postmortem reviews are "mechanisms to remember and recall what transpired during a project and to use these lessons to inform future behavior and actions" (Desouza et al., 2005, p. 205). By reflecting on previous work, team members can reuse past knowledge in future IS projects and avoid repeating past mistakes. In general, conducting postmortem reviews leverages knowledge from the individual level to the organizational level (Dingsøyr, 2005). This mechanism plays a significant role in transferring knowledge from past IS projects to future projects.

4.1.9 Regular Face-to-face Meetings

Several previous studies report that project managers and developers should regularly attend meetings to ensure effective knowledge sharing among IS projects (Betz et al., 2014; Boden et al., 2012). Project managers and developers can obtain an overview of projects currently underway at the organization, discuss current developments and problems, and share information on new technologies and tools that might be useful for other teams (Boden et al., 2012). In general, regular face-to-face meetings constitute a personalization mechanism that enables the transfer of tacit knowledge among IS projects and facilitates discussions and opinion sharing.

4.1.10 Storytelling

Some empirical evidence shows that storytelling has great potential as a knowledge-sharing mechanism. Through storytelling, one can capture and share the experience of past IS projects as stories and then convert them into tacit knowledge of team members working on new projects (Nielsen & Madsen, 2006). Project managers could also tell team members a simple story to explain how the new system should work and what the system should do (Uittenbogaard, 2013).

4.1.11 Use of Collaboration Tools

Collaboration tools include a wide variety of tools, such as email (Jasimuddin, 2007; Olsson et al., 2008; Oshri et al., 2008; Zaidman & Brock, 2009), telephone calls (Jasimuddin, 2007), video conferences (Betz et al., 2014; Boden et al., 2012; Kotlarsky et al., 2007; Olsson et al., 2008), and instant messaging (Boden et al., 2012; Jasimuddin, 2007; Zaidman & Brock, 2009). Team members of IS projects frequently use these tools to communicate, coordinate, exchange information, and share knowledge. These tools increase the speed and flexibility of knowledge sharing among IS projects independent of place and time.

4.1.12 IS Project Management Handbook

An IS project management handbook is a comprehensive document that provides a process description to help one understand the tasks involved in IS project management and suggests concrete techniques and methods to solve these tasks (Kjærgaard et al., 2010). Several experienced IS project managers often write this handbook. Based on real-world practical experience and case studies, an IS project management handbook offers project managers a framework for managing and improving every phase of IS project management.

Table 2. Results of Taxonomy Development

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5	Iteration 6
Step 3	Empirical to conceptual	Empirical to conceptual	Conceptual to empirical	Empirical to conceptual	Conceptual to empirical	Empirical to conceptual
Step 4	Communities of practice, knowledge repository, storytelling	Use of collaboration tools, cultural mediators, IS project management handbook	Structural dimension (Sarvary, 1999): centralized & decentralized	Mutual visits, experience factory, regular face-to-face meetings	Richness dimension (Daft & Lengel, 1986): high richness, low richness & mixed richness	Postmortem reviews, knowledge broker, creating a senior role

Step 5 and 6

	Who			When			What									Where			How		
	Reach			Tempo-rality			Type			Structure		Source				Spatiality			Richness		
Mechanisms	Individual	Collective	Both	Synchronous	Asynchronous	Both	Explicit	Tacit	Both	Centralized	Decentralized	Ongoing	Previous	Both		Co-located	Distributed	Independent	High	Low	Mixed
Communities of practice		2		1				1			3			4				4	5		
Knowledge repository		2			1		1			3				4				4		5	
Storytelling		2				1		1			3			4				4	5		
Use of collaboration tools			2			2			2		3			4				4			5
Cultural mediators	2			2				2			3	4					4		5		
IS project management handbook		2				2			2	3			4					4			5
Mutual visits		4		4				4			4	4					4		5		
Experience factory		4			4		4			4				4				4		5	
Regular face-to-face meetings		4		4				4			4	4				4			5		
Postmortem reviews		6				6			6	6			6					6			6
Knowledge brokers			6			6		6			6			6				6	6		
Creating a senior role		6			6				6	6				6				6		6	

Note: The numbers in steps 5 and 6 correspond to the iterations in which we established the respective association.

4.2 Results of Taxonomy Development

Table 2 shows the results of our applying steps 3-6 (see Figure 2) in each of the six iterations we performed to develop the taxonomy for knowledge-sharing mechanisms. Except for the final iteration, in each iteration, we had to repeat the method because we either created additional dimensions or needed to analyze additional knowledge-sharing mechanisms. At the end of the sixth iteration, we created a final taxonomy and classified all previously identified mechanisms in the taxonomy. Table 2 (above) describes the iterations and overviews our taxonomy development.

4.2.1 Iteration 1

Step 3: entails choosing between an empirical-to-conceptual approach or a conceptual-to-empirical approach. If both significant knowledge of the domain and ample data are available, the researcher can decide which approach is best (Nickerson et al., 2013). In this first iteration, we decided to use the empirical-to-conceptual approach due to the variety of empirical insights on mechanisms for knowledge sharing among IS projects.

Step 4e: we selected the following random sample of knowledge-sharing mechanisms from phase I:

- Communities of practice
- Knowledge repository
- Storytelling

Step 5e: we identified the following contextual characteristics for these mechanisms:

- The mechanism is used for sharing explicit or tacit knowledge.
- Knowledge is shared synchronously or asynchronously through the mechanism.
- Knowledge can be shared both synchronously and asynchronously through the mechanism.

For example, organizations usually implement knowledge repositories to share explicit knowledge. All of these characteristics are aspects of the knowledge-sharing context.

Step 6e: we grouped the characteristics into the following dimensions to form the first taxonomy:

- Temporal dimension: synchronous knowledge sharing (S), asynchronous knowledge sharing (AS), or both synchronous and asynchronous knowledge sharing (S&AS) characteristics. This dimension addresses the "when" of context.
- Type dimension: explicit knowledge (E) or tacit knowledge (T) characteristics. This dimension involves the "what" of context.

According to the notation we use above to define taxonomy, the first taxonomy T1 comprises the temporal dimension with synchronous, asynchronous, and both synchronous and asynchronous characteristics and the type dimension with explicit, tacit, and both explicit and tacit characteristics. Put more simply:

T1 = { When:
Temporal (synchronous, asynchronous, both synchronous and asynchronous),
What:
Type (explicit, tacit)}

Step 7: the method requires another iteration because we created two dimensions in this iteration and we still needed to examine additional mechanisms.

4.2.2 Iteration 2

Step 3: we decided to use the empirical-to-conceptual approach again because we identified several additional mechanisms in step 1 (see Table 1). Thus, we followed Nickerson et al.'s (2013) approach by using the empirical-to-conceptual approach when further insights were available from the literature.

Step 4e: we selected the following random sample of knowledge-sharing mechanisms from the results of phase I:

- Use of collaboration tools

- Cultural mediators
- Writing an IS project management handbook

Step 5e: we identified the following contextual characteristics in these mechanisms:

- Under the mechanism, knowledge is shared only at the individual level.
- Under the mechanism, knowledge is shared only at the collective level.
- Under the mechanism, knowledge is shared at both the individual and collective levels.
- The mechanism is used for sharing both explicit and tacit knowledge.

For example, cultural mediators facilitate knowledge sharing among individuals. All of these characteristics follow logically from the meta-characteristic.

Step 6e: we grouped the first three characteristics into the following dimension:

- Reach dimension: individual (sharing knowledge at the individual level, which we abbreviate as I), collective (sharing knowledge at the collective level, which we abbreviate as C), and both individual and collective (sharing knowledge at the individual and collective levels, which we abbreviate as I&C) characteristics. This dimension addresses the “who” of context.

We recognized that the last characteristic was a new characteristic in the type dimension. Thus, this dimension became:

- Type dimension: explicit knowledge (E), tacit knowledge (T), and both explicit and tacit knowledge (E&T) characteristics. This dimension addresses the “what” of context.

At this point we had our second taxonomy:

T2 = { Who:

Reach (individual, collective, both individual and collective),

When:

Temporal (synchronous, asynchronous, both synchronous and asynchronous),

What:

Type (explicit, tacit, both explicit and tacit)}

Step 7: because we created one dimension in this iteration, we needed to repeat the method. In addition, we needed to examine more knowledge-sharing mechanisms. We needed to perform at least one more iteration.

4.2.3 Iteration 3

Step 3: although further mechanisms were available for analysis, we decided to use the conceptual-to-empirical approach for the third iteration in order to gain a different perspective. This switch is in accordance with suggestions for taxonomy development and is left to one’s individual judgment (Nickerson et al., 2013).

Step 4c: in the process of reviewing the literature, we found that Sarvary (1999) suggests the following dimension of a knowledge-management system: centralized and decentralized. We introduced these concepts into the field of knowledge sharing and recognized that organizations implement certain mechanisms in a top-down direction and gather and share knowledge centrally (i.e., centralized mechanisms). In contrast, organizations implement other mechanisms in a bottom-up direction and gather and share knowledge in an “open market” (i.e., decentralized mechanisms). We identify these two concepts (centralized and decentralized mechanisms) as a structural dimension and note that it follows from the meta-characteristics:

- Structural dimension: centralized (CE) and decentralized (DE) characteristics. This dimension addresses the “what” of context.

Step 5c: we identified examples of these types of mechanisms. For instance, a knowledge repository is a centralized mechanism, whereas a cultural mediator is a decentralized mechanism.

Step 6c: by adding this dimension to the previous three dimensions, we created our third taxonomy:

T3 = { Who:

Reach (individual, collective, both individual and collective),

When:

Temporal (synchronous, asynchronous, both synchronous and asynchronous),

What:

Type (explicit, tacit, both explicit and tacit),

Structure (centralized, decentralized)}

Step 7: because we created one new dimension in this iteration, we needed to repeat the method. In addition, we needed to examine more knowledge-sharing mechanisms. We needed to perform at least one more iteration.

4.2.4 Iteration 4

Step 3: although using a conceptual-to-empirical approach in iteration 3 helped us to gain a new perspective, we returned to the empirical-to-conceptual approach in this iteration because more mechanisms were available (Nickerson et al., 2013).

Step 4e: we selected the following random sample of knowledge-sharing mechanisms from the results of phase I:

- Mutual visits
- Experience factory
- Regular face-to-face meetings

Step 5e: we identified the following contextual characteristics of these mechanisms:

- The mechanism is only available for sharing knowledge among IS projects at the same location.
- The mechanism is only available for sharing knowledge among IS projects at different locations.
- The mechanism is available for sharing knowledge among IS projects at same location and at different locations.
- Under the mechanism, knowledge is transferred only from ongoing IS projects to other IS projects.
- Under the mechanism, knowledge is transferred only from previous IS projects to other IS projects[1].
- Under the mechanism, knowledge is transferred from both ongoing and previous IS projects to other IS projects.

For example, co-located IS projects usually hold regular face-to-face meetings, whereas projects that occur at different locations use mutual visits. All of these characteristics follow logically from the meta-characteristic.

Step 6e: we grouped these characteristics into the following dimensions to form the fourth taxonomy:

- Spatial dimension: co-located characteristics (mechanism applies only to IS projects at the same location, which we abbreviate as CL), different characteristics (mechanism applies only to IS projects at different locations, which we abbreviate as D), and location-independent characteristics (mechanism applies only to IS projects at the same location and at different locations, which we abbreviate as LI). This dimension addresses the "where" of context.
- Source dimension: ongoing characteristics (projects acquire knowledge from ongoing IS projects, which we abbreviate as O), previous characteristics (projects acquire knowledge from previous IS

[1] We identified this characteristic based on the mechanism of writing an IS project management handbook.

projects, which we abbreviate as P), and both ongoing and previous characteristics (projects acquire knowledge from both ongoing and previous IS projects, which we abbreviate as O&P). This dimension addresses the "what" of context.

At this point, we had our fourth taxonomy:

T4 = { Who:

Reach (individual, collective, both individual and collective),

When:

Temporal (synchronous, asynchronous, both synchronous and asynchronous),

What:

Type (explicit, tacit, both explicit and tacit),

Structure (centralized, decentralized),

Source (ongoing, previous, both ongoing and previous),

Where:

Spatial (Co-located, different, location-independent)}

Step 7: because we created one new dimension in this iteration, we needed to repeat the method. We needed to perform at least one more iteration.

4.2.5 Iteration 5

Step 3: for the fifth iteration, we decided to use the conceptual-to-empirical approach. Once again, we did so based on our individual judgment and our desire to gain a new perspective for our taxonomy (Nickerson et al., 2013).

Step 4c: we found that certain mechanisms for knowledge sharing might transfer a variety of knowledge at one time and generate high levels of interactivity between knowledge holders and receivers, whereas other mechanisms might not transfer a variety of knowledge or facilitate rapid feedback. To summarize these characteristics, we introduce the concept of "richness". According to the media richness theory (Daft & Lengel, 1986), the richness of information refers to "the ability of information to change understanding within a time interval" (Daft & Lengel, 1986, p. 560). We describe the richness of a mechanism for knowledge sharing among IS projects as the ability of the mechanism to effectively transfer knowledge in a specific time interval. Mechanisms with high levels of richness are more capable of transferring a large amount of various types of knowledge at one time and allow high levels of interactivity between senders and receivers. On the contrary, mechanisms with low levels of richness are less capable of transferring significant amounts of knowledge at one time and generate less interactivity. With respect to mechanisms that are high in richness in certain respects but low in richness in other respects, we regard them as having a mixed richness characteristic. We identify this differentiation as the richness dimension and note that it follows from the meta-characteristics:

- Richness dimension: high richness (H), low richness (L), and mixed richness (M) characteristics. This dimension addresses the "how" of context because it describes whether knowledge is shared effectively through the mechanism.

Step 5c: we found several identified mechanisms with these characteristics. For example, the mechanism of regular face-to-face meetings is high in richness because it not only provides immediate feedback, which enables one to check the interpretation, but also provide multiple types of information through body language and tone of voice. In contrast, knowledge repositories (such as digital databases) are lower in richness because they provide less knowledge and restrict feedback.

Step 6c: by adding this dimension to the previous four dimensions, we created our next taxonomy:

T5 = { Who:

Reach (individual, collective, both individual and collective),

When:

Temporal (synchronous, asynchronous, both synchronous and asynchronous),

What:

Type (explicit, tacit, both explicit and tacit),

Structure (centralized, decentralized),

Source (ongoing, previous, both ongoing and previous),

Where:

Spatial (co-located, different, location-independent),

How:

Richness (high, low, mixed)}

Step 7: because we created one new dimension in this iteration, we needed to repeat the method. In addition, we needed to examine other mechanisms. We need to perform at least one more iteration.

4.2.6 Iteration 6

Step 3: because we had to examine other mechanisms, we repeated the procedure by following the empirical-to-conceptual approach.

Step 4e: we selected the remaining knowledge-sharing mechanisms from the results of phase I:

- Postmortem reviews
- Knowledge broker
- Creation of a senior role

Step 5e and 6e: we could not identify any new characteristics or dimensions from these mechanisms. We grouped these mechanisms along with the previous mechanisms using the existing characteristics and dimensions (see Table 2).

Step 7: because we created no new dimension in this iteration and because we had examined all mechanisms that resulted from phase I, we met the objective ending conditions:

1) We examined all selected objects.
2) We merged no object with a similar object and split no object into multiple objects in the last iteration.
3) We classified at least one object under every characteristic of every dimension.
4) We added no new dimensions or characteristics in the last iteration.
5) We merged or split no dimensions or characteristics in the last iteration.
6) Every dimension was unique and not repeated.
7) Every characteristic was unique in its dimension.

The final taxonomy (see Figure 3) meets the subjective ending conditions according to Nickerson et al. (2013) as we explain below.

1. **Conciseness:** our taxonomy is concise: it comprises seven dimensions and two or three characteristics per dimension.
2. **Robustness:** we carefully defined and delineated each dimension and characteristic as a distinct and non-overlapping attribute of a mechanism for knowledge sharing among IS projects. Therefore, we conclude that our taxonomy is robust.
3. **Comprehensiveness:** in general, because the literature review includes a broad range of articles and the identified dimensions cover all five types of meta-characteristics, we are confident that our taxonomy is comprehensive.
4. **Extendible:** because new mechanisms could appear that are neither centralized nor decentralized, one could add new characteristics to the structural dimension.
5. **Explanatory:** the five perspectives of the knowledge-sharing context illustrate the taxonomy's explanatory value. In summary, each dimension and characteristic contributes to the

understanding of mechanisms for knowledge sharing among IS projects. Thus, the taxonomy meets all five subjective ending conditions, which means one can consider the taxonomy to be useful.

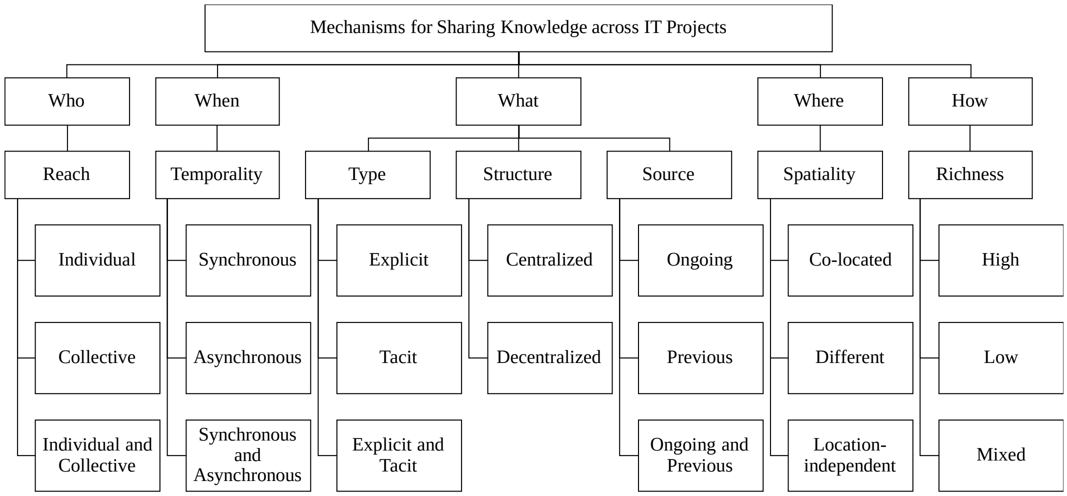

Figure 3. Taxonomy of Mechanisms for Sharing Knowledge among IS Projects

4.3 Description of Dimensions and Characteristics

Our taxonomy of knowledge-sharing mechanisms is based on the meta-characteristics of the context of knowledge sharing among IS projects. It comprises seven dimensions. In the following paragraphs, we summarize the dimensions and their characteristics from the five contextual perspectives: who, when, what, where, and how. In addition, we explain how we identify the characteristics of a mechanism through the results presented in Table 2 and by explaining our developmental approach used in Section 4.2.

4.3.1 The "Who" of Context: Reach Dimension

This dimension relates to whether knowledge is shared at an individual level (individual to individuals) or at a collective level (individual to a group of individuals). The individual level has limited reach and implies that individuals share knowledge to other individuals or to small groups of individuals. The collective level refers to knowledge that an individual transfers to a large number of individuals.

Under certain mechanisms, knowledge sharing occurs only at the individual level. Cultural mediators, for example, constitute an individualized mechanism because they avoid cross-cultural misunderstandings and facilitate knowledge sharing among individuals. Conversely, communities of practice are typically built across IS project boundaries and facilitate knowledge sharing in an organization-wide group (Mestad et al., 2007). Knowledge repositories also have a wide reach and are usually accessible by all individuals on different project teams throughout an organization. After captured knowledge is codified and stored in knowledge repositories, all people in the organization can retrieve and acquire the knowledge they need (Kotlarsky et al., 2007). Through storytelling, knowledge is shared among IS projects as stories; storytelling always occurs at an organizational rather than a project level (Nielsen & Madsen, 2006). Postmortem reviews are organized as collective learning activities (Dingsøyr, 2005). Regarding the mechanism of creating a senior role, senior managers (e.g., program managers) manage project managers and ensure a large scope of knowledge sharing (Project Management Institute, 2013).

Other mechanisms work at both levels. The use of collaboration tools is a typical example. Whereas video conferences often occur between two or more locations and allow for a large number of participants (Kotlarsky et al., 2007; Paasivaara & Lassenius, 2014), email, telephone calls, and instant messaging usually occur between two individuals or individuals in small groups. As another example, knowledge brokers can not only connect individuals but also support an entire project by satisfying the project's knowledge requirements (Hellström et al., 2001).

4.3.2 The "When" of Context: Temporal Dimension

This dimension describes whether people from different IS projects can share knowledge in real time (synchronously). Under certain mechanisms, people from different IS projects can share knowledge synchronously, which means that individuals can share knowledge in real time from one project to another project; under other mechanisms, individuals might defer transferring knowledge. Mutual visits and regular face-to-face meetings, for example, are both synchronous mechanisms because they enable face-to-face interaction among IS project leaders and team members. One can also view communities of practice as a synchronous mechanism because community members can discuss a topic directly with other members of the group and share their insight and experience. On the contrary, knowledge repositories and experience factories transfer knowledge asynchronously because one can share the experiences of one project with others only after one has stored and edited them in the repositories. However, other mechanisms can work both synchronously and asynchronously. Individuals can use many collaboration tools (e.g., telephone calls, instant messaging, or videoconferencing) synchronously, whereas other collaboration tools, such as email, may provide asynchronous communication. Regarding storytelling, certain IS projects choose to transmit stories asynchronously in a text document or a recorded video (Wende et al., 2014). However, oral storytelling not only allows stories to be shared in real time but also enables listeners to immediately and synchronously question the story and compare the story to their own experiences (Nielsen & Madsen, 2006).

4.3.3 The "What" of Context

This dimension comprises three subdimensions: type, structure, and source.

Type dimension: experience factories are similar to knowledge repositories in that one manages explicit knowledge in a central repository in both (Basili & Seaman, 2002; Haamann & Basten, 2012). However, the most common means of transferring tacit knowledge is face-to-face communication (Haldin-Herrgard, 2000). Hence, all mechanisms that involve face-to-face communication are a mechanism for sharing tacit knowledge. Stories can contribute to the transfer of contextual and tacit knowledge (Oshri et al., 2008). Program managers can acquire tacit knowledge through their involvement in various IS projects and their individual understanding of development processes (Kotlarsky et al., 2007). When suitable opportunities emerge, program managers can reuse acquired tacit knowledge in other IS projects.

Individuals use certain mechanisms to share both explicit and tacit knowledge. For instance, collaboration tools such as email and instant messaging enable individuals to share explicit knowledge, whereas telephone calls and video conferences enable them to share tacit knowledge. Postmortem reviews, on one the hand, provide an arena for discussing past events and thereby contribute to tacit knowledge sharing (Dingsøyr, 2005); on the other hand, postmortem reviews may constitute an attempt to codify knowledge from past projects in a report, which provides new insights to other project teams.

Structural dimension: one can use two approaches to build a knowledge-management system: centralized and decentralized (Sarvary, 1999). We introduce these characteristics in our study to describe the structures of mechanisms for knowledge sharing from one IS project to others. Information technology has always played an important role in centralized mechanisms. These mechanisms urge people to share knowledge (Sarvary, 1999). For example, knowledge repositories enable users to deposit knowledge created in prior projects in a centralized repository, which reduces the time and effort required to share knowledge among IS projects and among users in geographically dispersed locations (Bibbo et al., 2012). An experience factory has the same centralized structural characteristic. Furthermore, both IS project management books and postmortem reviews are organized from the top, and structured documents display their outcomes. In addition, senior roles manage centralized knowledge of various IS projects.

In contrast, decentralized mechanisms refer to those mechanisms that one implements in a bottom-up direction and that allow flexible knowledge sharing in an open market (Sarvary, 1999). Decentralized mechanisms typically emphasize people rather than IS. Individuals can decide for themselves whether to share knowledge with others. For instance, communities of practice are usually loosely connected and self-managed, which allows community members to participate and share their knowledge voluntarily. In the "open market" of knowledge, knowledge brokers are responsible for connecting knowledge seekers and knowledge contributors and, thereby, promoting the free exchange of knowledge (Hellström et al., 2001).

Source dimension: this dimension relates to whether an IS project acquires shared knowledge from previous IS projects. Certain mechanisms allow one to transfer only knowledge from previous IS projects to ongoing or future IS projects. For example, sophisticated IS project managers usually write IS project management handbooks based on their experiences and case studies of past projects. In addition, postmortem reviews ensure that team members recognize what they learned from a completed project and share that knowledge with other project groups (Birk et al., 2002). Conversely, certain mechanisms can only share knowledge among concurrent IS projects (e.g., cultural mediators). Other mechanisms enable knowledge transfers from both previous and ongoing IS projects to other projects. Team members can use knowledge repositories not only to reflect on postmortem project reviews (Krogstie, 2008) but also to keep track of the progress of multiple ongoing projects and to share information with other ongoing projects. Furthermore, storytelling and communities of practice can facilitate the collective understanding of previous projects and provide a vehicle to share knowledge (e.g., project requirements) (Wende et al., 2014).

4.3.4 The "Where" of Context: Spatial Dimension

This dimension relates to whether an IS project's location affects whether its team members will implement a mechanism. Several mechanisms used to share knowledge among IS projects depend on the geographical locations in which the IS projects take place. For instance, cultural mediators and mutual visits usually suit only projects located at different facilities or even countries. In contrast, co-located projects always have regular face-to-face meetings. Team members can adopt many other mechanisms regardless of geographical distance. For example, one can arrange communities of practice as regular face-to-face meetings among IS projects at the same site or as videoconferences among geographically dispersed project teams (Mestad et al., 2007; Paasivaara & Lassenius, 2014). A digital knowledge repository ensures a single environment for all teams regardless of where they are located (Kotlarsky et al., 2007), although it might take someone longer to access and use the knowledge repository from remote locations. Regarding storytelling, co-located project teams often share oral stories (Nielsen & Madsen, 2006), whereas geographically distributed project teams can transmit stories in a text document or via recorded videos (Wende et al., 2014).

4.3.5 The "How" of Context: Richness Dimension

The richness dimension describes the effectiveness of the knowledge-sharing mechanism. According to the media richness theory, a mechanism's capacity for immediate feedback and the amount and variety of information it transfers at one time determine its richness (Daft & Lengel, 1986).

We argue that mechanisms involving face-to-face interaction are high in richness because they provide immediate feedback and multiple cues via body language or signals. Therefore, one can view communities of practice, cultural mediators, mutual visits, regular face-to-face meetings, and knowledge brokers as mechanisms with high levels of richness. Storytelling is also high in richness because stories usually provide a broad range of context-rich information pertaining to IS projects (Wende et al., 2014). In contrast, knowledge repositories, experience factories, and senior roles are low in richness because they offer limied feedback and are less appropriate for resolving equivocal issues. Other mechanisms have mixed richness. For instance, collaboration tools have mixed richness: telephone calls and video conferences have high richness but emails and instant messaging have low richness. The mechanism of an IS project management handbook shares knowledge in two main ways. First, to create the handbook, the most experienced project managers interact to discuss the content of the handbook—a process high in richness. Second, new and inexperienced project managers can obtain project knowledge from the handbook—a process low in richness due to the limited variety of knowledge in the handbook and the lack of rapid feedback. Therefore, mixed richness characterizes this mechanism. Similarly, postmortem reviews possess mixed levels of richness because postmortem meetings or workshops are high in richness but the structured outcomes are low in richness.

5 Summary and Discussion

In this study, we develop a taxonomy of mechanisms for knowledge sharing among IS projects. Based on reviewing the literature, we analyzed 33 studies and identified 12 such knowledge-sharing mechanisms. We derived a taxonomy for the existing mechanisms by applying the method that Nickerson et al. (2013) developed. After six iterations of this method, we satisfied all objective and subjective ending conditions.

The dimensions of our taxonomy partially correspond with the results of previous studies, which have identified the dimensions of codification versus personalization and individualization versus institutionalization in project-based organizations (Boh, 2007; Hansen et al., 1999). The type dimension is consistent with the codification-versus-personalization dimension because they both relate to how individuals share different types of knowledge. However, we added the explicit and tacit characteristics to this dimension because we noticed that IS project teams use a considerable number of mechanisms to share both types of knowledge among themselves. Furthermore, the reach dimension is similar to the individualization-versus-institutionalization dimension. Whereas the former focuses on knowledge sharing at the individual or collective level, the latter differentiates between the individual and collective levels and between the informal and formal aspects of knowledge-sharing mechanisms (Boh, 2007).

The developed taxonomy overviews the existing mechanisms of knowledge sharing among IS projects. Combining the reach and richness dimensions can help organizations to overcome the limitations of the trade-off between them. With this combination, managers can identify the mechanisms that not only increase the reach of knowledge sharing by enabling potential receivers to access potential knowledge sources but also enhance the richness of knowledge sharing by transferring a large amount and a variety of knowledge at one time and allowing high interactivity between senders and receivers. The following mechanisms meet both requirements (i.e., broad reach and high richness): communities of practice, storytelling, mutual visits, and regular face-to-face meetings. Furthermore, knowledge repositories and experience factories share identical characteristics in all dimensions, which one might explain by the significant role that central repositories play in both of these knowledge-sharing mechanisms. Moreover, several gaps show that the taxonomy is not exhaustive. For instance, none of the mechanisms possesses the following combination of characteristics: collective, tacit, centralized, location-independent, and high richness. Thus, an opportunity might exist for mechanisms to fill this and other gaps. For example, one might establish a repository that allows users to store and share video project reports that contain the most valuable lessons learned from IS projects.

Our taxonomy identifies how one can classify various types of knowledge-sharing mechanisms. Different researchers in various research domains have discussed how taxonomies contribute to the scientific community in general. Larsen (2003) summarizes their value for research in noting that they allow one to harmonize an observed research domain and to identify and understand concepts and the interactions between them. Taxonomies can guide active researchers to relevant literature on a concept or help to identify concepts that address a current research problem. Serenko (2013) and Barki et al. (1988) summarize the value of taxonomies to different stakeholders. First, taxonomies provide guidance to those who search for gaps in the research and help to reduce the diversity of terms. In the education sector, taxonomies serve as input for developing curricula that are in line with research trends and helpful for future work experience. Journal editors may use taxonomies as benchmarks for their calls for paper initiatives. These benefits are available through our taxonomy.

Most importantly, with this work, we offer a nuanced and systematic classification of for knowledge-sharing mechanisms that others can use to structure and organize knowledge in the knowledge management field and IS projects, which may help researchers and practitioners alike to better understand existing knowledge in this domain. The systematic and nuanced character is a result of our extensive literature review and use of multiple databases and studies. By following an established taxonomy-development method, we ensure that we did not derive results ad hoc but rather in accordance with an iterative and systematic procedure. Moreover, we add to the knowledge on for knowledge-sharing mechanisms in the context of IS projects by identifying existing mechanisms in the previous literature. The results can help to shed light on gaps that researchers should address in the future. For instance, the concept-author matrix (see Table 1) provides a structured overview of mechanisms addressed in the literature. The comparison of these results helps one to identify the mechanisms that research need to address in greater detail in the future. Our taxonomy extends the previous research both by adapting the existing dimensions and by complementing the set of dimensions for classifying inter-project knowledge-sharing mechanisms. This taxonomy enables one to obtain a more concise overview of knowledge-sharing mechanisms among IS projects. For researchers, our study provides appropriate guidelines for describing practical problems and contexts that pertain to IS projects. For other stakeholders, such as editors and teachers, our taxonomy helps them develop and match their educational and editorial initiatives with the research results. This added value for all stakeholder groups not only ensures the quality of our results but also fosters an ongoing and cumulative debate about knowledge-sharing mechanisms and effective ways to implement them in practical settings.

Regarding our contribution to practice, we derive a taxonomy that allows IS project managers to distinguish between knowledge-sharing mechanisms and, thereby, more effectively implement mechanisms. For instance, one can use the taxonomy as a guide to determine which mechanisms work well with co-located or geographically distributed teams or with synchronous versus asynchronous communication. Thus, taking the taxonomy into consideration helps one to reduce the uncertainty and failure rates that might otherwise appear in an unstructured, non-literature-supported procedure. Furthermore, practitioners may use the results we present to better understand the knowledge-sharing mechanisms that dominate scientific research, which will help build new bridges and strengthen existing ones between research and practice and, thus, guarantee the sustainability of our results. In summary, researchers and practitioners can use the taxonomy as a starting point to discuss the different mechanism types and about more effective ways to adopt these mechanisms.

The study has certain limitations. Due to the limited number of databases, we most certainly did not identify all the relevant literature. Nevertheless, our approach of using backward and forward searches somewhat minimizes this bias. Additionally, the classification is subject to our experiences. Although we cannot exclude the possibility that other researchers might develop different taxonomies (i.e., only the second author coded the literature while the first and third acted as devil’s advocates), one can view the parallels with earlier research as supporting our outcome. Additionally, in analyzing the “what” dimension, we focused only on the differentiation between explicit and tacit knowledge. Whereas others might consider this dimension in more detail (e.g., Wijnhoven, 2008), we relied on the major distinction between explicit and tacit knowledge that seminal works in the knowledge domain have commonly used (Alavi & Leidner, 2001; Polanyi, 2009).

Further research in this area can follow several paths. One could refine the taxonomy by adding, deleting, changing, or combining dimensions or to continue to test its efficacy by categorizing more mechanisms and developing additional configurations to gain new knowledge. To do so, researchers could apply of the Delphi technique to discuss and modify the existing results with expert groups. This approach could generate valuable feedback and allow expert participants to dynamically adjust the taxonomy. Researchers could also conduct empirical studies to evaluate the use of the taxonomy. This approach combines the advantages of conceptual and empirical approaches and would strengthen the validity of the results by applying additional analysis methods to the same research objects from different perspectives. For instance, one could distribute the developed taxonomy to different project teams who work together on real-world projects. During an experiment, one could split the participants into two distinct groups, each of which should solve a concrete task related to knowledge sharing. Whereas the experimental group would solve the task using the taxonomy, the control group would solve the same task without the taxonomy. One could apply questionnaires or observation techniques to test and evaluate the taxonomy’s value, validity, and possible bias. One could apply the same setting to check the robustness of identified contextual characteristics according to the mechanisms the taxonomy presents. For instance, one could use observation techniques to evaluate whether knowledge repositories facilitate knowledge sharing in an explicit or even an implicit way. Such an evaluation would help to determine the correctness and applicability of results discussed in the literature to practical settings. Furthermore, one could expand the number of databases to identify new literature and test its relevance to the taxonomy, which would check whether one should add or consider new or additional literature in further evaluation rounds.

In conclusion, our taxonomy provides a rich picture of mechanisms for knowledge sharing among IS projects and facilitates continued inquiry into the study of knowledge-sharing practices in IS project contexts.

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Appendix A: Results of Study Quality Assessment

Table A1. Score of each Paper on Quality Assessment Criteria

Paper	Quality Criteria 1	Quality Criteria 2	Quality Criteria 3	Quality Criteria 4	Total
Aman & Nicholson (2009)	0.5	0.5	1	1	3
Aurum et al. (2008)	1	0.5	0.5	0.5	2.5
Basili & Caldiera (1995)	1	1	0.5	0.5	3
Basili & Seaman (2002)	1	1	0.5	0.5	3
Betz et al. (2014)	1	1	0.5	1	3.5
Bibbo et al. (2012)	1	1	1	1	4
Birk et al. (2002)	1	1	0	0.5	2.5
Boden et al. (2012)	1	1	1	1	4
Brössler (2006)	1	1	0.5	1	3.5
Desouza et al. (2005)	1	1	1	1	4
Dingsøyr (2005)	1	1	0.5	0.5	3
Ebert & De Man (2008)	0.5	0.5	0	0.5	1.5
Hellström et al. (2001)	1	1	1	0.5	3.5
Houdek et al. (1998)	1	0.5	1	1	3.5
Jasimuddin (2007)	1	0.5	0.5	0.5	2.5
Kähkönen (2004)	1	1	0.5	0.5	3
Kjærgaard et al. (2010)	1	1	1	1	4
Kotlarsky et al. (2007)	1	1	1	1	4
Krogstie (2008)	1	1	0.5	0.5	3
Licorish & MacDonell (2015)	0.5	0.5	0.5	0	1.5
Mestad et al. (2007)	1	1	1	1	4
Milovanović et al. (2012)	0.5	1	0.5	0.5	2.5
Nielsen & Madsen (2006)	1	1	1	1	4
Olsson et al. (2008)	0.5	1	0.5	1	3
Oshri et al. (2008)	0.5	0.5	0.5	0.5	2
Paasivaara & Lassenius (2014)	1	1	1	1	4
Pawlowski & Robey (2004)	1	1	1	1	4
Radziwill & Shelton (2004)	0.5	1	1	1	3.5
Rech et al. (2007)	0.5	0.5	0.5	0.5	2
Schneider et al. (2002)	0.5	1	0.5	1	3
Uittenbogaard (2013)	0.5	0.5	0.5	0	1.5
Wende et al. (2014)	1	1	0.5	1	3.5
Zaidman & Brock (2009)	0.5	1	1	1	3.5

About the Authors

Nora Fteimi, PhD, is an assistant professor at the Chair of Information Systems at the University of Passau, Germany. She teaches courses on text analytics, knowledge and data management and research methods. Her fields of research and interest are knowledge management and (big) data analytics. Particularly, her focus is on subtopics dealing with text analytics and privacy-related issues in this context. Her work has been published in several outlets such as the European Conference on Information Systems (ECIS) and the *Electronic Journal of Knowledge Management* (EJKM).

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