BUSINESS/IT SHARED UNDERSTANDING

An Empirical Analysis of the Contextual Formation and Time-Dependent Evolution of Shared Understanding Among Business and IT Professionals

by Christian Jentsch

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Zweitgutachter: Prof. Dr. Tim Weitzel
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INTRODUCTORY PAPER

Business/IT Shared Understanding

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Christian Jentsch

University of Bamberg

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1. INTRODUCTION

Baseball, soccer, basketball or cricket... every team sport has its own unique *structure* and *processes* which reflect and regulate how the sport is played. In terms of structure, baseball requires 18 players with one racket and a ball, while soccer requires 22 players, a ball and two goals. In terms of process, a baseball match is played by a pitcher and a batter who needs to hit the ball to become a runner and run four bases, while a soccer game is won by the team scoring more goals than their opponents in 90 minutes. Despite of these differences, there is one component which is very similar in every game. A shared understanding among the team members increases the quality of decision-making (Grand et al. 2016) and maximizes team performance (Mohammed et al. 2010). The execution of a blind pass in basketball is only possible when team players perfectly predict the position of their teammates, which depends on a high level of shared understanding (Cannon-Bowers and Salas 2001).

There are many similarities between team sports and organizational business. The ball for sport teams is the organizational IT system for business/IT collaborations, which needs to be perfectly played (i.e. organized) to maximize organizational success and IS research has shown that business/IT shared understanding (B/IT-SU) is crucially important for the success of collaboration (Preston and Karahanna 2009; Vermerris et al. 2014; Wagner et al. 2014). While there is no question about the importance of B/IT-SU, there are still various definitions of it (Bittner and Leimeister 2014). For example, research in strategic alignment describes B/IT-SU as the "mutual understanding of the role of IT [in the organization] between the CEO and CIO" (Johnson and Lederer 2010, p. 138), while research into team coordination typically includes more social aspects such as mutual beliefs (Cornelius and Boos 2003) or "understand[ing] each other – their preferences, strengths, weaknesses, and tendencies" (Cannon-Bowers and Salas 2001, p. 197).

One possible reason why conceptualizations of B/IT-SU vary among IS scholars is because of the structure and processes of the different business/IT collaborations, like strategic alliances, software development projects or daily IT operations. Fist, structural aspects such as organizational complexity or the strategic relevance of the joint task are the context of the business/IT collaboration in which B/IT-SU is formed (Dennis et al. 2008; Resick et al. 2014; Tiwana 2012). Thus, structural aspects will be considered in analysis on the *contextual formation* of B/IT-SU. Second, process aspects affect the evolution and volatility of B/IT-SU over time in business/IT teams, like different development phases or the timing of events and mechanisms in the collaboration. Many research findings have not yet been validated in a longitudinal context and there have been several calls for more studies on B/IT-SU-related processes (Benlian and Haffke 2016; Karahanna and Preston 2013; Vermerris et al. 2014). Thus, process aspects will be considered by the analysis of *time-dependent evolution* of B/IT-SU in this dissertation. This overall field of research of this cumulative dissertation is how the context (i.e. structure) and time (i.e. processes) of the underlying business/IT collaborations influence and shape B/IT-SU, as illustrated in Figure 1.

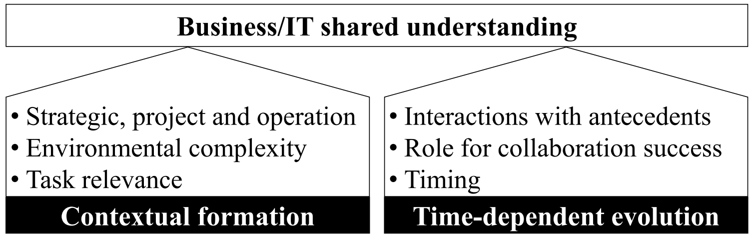


Figure 1. Overview of research field

Previous research into the contextual formation of B/IT-SU show that contextual factors such as organizational complexity and strategic task relevance have many implications for collaboration. Some research argues that the importance of knowledge sharing in a team becomes insignificant in collaborative tasks which are clearly described and formulated (Grand et al. 2016) and even warn that putting too much effort into knowledge sharing in a low-complexity environment "may even impede progress or decision-making efficiencies for some teams" (Resick et al. 2014, p. 173) which can lead to low performance due to "resource overkill" (Mani et al. 2010, p. 48). This research stream argues that contextual factors, like organizational complexity, affect the relevance of B/IT-SU. In contrast, other research indicates that it is not the relevance of B/IT-SU in general which is affected, but rather the content (i.e. dimensions) in which a shared understanding should be established (e.g. Dennis et al. 2008; Tiwana 2012). Research found that B/IT-SU of the business domain (as one particular dimension of B/IT-SU) is important when the task outcome is novel for the team, while B/IT-SU of the technical aspects (as another dimension of B/IT-SU) is important when the procedures of the task execution are novel (Tiwana 2012). Studies like these indicate the importance of a more deliberate discussion of shared knowledge by including different dimensions of B/IT-SU in a situational context.

In terms of the time-dependent evolution of B/IT-SU, research identifies B/IT-SU as a volatile variable which deserves more research attention (Benlian and Haffke 2016; Karahanna and Preston 2013; Vermerris et al. 2014). Most previous IS research has analyzed the development of shared understanding retrospectively (e.g. Vermerris et al. 2014), conducted experiments (e.g. Bittner and Leimeister 2014; Chiravuri et al. 2011) or used students as subjects (e.g. He et al. 2007; Levesque et al. 2001; Robert et al. 2008). Considering the low number of studies, the findings are remarkably contradictory. Some research indicates that the early implementation of shared understanding is critical for the success of the project – the sooner the better (Vermerris et al. 2014). Others argue that an initial low level of shared understanding has no effect on the success of the collaboration since it increases over time (He et al. 2007). Other research finds the exact opposite to be true, concluding that shared understanding commonly *decreases* in IT projects over time as a result of specialization (Levesque et al. 2001). For a team, it seems to be important to have a clear shared understanding of the collaborative work at the very beginning of the project, which has been found to decrease as team members start focusing on their individual tasks (van der Haar et al. 2015).

To address these contradictory results, IS scholars have called for more studies on shared understanding considering the context of the collaboration (Avgerou 2013; van Deth 2003) as well as the time-dependent evolution (Benlian and Haffke 2016; Grand et al. 2016; Vermerris et al. 2014). In response to these calls, this cumulative dissertation theoretically and empirically examines the concept and formation of B/IT-SU under various contextual and time-dependent conditions. The overarching research question of this thesis is:

Research Question: How do context and time influence the formation of shared understanding and its impact on the success of a business/IT collaboration?

This overarching research question is addressed in nine research papers, as illustrated in Figure 2. In the papers, I apply different theoretical foundations, like template theory, social capital theory and the theory of mental models, and leverage various research methods, including literature review, qualitative case studies, and quantitative methods.

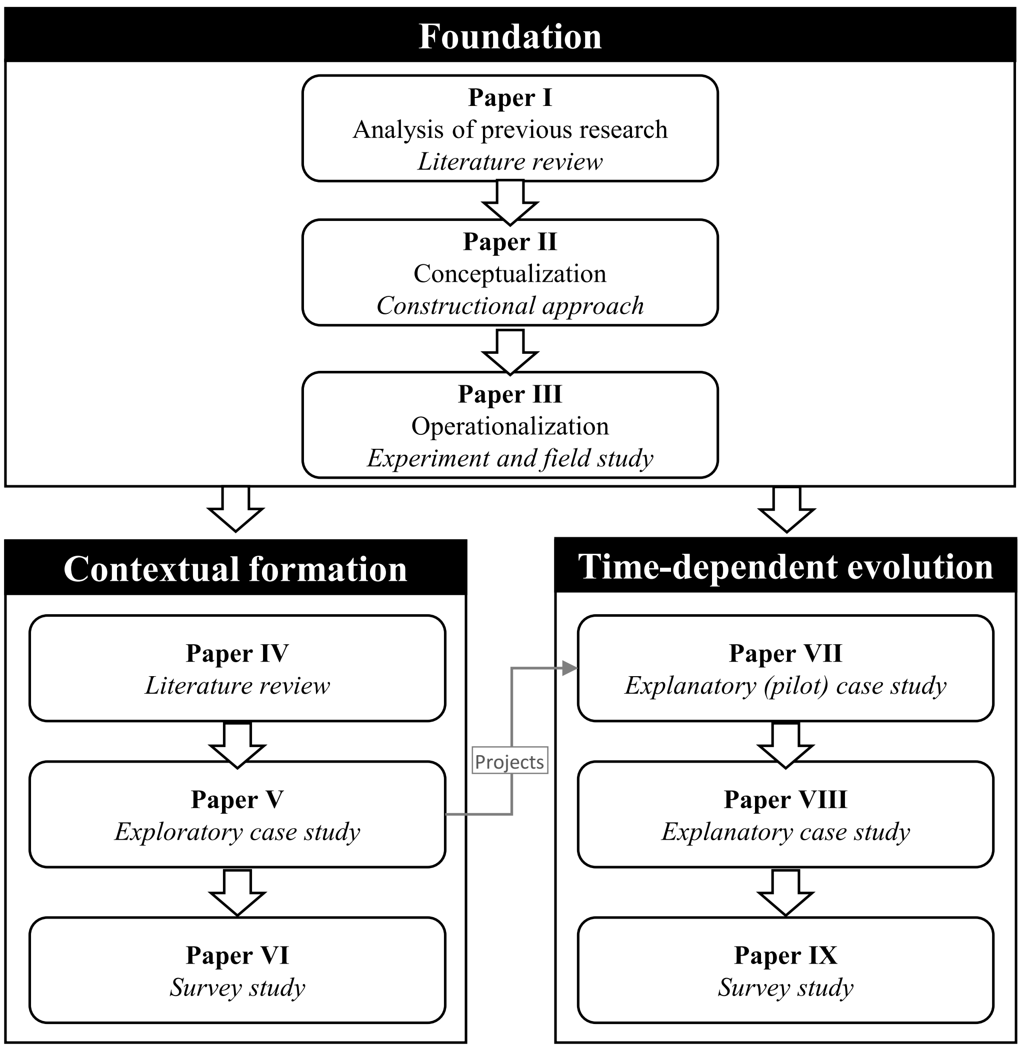


Figure 2. Structure of the thesis (research methods in italics)

This thesis has a three-part structure. In the first part, I establish the foundation for the research on B/IT-SU by reviewing the literature to identify research questions (Paper I), develop a comprehensive concept of B/IT-SU for the subsequent research (Paper II) and seek an adequate operationalization of B/IT-SU (Paper III). These three papers provide the foundation for the subsequent focused research steps. The second part of this dissertation starts with an adjustment of the generic concept developed in Paper II. I analyze the dimensions of B/IT-SU with respect to the situational context, in which B/IT-SU plays a major role, e.g. strategic CIO/CEO collaboration, IT projects or IT operations (Paper IV). Next, I empirically analyze the impact of context factors like organizational complexity and task relevance on the formation of shared understanding in a series of 21 case interviews (Paper V). Then I statistically analyze the effect of organizational complexity (as one specific context factor) on the formation of B/IT-SU (Paper VI). In the third and last part of this dissertation, I focus on the time-dependent evolution of B/IT-SU. To control for environmental context factors, I chose IT projects as a collaboration form between business and IT units and conducted three longitudinal research studies in 18 IT project teams in different companies. A sequence of two case study approaches explores and stabilize assumptions for the time-dependent evolution of shared understanding (Paper VII and Paper VIII). The findings of these studies are applied in Paper IX, in which I analyze the time-dependent aspects around B/IT-SU in a longitudinal survey study.

The next section of this introductory paper provides an overview of the most important theoretical foundation and related research. Based on this foundation the research questions are developed in section 3. Section 4 provides an overview of the research methodologies applied and the data used to evaluate the research questions addressed in this dissertation. Section 5 summarizes the main results of each paper. Finally, section 6 highlights the contributions to theory and practice, followed by a discussion of the limitations and opportunity for further research in section 7.

2. THEORETICAL FOUNDATION OF SHARED UNDERSTANDING

To lay the foundation for the contextual and time-dependent analysis of shared understanding, this section presents a theoretical description of the concept of shared understanding. In defining shared understanding, I ask three basic questions. First, what does *shared* imply? Second, what does *understanding* mean? And third, how can an understanding be shared between individuals? The theories and concepts introduced in the following were applied in different papers of this dissertation to define shared understanding and/or to theoretical frame the research design.

2.1. THE MEANING OF SHARED

In applied psychology research, Cannon-Bowers and Salas (2001) present a widely acknowledge differentiation between the meanings of shared, namely overlapping, similar/identical, compatible/complementary, and distributed. The differences regarding *shared* can be explained by the degree of specialization in a team. While overlapping means partly (not fully) redundant understanding, distributed understanding describes a fully specialized team in which every member has his/her own modular task. Similarly, related IS studies often describe shared understanding as either similar/identical, compatible/complementary or distributed (e.g. Davis et al. 2009; Schmidt et al. 2014; Wagner et al. 2014).

First, *similar* understanding refers to “similar belief about the value of feedback for team development” (Cannon-Bowers and Salas 2001, p. 198) or other team coordination processes that enable team efficiency (Yang et al. 2008) and reduce team conflicts (Chiravuri et al. 2011). Research that refers to that notion of shared argues that similar cognitive resources provide a joined reference framework (Bittner and Leimeister 2014). The conceptualization of shared as similar has been widely adopted in research on team coordination in IT projects (Bittner and Leimeister 2014; Charaf et al. 2013; Vermerris et al. 2014) as well as strategic alignment, analyzing shared understanding between CIOs and the top management team (Benlian and Haffke 2016; Johnson and Lederer 2007; Tallon 2013). The greater the level of agreement in a team (e.g. the role of IT for the organization), the higher the similarity of cognitive resources.

Second, *compatible* understanding describe shared understanding as the level of knowledge that “lead team members to draw similar expectations for performance” (Cannon-Bowers and Salas 2001, p. 198). Vlaar et al. (2008) introduce the notion of “congruent and actionable understanding” and present a framework of socio-cognitive processes to develop an understanding, that enables team members to take action. Previous IS research argues that business members do not need to have a similar/identical understanding of processes and technical tools applied in the IT unit and vice versa (e.g. Vlaar et al. 2008; Wagner et al. 2014). However, they need to make sense of the partner’s domain to achieve an actionable understanding. That does not imply that every team member will think alike (Tallon 2013). Diversity of perspectives is still a critical aspect in business/IT collaborations (Lee and Xia 2010). A great variety of compatible understanding leads to remarkable situations that can be only achieved in a group of more than one person (Weick 2005).

Third, the last category of “shared” applied in this dissertation is *distributed* understanding, which highlights a very different aspect of the term shared (Cooke et al. 2000), abstracting completely from an individual level to a team level. The question is whether knowledge is effectively distributed across the team members to complete the joint task. For example, in a military combat team every member has a highly specialized task but perfectly understands the behavior of each of his/her teammates (Cannon-Bowers and Salas 2001). In previous IS research, this type of shared understanding most commonly analyzes the variation of expertise in a team which is coordinated by an awareness of the distribution of expertise (Espinosa et al. 2007; Kotlarsky et al. 2009; Marks et al. 2000).

2.2. THE MEANING OF UNDERSTANDING

After analyzing the different meanings of shared, this section concentrates on the meaning of understanding. The applied theories to describe the concept of understanding are summarized in Table 1.

Table 1. Theories to describe individuals sense-making process

Theory	Description	Key References
Mental models	A mental model is an individual's organized mental representation of knowledge about key elements of the relevant environment.	Mohammed et al. (2010)
Personal construct theory	Individuals use personal constructs to interpret events in their environment. These constructs are formed by personal experiences.	Kelly (1955)
Social cognitive theory	Individual cognition is influenced by an individual's environment and behavior, which are, in turn, influenced by the individual.	Bandura (1986)
Cognitive capital	Interpretation and representation among individuals embedded in a social network.	Nahapiet and Ghoshal (1998)
Template theory	Individuals are able to structure chunks of information into large patterns, which are used as templates to evaluate to current situation.	Gobet and Simon (1996)
Situation Awareness	Individuals perceive their environment within time and space and are able to understand the meaning and future trends of the current situation.	Endsley (1995)

Discussions about human understanding are an old but elementary topic in the field of epistemology, in which philosophers attempt to answer the question of what knowledge actually is and how it can be acquired. Following Kant (1788) the epistemological discussion changed from the objective formation of the world to the individuals' perceptions of their social surrounding, arguing that humans interpret the same objects differently. This individual 'world view' consists of "...beliefs and assumptions by which an individual makes sense of experiences that are hidden deep within the language and traditions of the surrounding society" (Clark 2002, p. 5). Craik (1963) described the sense-making perception of a person as a "small-scale model of external reality" within the person's head and thereby established the concept of mental models, which is still frequently applied in related IS research to understand success differences between teams (Chiravuri et al. 2011; Schmidt et al. 2014; Windeler et al. 2015). According to Craik (1963), the individual's action relates to the mind's construction of the world, which is influenced by previously experienced events. In psychology research, conceptualizations of mental models focus on the task and the team (Mohammed et al. 2010). While task-related mental models focus on the tasks and processes that needs to be conducted in the collaboration, team-related mental models focus on the understanding of team members' characteristics as well as the distribution of knowledge (Espinosa et al. 2007; Marks et al. 2000; Waller et al. 2004). The concept of mental models was applied in almost all papers of this dissertation as a component in the conceptualization of B/IT-SU.

Similar to the concept of mental models, Kelly's personal construct theory proposes that individuals use a personal construct (or pattern of interpretation) to understand events in their social environment (Kelly 1955). Accordingly, individual understanding can be seen as a subjective construction of the world in terms of a mental small-scale model, which is constantly shaped and adjusted by personal experience and sense-making processes in the social environment. The impact of the social environment on individual understanding is the focus of the Bandura's social cognitive theory (Bandura 1986), which proposes an interactive model in which environmental, behavioral, and personal factors are triadic reciprocal determinants of each other. Individuals form and influence the environments they want to live in, in addition to being influenced by these same environments. Likewise, individual behavior in a given situation is affected by environmental characteristics but also affects the environment. Finally, behavior is influenced by cognitive factors, which in turn are affected by individual behavior. Previous research in IS has adopted this theory to analyze sense-making processes in a geographically distributed team environment (e.g. Subramani et al. 1999; Tallon 2013; Vlaar et al. 2008). This dissertation applies personal construct and social cognitive theories to (1) conceptualize B/IT-SU and (2) motivate the need for an operationalization of B/IT-SU which especially addresses content validity (see Paper III).

Another theory which I apply in this dissertation is social capital theory. Social capital is defined as the "sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit." (Nahapiet and Ghoshal 1998, p. 243). A frequently applied dimension of social capital is cognitive capital, which focuses on the interpretation and representation among individuals embedded in a social structure and has been conceptualized as the understanding of each other's work domains (e.g. Karahanna and Preston 2013; Ray et al. 2005; Wagner et al. 2014) or as a direct antecedent for understanding each other's work environment (Ko et al. 2005; Tiwana et al. 2003; van den Hooff and de Winter 2011). The latter conceptualize cognitive capital as similar values, interpretations or common visions and found a significant impact on the amount of sharing knowledge regarding the business and IT work environment, which results in understanding of each other's work environments. The understanding of each other's work environment is often also labeled as (shared) domain knowledge (Schlosser et al. 2015; Tiwana 2012; Vermerris et al. 2014). In this dissertation I apply the concept of social capital, first as a lens in the conceptualization of B/IT-SU, and second to frame the antecedents that are assumed to have an effect on the development of B/IT-SU, in Paper VII and Paper VIII respectively.

Another theory applied in this dissertation is the template theory, which expands the theory of mental models (Gobet and Simon 1996). The template theory was developed as an extension of the chunking theory introduced by Miller (1956). Chunking refers to the process of (cognitive) information sorting, where a chunk is a bundle of information. The template theory argues that individuals are able to cluster chunks into larger frameworks, which are the cognitive templates. An expert of a specific domain will recognize a larger set of possible scenarios and strategies depending on the current situation because the expert has stored several different templates related to the current scenario. Thus, an individual who perceived reoccurring chunks of information over time is able to build templates for different scenarios related to these chunks of information. If a group of individuals perceive the same reoccurring chunks of information over time, the cognitive templates of the individuals are more likely to be assimilated. Template theory has been widely applied to understand the differences between the cognition of experts and novices in the same situation and how a person evolves from a novice to an expert. The template theory was applied in Paper V, which analyzes the effects of modularization on B/IT-SU. I chose the template theory for this research because it allows to analyze individuals' capability of 'scrolling' through different hierarchical cognitive templates when recognizing the environment and to abstract from a part in a business process (i.e. module) to a higher system of business processes (i.e. network of modules).

A last concept, which was applied in this dissertation is the concept of situation awareness. The concept has been applied frequently in psychology studies, focusing on aviation and other real-time tasks. Endsley (1995) defines situation awareness as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" (p. 36). The environmental data perceived by an individual will be compared to the existing mental models. The result of this comparison is an adjusted understanding of the current time-dependent situation. Thus, in team processes with changing situations, team members will constantly reevaluate and adjust their recent mental model.

In summary, the concept of shared understanding is a multifaceted construct which has been operationalized and adjusted to fit the respective research purpose. Shared understanding can be described as *similar*, *compatible, or distributed* interpretation of *environmental elements* within *time and space* in a *group* of individuals. Environmental elements can be elements which are directly linked to a collaborative task (i.e. task-related and team-related mental models) or elements of each other's work domain, like daily challenges and operational tools. Shared understanding enables group members to draw similar conclusions of the current situation as well as for the near future.

2.3. THE DEVELOPMENT OF SHARED UNDERSTANDING

Various theories in psychology, philosophy and IS research have been developed to understand the emergence of shared understanding between individuals. A set of theories that elucidate different perspectives in the development of B/IT-SU will be presented in the following and are summarized in Table 2. The theories have been applied in the papers comprising this dissertation either to set the theoretical background or to motivate the research question.

Table 2. Theories that describe the development of shared understanding

Theory	Description	Key references
Theory of communicative action	Shared understanding between two individuals is developed in a communicative act by the comprehensibility of an information shared, the articulation of a validity claim and the acceptance of the validity claim.	Habermas (1985)
Process-oriented theory of team knowledge emergence	Shared understanding in teams is developed by the process of individuals learning and sharing knowledge with appropriate members in the team.	Grand et al. (2016)
Media synchronicity theory	The suitability of media usage to transfer information depends on the novelty and necessity to verify the information.	Dennis et al. (2008)
Transactive memory theory	Individuals can serve as external memory aids to other individuals. Individuals can benefit from each other's expertise if they build an awareness of who knows what in the group.	Wegner (1987)

The first theory introduced in this section originates from the philosophical discourse of epistemology. The communicative action theory describes on a microlevel the process of the development of shared understanding in a communicative act between two persons (Habermas 1985). The communicative success depends on three conditions – (1) comprehensibility, (2) validity claim, and (3) acceptance of validity claim. First, the hearer needs to understand the meaning of what is being said. Second, the speaker needs to formulate a validity claim. Habermas distinguishes three validity claims: Objective truth (the speaker informs the hearer about actual conditions); subjective truthfulness (the speaker informs the hearer about his/her interpretation); normative rightness (the speaker informs the hearer about the normative context). After understanding the content of the message (step 1) and claiming its validity (step 2), the third step is to accept the validity claim. Based on Marshall and Brady (2001), accepting a validity claim is not the same as agreeing on the quality of the validity claim. This distinction becomes important when focusing on validity claims 2 and 3. Sometimes, sufficient shared understanding can be established by a person only accepting the subjective interpretation or normative context of the other person without agreeing on it. However, the level of shared understanding will be higher if interacting people do not just accept but personally agree on the validity claim. This agreement can be reached if both partners identify their own positions within the validity claim.

The limitation of this theory for this dissertation is that it conceptualizes the development of shared understanding only between two persons and not in a group of individuals. The second theory introduced in this section focusses on a microlevel development of shared understanding in a group by sharing knowledge and learning from others knowledge. Grand et al. (2016) introduced a process-oriented theory of team knowledge emergence which consist of two basic mechanisms: learning (information processing) and sharing (communication). First, an individual acquires novel knowledge by selecting an appropriate data source to elicit new information. Second, the individual encodes (learning from environmental events) or decodes (learning from others) the data. The processed information will be integrated and stored in the existing body of knowledge of the individuals. In the sharing phase, the individual selects appropriate team members to share the information with. In the subsequent retrieval process, the individual identifies the piece of information from memory and brings it into active awareness. Next, the individual shares the information with the selected team members. Sharing can be enabled by different media (see media synchronicity theory). Last, the team member who receives the information needs to verbally acknowledge the information (see acceptation of validity claim in theory of communicative action). This theory allows the emergent team knowledge to be mapped by identifying: (1) which team members has processed which information, (2) which processed information has been shared between and among team members (3) which team members has been selected to share the information. Since the theory is quite new, not many studies have empirically applied or additionally tested the theory. However, it combines critical components of previous theories on information processing and knowledge sharing, for which reason it represents a useful approach to describe the development of shared understanding in a team on a microlevel.

Both of the theories outlined above are based on communicative interactions between and among individuals. However, especially in globally distributed teams, the possibilities for interactions are limited. Hence, the third theory introduced in this section concentrates on the opportunities of media usage in the development of shared understanding. The media synchronicity theory initially suggested by Dennis and Valacich (1999) and further enhanced by Dennis et al. (2008) distinguishes between two primary processes in a communication act – conveyance and convergence processes. The processes should be applied depending on the information that needs to be transferred. First, an information should be conveyed when it is very explicit and does not need any feedback from the recipients of the information (e.g. the project lead informs other project group members about the agenda for the next meeting). In that case, use of media supporting lower synchronicity among team members results in better communication performance leading to a higher level of shared understanding. Second, a convergence process needs to be applied when the information contains novel or negotiable content. In that case, the use of media supporting higher synchronicity among team members should be applied. The choice of appropriate media is influence by the familiarity of the information, previous trainings, past experience and social norms among the team members.

The last theory, introduced in this section focusses on the group level and applies group coordination mechanisms to describe the development of shared understanding. A transactive memory system is a system through which members of a group distribute and retrieve information from other members of the group. The objective is to achieve a group-wide coordination of individual knowledge (Wegner 1987). The theory argues that individuals in a group can retrieve information from an internal memory (the own memory) or encode information from external memories, like reports, books or – most commonly – memories of other team members. The theory postulates that groups develop a transactive memory system which allows them to reduce the cognitive load of individual group members. Thus, the major difference of this theory compared to the theories introduced above lies in the semantic categorization of the meaning of shared. While the previously introduced theories describe *shared* as overlapping or similar knowledge between individuals, the transactive memory system describes the set of knowledge in a team as distributed, which gets linked by "team's collective awareness of who knows what" (Chou et al. 2012, p. 383). Previous research has confirmed that this ability of transactive memory systems enable groups to perform higher than groups which are not able to draw on one another's knowledge (Jarvenpaa and Majchrzak 2008; Kotlarsky et al. 2009; Oertel and Antoni 2015). I apply this theory in Paper IX to interpret the findings regarding the negative impact of B/IT-SU on team success.

In summary, shared understanding among team members is achieved in a communicative act of learning and sharing information. The process of information sharing additionally relies on the comprehension of the information, the articulation of a validity claim and the acceptance of the validity claim. The suitability of media to transfer the information depends on the novelty and potential for negotiation of the information. Also, in highly specialized teams, research suggests that team performance increases when team members are aware of knowledge distribution among team colleagues and are able to retrieve and consolidate necessary information from internal and external memories. In the absence of formal hierarchies or procedural communication standards, the quality of member selection for the information sharing process depends on this awareness of expertise distribution (who knows what and who needs to know what).

2.4. Business/IT shared understanding in the context of this dissertation

The concept Business/IT Shared Understanding is applied as an umbrella concept which comprises different sub-concepts that have been applied in previous research. As introduced in the prior section, shared understanding can imply very different definitions and cover various perspectives. For that reason, the following section provides a definition and conceptualization of shared understanding as I apply it in this dissertation. In referring to the previous introduction of shared understanding, I define shared understanding as follows:

> *Shared understanding is defined by similar, compatible or distributed interpretation of environmental elements within time and space in a group of individuals. By that, shared understanding represents an intersection of two or more individual cognitive models, which are constantly formed and adjusted by experiences and sense-making processes.*

In a collaboration between business and IT professionals, the environmental elements mentioned in the definition can be described as …

1. … the **task- and team-related aspects** that result from the objectives of the underlying collaboration, like requirement elicitation in a software development project or documentation standards in an IT infrastructure system.
2. … the **business domains**, which are addressed by the objectives of the collaboration, like daily routines and common challenges of the business unit.
3. … the **IT domains**, which provide the technical foundation in the collaboration, like potentials and limitations of the current IT systems.

The first element focusing on shared understanding of **task and team related aspects** has been often conceptualized within the concept of team mental models, which focus on the understanding of the task as well team characteristics in collaborative projects. Team mental models (TMM) has been frequently applied to analyze the success in software development (e.g. Espinosa et al. 2007; Levesque et al. 2001; Yang et al. 2008) and/or globally distributed teams (e.g. Chiravuri et al. 2011; Robert et al. 2008; Windeler et al. 2015). Task-related aspects in IT project teams have often been described as elicitations of software requirements (Chakraborty et al. 2010), IT development procedures (He et al. 2007) or technology implementation (Davis et al. 2009). The team-related aspects most commonly refer to the understanding of expertise distribution or who-knows-what (He et al. 2007; Levesque et al. 2001; Yang et al. 2008). Especially in globally distributed software development, task-related and team-related mental models were found to be significantly supportive for team coordination, since the synchronization and coordination of task processing requires virtual teams to be well organized (Espinosa et al. 2007). However, TMM has been also found to increases team effectiveness (Yang et al. 2008), decision quality (Robert et al. 2008), as well as satisfaction in a team (Guchait et al. 2016).

The second and third elements focus on shared understanding of the **business domain** and **IT domain**, which have been frequently labeled as shared domain knowledge in previous research (Reich and Benbasat 2000; van den Hooff and de Winter 2011; Wagner et al. 2014). Previous IS studies find that shared domain knowledge enables effective collaboration (Tiwana 2012) and harmonized partnership (Bassellier and Benbasat 2004) among business and IT units. When employees from the business and IT units understand each other's work environment (Nelson and Cooprider 1996) or key processes (Reich and Benbasat 2000), they are able to increase business process performance (Ray et al. 2005), facilitate IT flexibility (Wagner et al. 2014) and collaborate efficiently in IT projects (Tiwana 2012).

In line with different conceptualizations of B/IT-SU, I also propose a multi-dimensional conceptualization of the outcome of B/IT-SU. In this dissertation, my conceptualization of the outcome of B/IT-SU encompasses three types of collaboration: strategic, operational and project-related. Research on strategic collaborations has shown that B/IT-SU enables strategic alignment (Reich and Benbasat 2000), IS contribution to firm success (Leidner et al. 2010) and consensus among executives (Tallon 2013). The conceptualizations do not refer to a specific process, product or service, but more generically to overall firm success and satisfaction with the services of the IT unit. I adapt this conceptualization to the outcome of B/IT-SU in strategic collaborations, focusing on the overall IS contribution to the firm's strategic growth and success. In contrast, operational collaborations focuses on concrete operational success indicators, like flexibility of an IT systems in respect to changing business needs (Wagner et al. 2014), business (process) performance

(Schlosser et al. 2015) or responsiveness of the IT unit to business requests (Chen et al. 2014). In this dissertation, I refer to this conceptualization of success in operational collaborations as IT change effectiveness in terms of change responsiveness of the IT unit in building IT solutions for the business unit. Last, in IT project teams, B/IT-SU was found to improve functional/technical quality (Lee and Xia 2010), team coordination (Espinosa et al. 2007) or team efficiency (Yang et al. 2008). A comprehensive conceptualization of team success in IT projects comprises eleven success dimensions covering aspects of project management, like adherence to schedule or budget, technical aspects, like system quality and use, as well as business aspects, like business continuity or functional quality (Thomas and Fernández 2008). For the purpose of this dissertation, I describe team success as the quality of the final outcome of a team task. Aspects like functionalities, technical specificities as well as stakeholder satisfaction are critical indicators of team success in an IT project.

Table 3 below summarizes the conceptualizations based on the research question and design in the respective papers of this dissertation. A detailed reasoning for the differing conceptualization can be found in the papers themselves. Since Paper I, Paper II and Paper IV are not empirical research studies, a holistic concept of B/IT-SU was applied based on previous research. In addition, Paper III attempts to develop a survey instrument based on a holistic theoretical concept of B/IT-SU, including various perspectives of shared understanding. The respective conceptualizations in Paper V to Paper IX result from the underlying research objectives, which are described in the respective paper.

Table 3. Conceptualizations in this dissertation

	B/IT-SU of task/team aspects	B/IT-SU of business domain	B/IT-SU of IT domain	Outcome of B/IT-SU
Paper V	Objectives, work environment and language usage in various collaborations	X	X	IS contribution to strategic and operational efficiency
Paper VI	X	Processes and strategy of the business units	X	IT change effectiveness
Paper VII	Objectives and work environment in IT projects	X	X	Project success
Paper VIII, Paper IX	Tasks and team characteristics of IT projects	Market, products, daily routines and challenges in business units	Challenges of IT, tools and common procedures of IT units	Project success

3. RESEARCH QUESTIONS

In the following three sections, I present the research questions for each building block of the research framework. First, I address the discrepancy between the definition, conceptualization and operationalization of B/IT-SU. Second, I focus on the role of the context on the formation of B/IT-SU and provide an overview of recent contradictory research findings. Third, I present the research question regarding the time-dependent evolution of B/IT-SU by highlighting the to date limited and contradictory research findings. Figure 3 provides an overview of the research questions which will be introduced in the following sections.

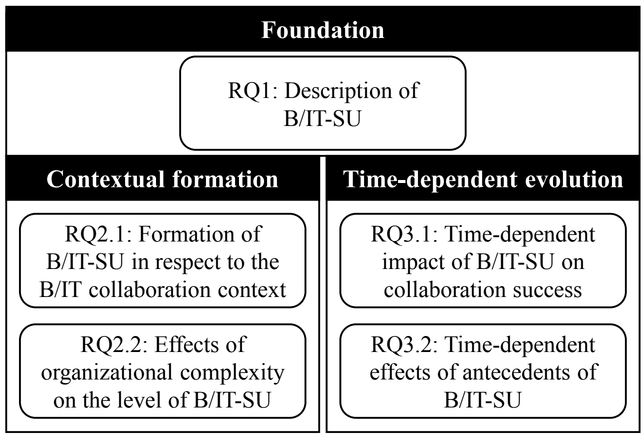


Figure 3. Overview of research questions

3.1. FOUNDATION OF BUSINESS/IT SHARED UNDERSTANDING

Despite widespread agreement among scholars about the importance of B/IT-SU for organizational success, conceptualizations largely differ depending on the research stream. For example, shared understanding in business/IT alignment research mainly focuses on B/IT-SU of objectives or strategies (Reich and Benbasat 2000) and/or the role of IT in the firm (Johnson and Lederer 2010). Research on operational fit, like in IT projects, in contrast, analyzes shared understanding at the level of the business (and IT) processes (Davis et al. 2009; Ray et al. 2005; Wagner et al. 2014) or linguistic aspects (Charaf et al. 2013). Initial studies, like Tiwana (2012) or Dennis et al. (2008) indicate that shared understanding must be conceptualized as a multidimensional construct, which adjusts against the present contextual needs. Thus, as a first step toward a contextual and time-dependent analysis of B/IT-SU, this dissertation starts with a comprehensive analysis of findings and statements in existing literature in order to derive a comprehensive definition and concept of B/IT-SU. The first research question is:

RQ 1: What aspects of B/IT-SU have been discussed in previous literature?

The first objective of this research questio is to provide a comprehensive overview of the concept of B/IT-SU and identify the limitations of previous conceptualizations. Thus, a first sub-question can be formulated as followed:

RQ 1a: What are important research directions as well as limitations in research on shared understanding among business and IT?

The second objective is to provide a clear definition and conceptualization of B/IT-SU based on previous research. The goal is to develop a holistic concept, including the most important dimensions of B/IT-SU based on previous research, which can be adjusted and aligned in subsequent research steps. The second sub-question is therefore:

RQ 1b: How can shared understanding among business and IT be conceptualized?

The third and last objective in the foundation research is the analysis of previous operationalizations of B/IT-SU. The resulting recommendation for adequate measures provides the basis for the quantitative measurements in Paper VI to IX. The last sub-question can be stated as followed:

RQ 1c: How can shared understanding among business and IT be measured?

This initial research step attempts to build a holistic and unified concept of B/IT-SU, which provides the foundation for the next steps in this dissertation. In the main body of the dissertation, I explore the divergent research findings into the influence of shared understanding in previous research, which will be presented in the next two sections. To identify the underlying research gaps, I adopt a contingency-based approach and analyze the impact of the dimensions of shared understanding in different scenarios. This approach builds on the well-established contingency theory, which postulates that organizational effectiveness results from a fit between structural characteristics of the respective organization and the contingencies that reflect the situation of the organization (Burns and Stalker 1961; Lawrence and Lorsch 1967; Woodward 1965). Contingency factors are often conceptualized related to contextual situations and circumstances (Burns and Stalker 1961; Mathiassen et al. 2007; Resick et al. 2014). Since a strong fit between organizational characteristics and contingencies results in high performance, organizations are motivated to maximize and maintain this fit. Therefore, organizations are shaped by contingencies. An example of this phenomenon can be found in digital transformation, where the potential availability of data-driven information is triggering huge changes in various industries, which are adjusting their organizational structures in response to this contingency change (Henfridsson et al. 2014). Thus, contingency theory contains the concept of fit, which affects performance, which, in turn, affects organizational adaptability (Woodward 1965).

In this dissertation, my analysis of contingency factors adopts a split which has been made in previous research, namely contextual structure and time. Most research applying contingency models to describe organizational success differentiate between structure-related contingencies like organizational complexity (Adler and Kwon 2002; Mathiassen et al. 2007), organizational experience (Marks et al. 2000; Waller et al. 2004) or strategic orientation (Donaldson 2001; Jiang and Klein 1999; Olson et al. 1995) and time-related contingencies like environmental stability (Donaldson 2001; Resick et al. 2014) or phase-specific, situational changes in an organization (Cho et al. 2008; Jarvenpaa et al. 2004). I adopt this split by analyzing structure-related contingencies representing the context which shapes the collaboration (see next section) separately from time-related contingencies that drive the time-dependent evolution of a business/IT collaboration (see the section after that).

3.2. Research on the contextual formation of B/IT-SU

Contingencies reflecting the contextual structure have been formulated in terms of organizational complexity and strategic orientation.

A common aspect of **organizational complexity** is organizational size (e.g. Donaldson 2001; Duffy et al. 2000), which affects the degree to which an organizational structure is bureaucratic. Centralized organizations more commonly have a rule-based structure than decentralized organizations (Pugh et al. 1969). In IT-related research, the contingency of size has also been applied to IT system size measured by the number of function points (Banker et al. 1991) or number of tasks that need to be conducted in a project (Roberts et al. 2004). Thus, size of the organization – e.g. an IT project team – combined with size of an IT system can be viewed as one aspect of the contingency factor organizational complexity. However, size is certainly not the only aspect of organizational complexity. In the case of software development projects, Mathiassen et al. (2007) present a contingency model in which they describe complexity as a larger set of not fully specified requirements, which are difficult to understand and communicate. They find that an additional source of complexity results from varying and often conflicting views and opinions of stakeholders regarding the quality and content of requirements. More generally, "complexity can be related directly to the task attributes that increase information load, diversity, or rate of change" (Campbell 1988, p. 43). A task is considered complex when it can be executed by multiple paths, generate multiple outcomes, or when there are conflicting interdependencies among paths to multiple outcomes or uncertain linkages between path and outcome (Campbell 1988). In terms of complexity in IT-driven collaborations, the role of trust in teams weakens when the joint task can be precisely formulated (Jarvenpaa et al. 2004), i.e. for a low-complexity task. Also knowledge sharing seems to lose importance in collaborative tasks when they are clearly described and formulated (Grand et al. 2016). Putting too much effort into knowledge sharing in a low-complexity task environment "may even impede progress or decision-making efficiencies for some teams" (Resick et al. 2014, p. 173).

The second structure-related contingency, **strategic relevance**, is frequently cited in related literature (e.g., Donaldson 2001; Olson et al. 1995). The respective contingency of strategy influences the impact of functional (or divisional) structure. Undiversified strategies can be best managed by functional division and diversified strategies should be coordinated by a divisional structure (Chandler 1969). IS research finds that innovative and unique tasks require different forms of team collaboration than routine and operational tasks. Specifically, innovative, novel and diversified tasks with a high strategic relevance require more participative structures and a more detailed level of shared understanding among team members than less innovative projects (Marks et al. 2000; Olson et al. 1995). This seems to imply that shared understanding is more important in strategically relevant tasks than in non-strategic (i.e. operational) tasks.

However, previous B/IT-SU research yields very different results. It has been found that complexity and strategic relevance increase the relevance of shared understanding between business and IT professionals. Especially in routine environments, shared understanding seems to have a weak or even negative effect on the success of a collaboration (Levesque et al. 2001; Marks et al. 2000; Resick et al. 2014). These findings contradict the ideas of the media synchronicity theory (Dennis et al. 2008), which explicitly highlights the importance of shared understanding in familiar *and* unfamiliar environments for team success, unlike the suitability of media usage, which varies depending on whether the environment is familiar or unfamiliar. By conceptualizing shared understanding as a two-dimensional construct, Tiwana (2012) provides initial indication that different facets of shared understanding gain importance depending on the familiarity of different environmental elements. In the context of information system development projects, the author found that shared (here: similar) *technical* understanding is essential in IT projects with novel development procedures. In contrast, shared *business* understanding among business and IT professionals is important when the application being developed is novel for the team members. Thus, depending on environmental factors, different dimensions of shared understanding are more important than others. In addition to contradictory in research findings about the degree of familiarity of the joint environment discussed above, knowledge sharing among team members seems to be less important if the joint objectives and responsibilities among team members are formulated precisely (Grand et al. 2016), which can be directly linked to the contingency factor of organizational complexity. These results are partly contradicted by the findings of Guchait et al. (2016), who confirm that shared understanding regarding task work has no effect on team success, while shared understanding of the team work (operationalized as team values) has a strong positive effect on team success in precisely formulated environments.

Most of these studies were conducted in an educational environment with student respondents (exceptions are Dennis et al. 2008; Tiwana 2012). However, if these results hold true in an organizational business context, it would imply that the completion of low-complexity tasks, like desktop services or first-level support would not require shared understanding between business and IT professionals. Nonetheless, as mentioned above, initial studies in organizational business environments have different results, underscoring the need for a more deliberate discussion of various dimensions of shared understanding. In response to this need, my second research question is:

RQ 2.1: How do contextual contingencies moderate the effect of different dimensions of shared understanding among business and IT on collaboration success?

After analyzing whether the conceptualization of B/IT-SU changes with regard to contextual contingencies, I analyze the statistical effects of contingency factors on the formation of B/IT-SU. I focus on the role of organizational complexity since this factor is a common motivation for research on B/IT-SU (e.g. Bittner and Leimeister 2014; Ko et al. 2005; Zelt et al. 2014) and one of the most common contingency factors in research on B/IT-SU. As outlined above, research findings related to organizational complexity vary, sometimes describing B/IT-SU in a low-complexity environment as threat for organizational success (Mani et al. 2010; Resick et al. 2014) and sometimes as a multidimensional concept with various focal points (Dennis et al. 2008; Tiwana 2012). To bridge this variance, the second sub-question in this research step is:

RQ 2.2: How does organizational complexity impact different dimensions of shared understanding among business and IT professionals?

3.3. Research on the time-dependent evolution of B/IT-SU

The research questions above address the impact of contextual factors on the formation of B/IT-SU. Next, I analyze and discuss previous research on the time-dependent evolution of B/IT-SU, addressing time as the second contingency factor in this dissertation. To limit the scope of context, I focus on the time-dependent evolution of B/IT-SU only in IT projects as a temporally limited collaboration form, leaving strategic and operational (daily business) collaborations for future studies.

In their contingency framework, Mathiassen et al. (2007) establish requirement volatility over time as a critical contingency factor influencing IS development approach design. The authors argue that requirements volatility is driven by changing internal or external conditions or learning effects during the development process. IT-related collaborations as well as the internal/external conditions, needs and opinions of team members evolve over time, causing the intensity and content of collaboration to change over time as well. Internal conditions were analyzed by Cho et al. (2008), who captured time-dependent changes in the stakeholder network across an IT implementation project. Based on a case study, the authors found a constantly changing stakeholder network across the duration of the project. In the initial phases of the project, there was strong focus on functional, business-related topics involving a high number of business representatives, while technical details made the involvement of IT professionals more important towards the second half of the project. This change of the network over time and its effects on collaboration was confirmed by Jarvenpaa et al. (2004), who found that the impact of trust fundamentally depends on the underlying (time-dependent) situation.

The findings of previous research focusing on business/IT shared understanding vary remarkably with regard to the time-dependent evolution of B/IT-SU and its effects on team success. The findings raise questions about the optimal timing of implementation and about whether an increasing, decreasing or a stable level of B/IT-SU over time positively affects team success. Vermerris et al. (2014) found indications that early implementation of shared understanding is critical for the success of a business/IT project – the sooner the better. In contrast, He et al. (2007) found that it is common for shared understanding to start at a low level and *increase* over time. They argue that an initial low level of shared understanding has no effect on the success of the collaboration. Levesque et al. (2001) conclude the opposite, namely that shared understanding commonly *decreases* in IT projects as a result of specialization. They show that it is important for a team to have a clear understanding of the collaborative work at the very beginning of the project, which decreases as team members focus increasingly on individual tasks. van der Haar et al. (2015) found that a *decreasing* as well as an *increasing* level of shared understanding can have a positive effect on team success, and that only a stable level of shared understanding negatively effects team outcomes. The authors argue that a decreasing level of shared understanding does not necessarily have a negative impact on team success "as long as members of a team have reached a certain level of shared understanding of the team's relevant situation" (p. 605).

One reason for these contradicting findings might be related to the conceptualization of business/IT shared understanding or, more specifically, to the meaning of "shared" (Cannon-Bowers and Salas 2001). While some research conceptualizes "shared" as similar understanding, e.g. regarding business and IT processes (Ray et al. 2005), project objectives (Vermerris et al. 2014) or a problem (Chakraborty et al. 2010), other research describes "shared" as combined or congruent understanding (Okhuysen and Eisenhardt 2002; Vlaar et al. 2008; Wagner et al. 2014) representing the knowledge and expertise consolidated in a team. These different conceptualizations make it impossible to determine a generic answer on the question whether B/IT-SU increases or decreases along an IT project lifecycle and how different facets and meanings of B/IT-SU become important at other stages during the IT project to improve team success. Since this research step focuses on IT projects, I strive to determine the strength of potential indicators of IT project team success, such as quality of functionalities and technical specificities, adherence to time and budget, and stakeholder satisfaction (Lee and Xia 2010; Thomas and Fernández 2008). Thus, the underlying research question of the third part of this dissertation can be expressed as follows:

RQ3.1: How does the time-dependent evolution of shared understanding among business and IT professionals affect team success?

Parallel to understanding the time-dependent effects of B/IT-SU on team success, the time-dependent antecedents of B/IT-SU must also be considered. Previous research has studied and identified various antecedents of B/IT-SU, like communication intensity (Robert et al. 2008) or trainings (Vlaar et al. 2008) with the ultimate goal of increased collaboration success. However, most of these studies do not consider evolution over time. Only few studies provide initial empirical (mostly qualitative) evidence for the time-dependent impact of antecedents of B/IT-SU, and these tend to be single case study approaches (e.g. Charaf et al. 2013; Chua et al. 2012; Wagner and Weitzel 2012).

Most relevant quantitative studies with statistical analysis were conducted in an educational environment with student respondents (He et al. 2007; Levesque et al. 2001; Robert et al. 2008; Windeler et al. 2015), which, as the authors acknowledge, leads to a potential lack of transferability of the findings to an organizational context. As previous research indicates, the antecedents of shared understanding in a business/IT collaboration are directly impacted by experience and previous knowledge (e.g. Preston and Karahanna 2009; Tan and Gallupe 2006; Yang et al. 2008). Students lacking professional project insights are likely to act very differently than professionals who have experienced team conflict and coordination challenges in many projects. For that reason, data collected about the antecedents of the development of shared understanding is likely to vary depending on whether it is collected in an educational or a professional environment. In order to overcome this potential lack of transferability of previous findings and in response to calls for more longitudinal research on B/IT-SU (e.g., Benlian and Haffke 2016; Mohammed et al. 2010; Vermerris et al. 2014), this dissertation asks the following research question:

RQ3.2: How do different antecedents affect the time-dependent evolution of shared understanding among business and IT professionals?

In summary, this dissertation starts with a literature-based analysis of the concept of B/IT-SU, its causes and consequences as a foundation for further research. Next, a contingency-based approach is taken to understand the contextual formation and time-dependent evolution of B/IT-SU, including the effects of different antecedents and its effect on collaboration success.

4. Research methodology

Based on previous discussions about human knowledge, it is widely acknowledged that research should consider more than one research method to analyze different perspectives of the research variable. A mixed method approach limits the potentials of failing to capture or misinterpreting critical observable events (Ågerfalk 2013; Tsang 2014). In particular, the sole reliance on statistical analysis approaches has been raised as being potentially equivocal for research analyzing and interpreting causal effects. Thus, research recommends a mixed method approach to compensate for potential shortcomings. As recommended by Gable (1994), I follow a sequential mixed method approach of various qualitative and quantitative research techniques. First, the research is built on a strong foundation based on a structured literature review. Second, a series of exploratory followed by explanatory case studies reveal potential mechanisms of and around the research variable. In the last step, two structured survey studies provide evidence for external validity and generalizability of the results. This multi-method research approach combines the strength of each method. An overview of the research method is provided in Figure 4.

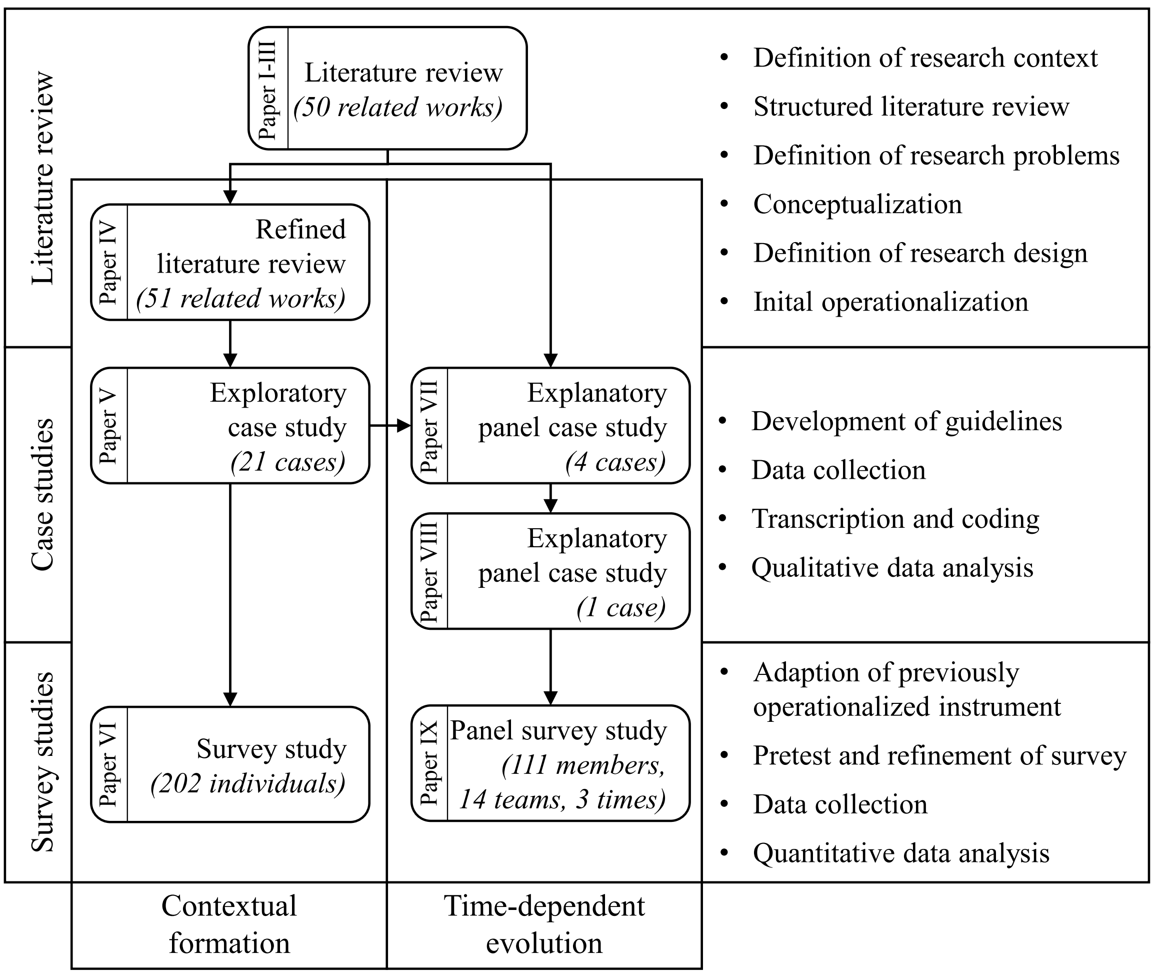


Figure 4. Overview of mixed method approach in this dissertation

Since this dissertation examines two loosely coupled research problems, namely analysis on the contextual formation and time-dependent evolution of B/IT-SU, I apply a mixed method approach for both research paths. The specialization of both research problems is based on a structured literature review (Paper I), generic conceptualization (Paper II) and initial operationalization (Paper III). The operationalized instrument of the comprehensive B/IT-SU concept will serve as source for the more focused survey-based studies in the final papers of each research focus. An additional literature review (Paper IV) focusing on conceptual commonalities and differences of B/IT-SU in different research streams provides a foundation for analyzing the contextual formation of B/IT-SU. An exploratory (Paper V) and a two-stage explanatory case study (Paper VII, Paper VIII) further adjusts and stabilizes the research framework. In a last step, the contextual formation and time-dependent evolution of B/IT-SU is empirically tested in a survey-based study (Paper VI) and one longitudinal survey-based study (Paper IX). The details of the respective methodologies are presented in the following.

4.1. Literature review

The literature reviews in this dissertation are carried out in accordance with general guidelines for literature reviews (Webster and Watson 2002) and following the recommendations of Rowe (2014). As an initial step, the concept of B/IT-SU was defined based on previous philosophical discussions in the field of epistemology (see Paper I and Introductory Paper). Next, appropriate keywords were selected for the search process. The keywords were applied in a search of the leading journals in the IS community – namely the Senior Scholar Basket. In addition, further appropriate journals and highly ranked conferences were included in the search (see Paper I and IV for more details). Subsequent backward and forward searches were performed to screen additional outlets not considered in the first step of the search process. According to Paré et al. (2016), the review processes were structured and made transparent through clear documentation and detailed protocols in terms of the planning, searching, selecting, quality assessing, data extraction and interpretation phases.

Based on Schwarz et al. (2006) a literature review pursues the following four objectives: First, it summarizes prior research. Second, it is applied to critically analyze the contribution of prior research. Third, it sorts and compares the research findings into research stream. Fourth, if appropriate, it should clarify alternative views of past research. These four objectives are traced in the two structured literature reviews of this dissertation (Paper I and Paper IV). In addition, the conceptual work in Paper II builds on the literature findings of Paper I. The papers focus on the conceptualizations and findings on shared understanding between business and IT employees in previous IS research. Paper I provides an overview of different research streams that apply the concept of shared understanding and highlights the different findings and conceptualizations according to the research stream. The second literature review (Paper IV) focusses on the research context and analyzes the differences between strategic, project-related and operational business/IT collaborations in previous research.

The literature analysis reveals that the two research problems are widely unexplored in previous research. Despite extensive research into B/IT-SU in general, most studies (1) focus on quite specific collaboration types and (2) analyze mainly snapshot data. To facilitate the analysis of the contextual formation of B/IT-SU as a first analysis step, the different collaboration types were consolidated into a comprehensive concept based on the prior literature review. This concept is tested in the next phase, applying a set of qualitative research methods.

4.2. Qualitative research

Scholars widely agree that qualitative research is an adequate approach to create a detailed understanding of observable events and to determine underlying mechanisms of a research variable (Mingers 2001). Since this dissertation focusses on environmental effects (collaboration type and time) that form B/IT-SU, in-depth case studies were chosen as most suitable to amplify our understanding of the concept. Yin (2014) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon (the 'case') in depth within its real-life context, especially when the boundaries between phenomenon and context may not be clearly evident" (p. 16). The objective of case study research is to study a single unit or a set of units in detail to infer propositions for a larger group of similar units (Gerring 2008). However, recent research argues that the objectives can differ in detail. In a literature review on case study research, Dubé and Paré (2003) determined the categorization of case study research into descriptive, explorative and explanative case study design. The descriptive case study design is by far the most frequently applied approach in previous research (61% of 183 studies). The authors assume the reason for this unequal distribution is the distinct complexity of the approaches. While descriptive case studies do not need a theoretical basis or analysis of causality between constructs, exploratory case studies (30% of 183 previous case studies) are commonly applied to build explanations for a phenomenon and compare the findings with previous literature. The explanatory case study approach on the other hand, which makes 9% of previous case study research, is considered the most demanding approach. In contrast to the descriptive and explorative approach, the evaluation and reconsideration of (existing) theories is in focus. Also, the case study approach applies instrument for empirical testing, most commonly to conduct a time series analysis (Yin 2014).

Based on these categorizations of case study research, this dissertation follows a three-stage qualitative case study approach. In the first phase, an exploratory case study, based on 21 case interviews is applied to explore the contextual formation of the B/IT-SU construct (Paper V). The objective is to find explanations for the contextual impact of the collaborations type on joint success in different collaboration types. The findings for the *project*-related formation are transferred to the subsequent research step on the time-dependent evolution of B/IT-SU, since the empirical studies in this research stream focus on temporal collaborations with a clear start and end, like in IT project teams. A sequence of two explanatory case studies determine (Paper VII) and then test (Paper VIII) various mechanisms that define the time-dependent evolution of B/IT-SU. The approaches are presented in detail in the next two sections.

4.2.1. Exploratory case study approach

The foundation for an exploratory case study is a clean theoretical slate (Eisenhardt 1989). This foundation enables a structural framework and reasoned guideline for the exploratory analysis of the "how" and "why" the phenomenon of interest occurs (Yin 2014). Especially because the research takes place in a real-life-context, this approach has been raised as "a source of well grounded, rich descriptions and explanations of processes occurring in local contexts" (Kaplan and Duchon 1988, p. 15). Thus, if there is a close linkage between context and phenomenon of interest, a case study is the most favorable approach to investigate the mechanisms (Yin 2014).

In the analysis of the contextual formation of B/IT-SU the close linkage between B/IT-SU and the environmental context is granted. To explore *how* and *why* B/IT-SU is formed in different contextual settings in Paper V, the theoretical slate of previous B/IT-SU research and crucial contextual factors were set at the beginning of the research. Next case-related interviews were conducted in 21 different companies in Germany. The case study respondents were selected based on their current positions and responsibilities in the organization. The research objective was to cover a wide range of different responsibilities and project experiences. Moreover, I followed a theoretical case sampling approach to ensure sufficient cases for each combination of contextual characteristics (Eisenhardt 1989). Each case interview was conducted by at least two researchers (Eisenhardt 1989). The interviews, which took between 52 and 109 minutes (avg. 81 minutes), were recorded and finally transcribed and analyzed with MAXQDA. Further details about the cases are provided in Paper V.

In the exploratory as well as explanatory case study approach (as introduced in the next section) the technique of thematic coding was used to analyze the transcribed interview data, encompassing the stages of data reduction, data display, and conclusion drawing. The bins of complexity and relevance were used as the seed categories in the data reduction phase (Miles and Huberman, 1994). The data was then coded in MAXQDA by consolidating the data into a hierarchy of nodes which were used amongst the researchers to prompt discussion as to the classification of the data. The final phase consisted of drawing conclusions from the analysis, "noting the regularities, patterns, explanations, possible configurations, causal flows and propositions" (Miles and Huberman, 1994, p. 11).

4.2.2. Explanatory case study approach

The results of the exploratory analysis on the contextual formation of B/IT-SU were adapted to the research regarding the time-dependent evolution of B/IT-SU. More precisely, the findings regarding the formation of B/IT-SU in a timely confined business/IT collaboration, like in IT projects, were adapted for the explanatory case study research on the time-dependent evolution of B/IT-SU. As described above, the research on time-dependent evolution only considers timely limited collaborations like IT project teams to reduce the complexity of the research object.

The major objective of the two-stage explanatory case study was to (1) explore the mechanisms and events that have a time-dependent impact on the repeatedly measured construct of B/IT-SU and (2) to empirically test and stabilize the assumption within this thesis. In both stages, the social capital theory was applied. The description is structured into details about the research design, data collection as well as data analysis (Dubé and Paré 2003) and addresses the criteria to assess the quality of design and data-based inferences (Venkatesh et al. 2013). The descriptions are summarized in .

Research Design: A critical aspect, which confines explanatory case study research from other case study research is the conscious choice of one or more *theories of interest* that provide essential input in the design (Yin 2014). This dissertation applied the social capital theory as a foundation for the exploration and testing of time-dependent effects among the dimensions of social capital. In addition, Eisenhardt (1989) recommends a prior *specification of constructs* in an exploratory case study, which was conducted in Paper V.

Next, the *case selection* and *unit of analysis* needs to be stressed (Dubé and Paré 2003). The cases in both explanatory case studies of this dissertation were selected and sampled based on their conditions that allows to test the theory. The focus is on interactions in timely confined teams. In addition, both case study settings of Paper VII and Paper VIII are very similar and very different at the same time. All team interactions that are analyzed in the cases are software development projects, however the analyzed teams in Paper VII applied a more traditional waterfall approach and the team in Paper VIII applied a relatively mature form of agile project management. The data was collected on an individual level, but the analysis was raised to a team level.

Data Collection: When the cases are selected, the measurement instruments need to be designed and implemented to adequately address the research intent. Common instruments for qualitative data collection are interviews, observations, documentations and physical artefacts (Yin 2014), while quantitative instrument can be questionnaires and/or time series data (Benbasat et al. 1987). Since this dissertation focuses on the time-dependent evolution of B/IT-SU, the quantitative instruments of all cases are designed to measure the perceived B/IT-SU of all team members at different times during the project execution. Paper VIII extents the design by also quantitatively measuring all critical factors that are antecedents and outcome of B/IT-SU. The analysis, however, was conducted on a qualitative basis. The core qualitative instrument was a set of interviews with business sponsors, IT project managers and team members. The case of Paper VIII also includes a two-weeks long observation of the research subject (job shadowing), regular coordination meetings between researcher and project team, as well as all available reports and documentations, covering status reports, burn down charts or project charter.

Data Analysis: First, the measurement instruments need to be assessed regarding their analytical adequacy (Venkatesh et al. 2013). Items measuring the level of B/IT-SU in the survey instrument were applied from previous research and already been tested in Paper III. The structure in the interviews was designed to address the research question, by focusing on reasons for the changing level of B/IT-SU across the project life-cycle. All interviews were recorded and transcribed. The coding was conducted bases on the recommendations of Miles and Huberman (1994) using the thematic coding technique (see description above).

Next, the inferences need to be logically structured to answer the research questions. Dubé and Paré (2003) differentiate between quantitative, qualitative and integrative inference. In all case studies, the quantitative instrument provided indications regarding an increase or decrease of the level of B/IT-SU. The responses from all individuals were aggregated to a group level. The aggregated results were compared across the project life cycle. This comparison enables quantitative inference regarding an increase or decrease of B/IT-SU. The qualitative interviews and additional qualitative information were used to identify factors that drive and results from B/IT-SU. A comparison of the single interviews provided the basis for this discussion. In Paper VIII, additional information determined by documents and observations were applied to assess the validity of the statements and argumentations elicited in the interviews. The results of the quantitative and qualitative inference were combined to derive reasons for the concrete changes observed across the project life cycle. In Paper VII, a subsequent cross-case study, in which the findings of each case were compared, provides additional information for an integrative research finding.

Table 4. Details of explanatory case study approach

		Cases in Paper VII	Case in Paper VIII
Research Design	**Theory of interest**	Social capital theory	
	Construct specification	See Paper V (based on Paper II and IV)	
	Case selection	Critical and bipolar cases	
	Number of Cases	Four	One
	Unit of Analysis	Business/IT project teams	
Data collection	**Qualitative instrument**	Two interviews in each case	Two interviews, job shadowing, reports and other documents
	Quantitative instrument	Panel survey (Four times, 20 individuals)	Panel survey (Three times, 10 individuals)
	Duration	Five months	Four months
Data analysis	**Interview coding**	Thematic coding	
	Quantitative inference	Comparison of aggregated group-level results across the project life cycle	
	Qualitative inference	Factors were determined based on a comparison of findings and themes addressed in the interviews	
		-	Additional information (e.g. documents) provided indications for validity of interview statements
	Integrative inference	Feedback from the interviews were applied to find indications for the changing level of B/IT-SU	
		Analysis of similarities and differences between cases	-

4.3. Quantitative research

The last step in this dissertation adapts the findings of the case studies and empirically tests the developed conceptual models. First, to measure the level of B/IT-SU in the different studies, a measurement instrument was developed and validated by 101 survey responses and 62 interviews at an early stage of this dissertation in Paper III. Second, a total of 171 participants from the German, Austrian and Swiss banking sector served as respondents in Paper VI for quantitative analysis on the contextual formation of B/IT-SU using Partial Least Square Structural Equation Modeling (PLS-SEM). Third, for the analysis of the time-dependent evolution in Paper IX, structured panel data was collected in 14 project teams of business and IT professionals over one year at three different times applying hierarchical (multivariate) linear modeling (H(M)LM). The final calculations are based on 353 responses. Table 5 provides and overview of the data sources and applied data collection and analysis approaches as well as the number of participants.

Table 5. Overview of applied quantitative research approaches			
Paper	**Data collection**	**Analysis**	**Participants / Sources**
III	Survey, Repertory Grid Technique	Factor and Correlation Analysis	62 structured interviews, 101 survey responses
VI	Survey	PLS-SEM	171 responses
IX	Panel survey at 3 times	H(M)LM	353 responses from 161 individuals in 14 teams

Even though Paper VII and Paper VIII apply a panel survey instrument, as described in the previous section, the approaches in both papers are seen as qualitative and not quantitative analysis approaches, since the analysis is based on a descriptive rather than hypothesis-driven approach.

The other studies of Paper III, Paper VI, and Paper IX were conducted by using quantitative research elements to analyze the phenomenon of B/IT-SU. Quantitative instruments, like structured surveys, are recommended to analyze recurring patterns of a research variable that can be used for subsequently corroborating the proposed mechanisms and relationships (Miles and Huberman 1994; Mingers 2004). From a positivism stance, a structured survey study is a strong instrument to provide generalizable statements about the research object, by comparing the structure across different units of analysis (Dubé and Paré 2003; Gable 1994).

The foundation for the quantitative studies in this dissertation was provided by Paper III, which concentrates on the structural development of a survey instrument to measure the different dimensions of B/IT-SU defined in Paper II. In the development process the survey was validated by the Repertory Grid Technique which represents a cognitive measurement approach (Tan and Hunter 2002). After I developed both approaches, I tested the method in two settings, first in a lab experiment with 44 business and IT students and second in a field study with 63 employees and middle managers of a large IT and software solution company. A subsequent correlation analysis, calculating the Pearson correlation coefficients, provided indication for the accuracy (or content validity) of the survey instrument. The result of this paper represents the foundation for later instrument adaptions in the subsequent papers.

The two modeling techniques used in this thesis – namely PLS-SME and H(M)LM, are commonly applied on research to analyze latent variables (also referred to as in-/dependent variable or construct). A latent variable is of theoretical interest which is not directly observable or measurable. To determine this type of unobservable variable, indicators or other observable measures are applied to infer the characteristics of the latent variable. An example for a latent variable is team mental models in Paper IX inferred by four indicators measuring the individuals understanding for the task- and teamwork. The indicators are rated by participants on a 5-point Likert scale from “very poor understanding” to “very good understanding”. The indicators are applied to analyze the relationships between unobservable latent variables. Indicators can either reflect or form a latent variable. Based on this differentiation, indicators are specified as reflective or formative measurement model (Hair et al. 2016). In this thesis, the majority of constructs were operationalized by reflective multi-item measures while the minority uses formative measurement models. In addition, most constructs in this thesis are first-order constructs that comprise of only one latent variable. However, Paper VI includes one second-order construct in the research model. This higher order latent variable was used since the theoretical construct has different subdimensions that each should be measured by its own measurement model (Chin 1998).

Before applying the data for regression analysis based on structural equation modeling techniques or hierarchical linear modeling, the measurement model needs to be validated. Thus, after an introduction of measurement model evaluation approaches, the two forms of regression analysis, which were applied in this dissertation, will be presented – namely structural equation modeling using partial least square (Paper VI) and hierarchical linear modeling (Paper IX), analyzing the interplay of different levels of analysis as well as longitudinal data.

4.3.1. Measurement model assessment

Before using the measurement model for the analysis in the subsequent studies of this dissertation, the items were subjected to the common factor analysis for assessment of unidimensionality (Straub et al. 2004). The factor analysis is a statistical technique to determine the variability among observed variables in the research setting related to a potentially lower number of unobserved variables (Hair et al. 2016). In the factor analysis, the observed variables, which are highly correlated, are consolidated to aggregated factors. Variables categorized in different factors commonly show limited correlations among each other in respect to the cross-loading (Bühl 2012).

There are three types of factor analysis: Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA) and the Principal Component Analysis (PCA). The PCA represents an adequate analysis, when the construct is newly developed by the researchers (Straub et al. 2004). Since all studies in this dissertation apply measurement items from previous research, the EFA and CFA were applied to analyze the reliability and validity of the measurement construct. The following introduction regarding the evaluation of reliability and validity criteria is summarized in Table 6.

Table 6. Criteria for evaluating measurement models

Criteria			Requirement
Reliability	Indicator		- Loading > 0.7 or - Loading > 0.4 if compatible with Composite Reliability and R^2
	Construct		- Cronbach‘s Alpha > 0.7; - Composite Reliability > 0.7
Validity	Content		Indicators (1) adapted from previous research, (2) pre-tested in pilot studies and (3) tested by using RepGrid-Technique
	Construct	Convergent	Average Variance Extracted > 0.5
		Discriminant	- Fornell-Larcker-criterion: inter-construct correlations < the square root of the respective construct’s AVE - Indicator’s loadings > cross-loadings; - HTMT < 0.9 - Variance Inflation Factor < 3.3

The reliability of the model can be addressed by analyzing the factor loadings of the items to assess the indicator reliability, which describes the extent to which an item is consistent regarding what it intends to measure. The higher the indicator reliability, the better the item works as a measurement of the construct (Hulland 1999). Most research accepts a value of above 0.7. Also, Hair et al. (2016) argue that items below 0.7 and above 0.4 should only be deleted if this increases the composite reliability and R^2 (explained variance) substantially. Next, cronbach's alpha and composite reliability provide information regarding the construct reliability. The two criteria for measuring construct reliability describe the extent to which the indicators of a construct have the same range and meaning. Hair et al. (2016) suggest a value greater than 0.7 for both reliability criteria.

The validity of a measurement model can be described by the validity of the content and the construct measured in the model. Content validity "reveals to what extent a measurement model's variables belong to the domain of the construct" (Götz et al. 2010, p. 694). Content validity is addressed in this thesis by adopting and adapting indicators based on previous research as well as by carrying out pre-tests in every study with participants from a representative subject group. In addition, Paper III presents an approach to minimize the risk of limited content validity by applying measurement approaches, like the Repertory Grid Technique (RepGrid) in the design of the survey instrument.

Focusing on the construct validity, the convergent validity is used to analyze the convergence of the model described by the Average Variance Extracted (AVE). An AVE above 0.5 implies that, on average, the construct explains more than half of the variance of the indicators (Hair et al. 2016). In addition, the discriminant validity describes the extent to which the items of a given variable differ from those that are not considered to reflect the construct (Straub et al. 2004). There are three approaches to evaluate discriminant validity in a reflective measurement model. First, Fornell-Larcker-criterion (Fornell and Larcker 1981) is a measure that "compares the square root of each construct's average variance extracted with its correlations with all other constructs in the model" (Hair et al. 2016, p. 317). The construct needs to be greater than the squared correlations with all other constructs to fulfill discriminant validity. Second, cross-loadings can be considered in the evaluation of discriminant validity, by comparing the cross-loadings and the loading of each indicator. When the loading of an indicator is higher in respect to the assigned latent variable than its cross-loadings on other constructs, discriminant validity is fulfilled. Third, heterotrait-monotrait ratio (HTMT) can be applied to describe the ratio of the between-trait correlation to the within-trait correlation (Henseler et al. 2015). Research found that this approach provides more accurate results regarding discriminant validity than the two previous measures (Henseler et al. 2015; Voorhees et al. 2016). The HTMT test calculates "a ratio of the average correlations between constructs to the geometric mean of the average correlations within items of the same constructs." (Voorhees et al. 2016, p. 124). Henseler et al. (2015) suggest a threshold of 0.9 when the constructs in the model are conceptually similar and 0.85 when the constructs are conceptually more distinct. Focusing on formative measurement models (applied in Paper IX), discriminant validity can be evaluated by the variance inflation factor to test for multicollinearity among the indicators (Hair et al. 2016). A value below 3.3 is considered as acceptable to consider indicators as not being collinear (Cenfetell and Bassellier 2009).

Besides the evaluation of the measurement models regarding their reliability and validity, there are potentially a number of biases that need to be considered in the analysis of the data. First, there is the non-response bias which implies the risk that "persons who respond differ substantially from those who do not" (Armstrong and Overton 1977, p. 396). The authors assume that the answers of respondents who answer after a reminder will share some similarities with persons who do not answer at all. To control if the data set is prone to non-response bias, the answers of persons who responded without a reminder were compared to the answers of persons who answered after a reminder.

Second, the data set can be prone by a common method bias (CMB). If the data set is flawed by CMB the observed variance is essentially defined by the chosen method rather than to the latent variables of interest that the measures should represent (Podsakoff et al. 2003). Three procedures are applied in this dissertation to identify CMB. First, the Harman single-factor test uncovers a single component explaining the majority of overall variance (Podsakoff et al. 2003). Second, a theoretically unrelated marker variable was linked to each construct of the original model. Structural differences of the results in levels and significance of path coefficients or in the level of R^2 of the dependent variable indicate CMB (Lindell and Whitney 2001). Third, the variance inflation factor, as described above, was applied to address the CMB in a reflective measurement construct (Kock and Lynn 2012).

4.3.2. Partial least squares structural equation modeling

To test the hypotheses of this dissertation, Paper VI uses PLS-SEM and the software application SmartPLS (Ringle et al. 2015). PLS-SEM, which is a multivariate methods, is a widely applied technique in IS research (Gefen et al. 2011). PLS-SEM represents a second generation technique, which enables "researchers to incorporate unobservable variables measured indirectly by indicator variables" (Hair et al. 2016, p. 4). While it also includes techniques to evaluate the measurement model (see section above), it has been applied to test structural relationships. The modeling technique is recommended for path diagrams which involve latent variables with multiple indicators, since it allows "the creation and estimation of models with multiple dependent variables and their interconnections at the same time" (Gefen et al. 2011, p. iv). Hair et al. (2017) recommends PLS-SEM over other related techniques, when "the measurement models have few indicator (<6) **OR** the sample size is medium or large" (p. 628). Also, PLS is the preferred method, when the measurement model includes formatively measured constructs and when the explaining of the variance of the dependent variables is of primary interest, rather than an overall model-fitting (Petter 2018). All criteria are fulfilled in the measurement model.

The structural model can be evaluated using the coefficient of determination (R^2) and the significance level (p-value) of each path coefficient (β) (Chin 1998). R^2 is defined as the "amount of explained variance of endogenous latent variables in the structural model" (Hair et al. 2016, p. 326). Thus, the higher the R^2 value, the better the model is explained by the latent variables. The path coefficient (β) can be understood as standardized beta coefficient that is calculated in ordinary least squares regressions. The significance level (p-value) of β can be determined by the bootstrapping technique.

However, also the sample size as well as the number of independent variables have a major impact on the results of the calculations, especially when it comes to sequential construction of the structural model, to describe the explained variance of each individual variable. Cohen (1992) recommends a list of minimum sample size in respect to the number of independent variables to detect *minimum* R^2 values of 0.1, 0.25, 0.5 and 0.75 for significance values of 1%, 5% and 10% by presuming a level of statistical power of 80%. Based on this categorization, the studies in this dissertation are able to detect minimum R^2 as highlighted in the following Table 7. Even though, Paper IX applied hierarchical linear modeling, which will be introduced in the next section, it still reports a pseudo-R^2, which can be compared with the R^2 calculated in PLS-SEM. Also, Paper IX comprises two models in which the data of model B is a subset of the data of model A.

Table 7 . Minimum R^2 detectable

	Independent Variable	Sample Size	Minimum R^2	Significance level
Paper VI	6	171	0.1	>10%
Paper IX (Model A)	6	106	0.1	10%
Paper IX (Model B)	6	72	0.25	>1%

4.3.3. Hierarchical linear modeling

For the last research step on the evolution of B/IT-SU, presented in Paper IX of this dissertation, a multilevel analysis approach was chosen. Hierarchical linear modeling, which is a technique of multilevel analysis, is recently being applied in in IS research more and more often (Kudaravalli et al. 2017; Rai et al. 2009; Zhang 2017). It is especially the most preferential approach when the analysis is based on nested data, reflecting a hierarchical structure (Raudenbush and Bryk 2006; Sasidharan et al. 2012). Examples for nested data are students nested in workgroups (He et al. 2007), offshore projects nested in project managers (Rai et al. 2009) or repeated survey responses nested in study participants (Samaha et al. 2011). The definition reflects this condition of nested data by describing multilevel analysis as “a methodology for the analysis of data with complex patterns of variability, with a focus on nested sources of such variability” (Snijders and Bosker 2012, p. 1). This type of research is also described as *meso*-level research (Klein and Kozlowski 2000), since it “examines the relationships between organizational contexts and behavior of components (individuals, dyads, groups, organizations, and groups of organizations) and evaluates how those relationships shape outcome” (House et al. 1995, p. 85). Thus, previous research argues that multilevel research is the best choice, when the distribution of variance between at least two levels of analysis is theoretically relevant (Bélanger et al. 2014; Rai et al. 2009; Raudenbush and Bryk 2006).

One of the most mentioned advantages of multilevel approaches like HLM, is that the percentage of variability in the dependent variable is accounted for by level-1 coefficients (e.g. individual) as well as level-2 coefficients (e.g. group). That is achieved by calculating a ratio of the between-group variance divided by the total variance (Raudenbush and Bryk 2006). Ignoring the nested structure of level-1 coefficients nested in different groups would assume “that there is no between-unit variance on the dependent variable” (Rai et al. 2009, p. 629) which leads to artificial small standard errors, which increases the probability of a Type I error. On the other side, ignoring the non-independencies may lead to Type II error (Bliese and Hanges 2004). Thus, the ignorance of the nested structure may have a significant impact on the determined results and therefore might lead to substantially different (or wrong) conclusions (Bélanger et al. 2014; Garson 2013).

Analyzing the nested structure of the data

As a first step in a multilevel analysis the nested structure of the data needs to be analyzed. A simple aggregation and/or disaggregation between micro and macro level coefficients, implies various risks, since the ‘real’ structure of the data does not necessarily need to match the structure of research framework (Snijders and Bosker 2012). That leads to a shift of meaning (Firebaugh 1978). As an example, a project team’s average of members rating on the efficiency of group processes, might be applied as measure for team success. The variable belongs to the team level and not team member level. A simple aggregation from a team member level to a team level would ignore individual differences, i.e. within-group variance. In contrast, disaggregation of the data would ignore that there are differences between groups, i.e. between group variance (Snijders and Bosker 2012). A researcher might be interested in the individuals efficacy in a team, based on his or her previous experience in similar projects and collects data in 100 teams on the individual level. A disaggregation of the data on the individuals level will therefore ignore potential team-level factors impacting the individual’s efficacy.

The multilevel analysis approach takes within- and between-group variance into account. As an initial analysis step, the data structure needs to be analyzed regarding within and between group variance which indicates the nested structure of the data. Two approaches have been mainly applied in previous research (Caya et al. 2008; Klein and Kozlowski 2000).

First, the inter-rater agreement (IRA) indicates the level of agreement *within* each macro-level unit (e.g. team) which provides a justification to aggregate this indicator to the next level analysis (Klein and Kozlowski 2000). While there are different indices to analyze the IRA, this dissertation applies the index r_{WG} introduced by James et al. (1984) and frequently applies in previous research (e.g. Bélanger et al. 2014; Kudaravalli et al. 2017; Maruping et al. 2009). An index above 0.7 on average across all teams indicates a sufficiently high level of agreement within the teams and allows to interpret the variable as team-variable, by lifting it to the next level (Klein and Kozlowski 2000). The minimum r_{WG} in this dissertation is 0.802.

Second, I focus on the variance that can be explained between meta-level groups by applying the analysis of intra-class correlation (ICC) as recommended by Bliese (2000). The ICC(1) represents an estimate of the proportion of variability that can be explained by team membership – i.e. between-group variance (Maruping et al. 2009). The higher the estimate of ICC(1) the higher the likelihood that an individual’s rating provides a reliable rating for the group mean. ICC(2) indicates the stability of the team means across the sample, i.e. “whether groups differ based on the mean team member scores” (Kudaravalli et al. 2017, p. 51). ICC(2) represents a function of ICC(1) adjusted by group size (Shieh 2016). The larger the average group size, the larger the ICC(2), when ICC(1) is fixed (Klein and Kozlowski 2000). Group means which are based on just a few people are not as stable as group means which are based on the response of many people (Bliese 2000). Previous research has shown a common ICC(1) between 0.1 and 0.5 (Hedges and Hedberg 2007; Kudaravalli et al. 2017; Zhang 2017), while the optimal level of ICC(2) depends on the research focus, since it highly depends on the group size (Shieh 2016). Research on project teams most commonly accepts an ICC(2) above 0.5 without limitations (Liao and Chuang 2004; Maruping and Magni 2015) and still considers values over 0.4 as moderately acceptable for aggregation (e.g. He et al. 2007; Kudaravalli et al. 2017; van der Haar et al. 2015). The results in this dissertation are significant with the lowest ICC(1) of 0.152. The ICC(2) varies between 0.456 and

0.823. The implications for the variables showing an ICC(2) below 0.5 were considered in the interpretation of the results in Paper IX.

Mixed models to analyze hierarchical and longitudinal data

After the evaluation of the hierarchical data structures, the model testing can start. Most commonly, research in multilevel analysis differs between the impact of the lowest level of analysis (level-1) and the impact of a higher level of analysis (level-2) on a dependent variable on level-1. The model on level-1 examines the relationship of variables at the lowest level of analysis that are linked to the outcome measured on the lowest level for each group, by estimating intercept and slope parameters (Klein and Kozlowski 2000). Analysis on this level is very similar to analysis using PLS, although the applied Bayes algorithm in HLM to estimate the level-1 parameters is considered more precise and reliable (Raudenbush and Bryk 2006). Calculations on level-1 are often labeled as fixed effect models and represents a simple regression model on level-1 (i.e. answers of all responses are treated the same; a respective group membership is not considered in the calculations). The model on level-2 applies the parameters of the level-1 variables as outcome variables which are regressed on level-2 variables (i.e. group means define the intercepts in the model). The model is called variance component model or random effect model (Snijders and Bosker 2012). By combining the fixed effect and random models, a so called mixed effect model analyzes the fixed and random effects simultaneously to consider individual variance and group variance in the same model (Gill 2005)[1]. The formula for the four models – linear regression model, fixed effect model, random effect model and mixed effect model are presented in Table 8.

Table 8. Regression models	
Linear regression	$Y_i = \beta_0 + \beta_1 x_i + R_i$
Fixed effect	$Y_{ij} = \beta_0 + \beta_1 x_{ij} + \beta_2 z_j + R_{ij}$
Random effect	$Y_{ij} = \beta_{0j} + \beta_{1j} x_{ij} + R_{ij}$ (level-1 model) $\beta_{0j} = \gamma_{00} + \gamma_{01} z_j + U_{0j}$ (level-2 model) $\beta_{1j} = \gamma_{10}$
Mixed effect	$Y_{ij} = \gamma_{00} + \gamma_{01} z_j + \gamma_{10} x_{ij} + U_{0j} + R_{ij}$
where and and and	Y_i and Y_{ij} are the dependend variables x_i and x_{ij} are the explanatory variables at the individual level-1 z_{ij} is the explanatory variable at the group level-2 R_i and R_{ij} are the residuals at the individual level-1 U_{0j} is the residual at the group level-2

Garson (2013) argues that mixed models are adequate for analysis of three different types of effects: random effects (model as described above), hierarchical effects and repeated measures. This dissertation focused on analysis of hierarchical effects (by using a hierarchical linear model) and repeated measures (by using a hierarchical multivariate linear model).

[1] Please note that the models are frequently labeled very differently, so that a mixed model might be labeled as random effect model

Hierarchical linear models (HLM) are mixed models, which are based on nested data structures as described above. A differentiation of random *intercept* models and random *coefficient* models can be applied to structurally uncover the mechanism behind HLM (Garson 2013). A random intercept model - often represents the empty model at the beginning of the calculation (Snijders and Bosker 2012) – is a model which “predicts the level 1 intercept of the dependent variable as a random effect of the level 2 grouping variable, with no other predictors at level 1 or 2 in a two-level model.” (Garson 2013, p. 8) Also, other models that include level-2 (or in some cases also levels-1) coefficients represent random intercept models. In these models the intercepts are random based on the grouping on level-2. By including random slopes, the model can be expanded to a random coefficient model, or multilevel regression model. The grouping variable on level-2 influences not only the dependent variable (see random intercept model) but also the independent variables on level-1. The model assumes that each group on level-2 has a different intercept *and* a different regression in the prediction of the depended variable on level-1 (Raudenbush and Bryk 2006). A simplified example for this model is the impact of perceived shared understanding (independent variable on level-1) on the perceived team success of an individual (dependent variable on level-1). A random intercept model would assume that the regression of all teams regarding the impact of shared understanding on team success is the same, only the intercept differs. In contrast, a random coefficient model will also assume that the slope (i.e. relative increase of the impact on team success by increasing the level of shared understanding) might be different in each group. For that reason, random coefficient models are appropriate when the study design assumes a hierarchical dependency of level-1 dependent as well as independent variables and level-2 grouping variables.

Hierarchical multivariate linear models (HMLM) are an extension of HLM which can be used to analyze data based on longitudinal or repeated measures (Raudenbush and Bryk 2006). Fitzmaurice et al. (2011) state that longitudinal data represents a special type of multilevel data, with only one level of clustering as well as a natural sorting of the responses within a cluster. For that reason, previous research which is based on longitudinal or repeated measurements frequently applies multilevel analysis like hierarchical multivariate linear modeling (He et al. 2007; Ko and Dennis 2011; Samaha et al. 2011). As recommended by Snijders and Bosker (2012), multilevel analysis may be applied for two kinds of longitudinal data – longitudinal data with a fixed measurement occasion design or a variable measurement occasion design. This dissertation exhibits a longitudinal data design with fixed occasions, since data was collected at three predefined points in time within business/IT teams.

The major differences between traditional multilevel analysis and longitudinal multilevel analysis is the treatment of the random effect on level-1 and level-2 (Snijders and Bosker 2012). In the traditional multilevel analysis, a random effect variable is a component of the formal calculations on level-1 and level-2, represents the core of the random coefficient model as described above. In a longitudinal model the random effect on level-2 (person-level) is absorbed in level-1 (response-level) (Raudenbush and Bryk 2006). In this model, the random effect variable on level-1 includes an arbitrary covariance matrix variable, which captures the variations among the repeated occasions. The arbitrary covariance matrix in turn is included in the fixed effect part of the model and covers all level-1 variables measured at the different occasions (which results in a covariance matrix of variable x occasion). This, model is an unrestricted model, which is recommended when the observations per participants are based on a fixed design (Raudenbush and Bryk 2006), which is the case in the research of this dissertation.

5. MAIN FINDINGS

This cumulative dissertation comprises nine papers that analyze the contextual formation and time-dependent evolution of B/IT-SU. Each paper in this dissertation addresses one or more research questions. Roughly speaking, Paper I to Paper III provide the foundation for the subsequent analyses, by defining, conceptualizing and operationalizing B/IT-SU. Paper IV to Paper VI concentrate on the contextual formation of B/IT-SU by analyzing the concept and mechanisms of and around B/IT-SU by controlling environmental aspects like organizational complexity. In the last step of this dissertation, Paper VII to Paper IX focus on the time-dependent evolution of B/IT-SU by conducting longitudinal research studies in 18 IT project teams in different companies.

5.1. PAPER I: SHARED UNDERSTANDING AMONG BUSINESS AND IT – A LITERATURE REVIEW AND RESEARCH AGENDA[2]

The first paper of this cumulative dissertation provides a structured review of IS literature addressing the question how shared understanding among business and IT has been conceptualized and used in the various fields of the IS research community. The purpose of this paper is to structure previous literature and identify differences and commonalities between research streams.

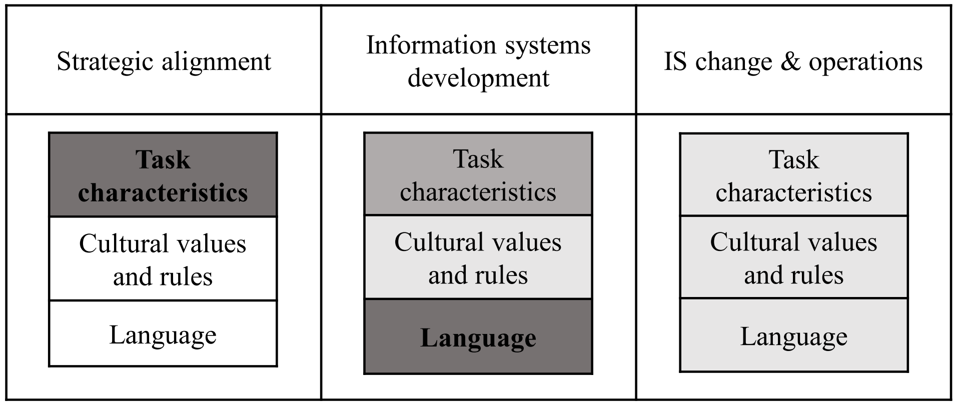
A final set of 50 IS research articles were identified and analyzed in this review. Most papers relate to (social) strategic alignment research, information systems development (ISD) research, and research on IS change and operations (e.g., in outsourcing relationships). Each of the three research domains has its own primary approach in conceptualizing B/IT-SU. While alignment research describes B/IT-SU mainly as shared understanding or agreement about the role of IS in an organization, ISD research applies a more language-based approach and focuses mainly on communication content and processes. Lastly, research on IS change and operations applies a more knowledge-based interpretation and focusses on shared understanding of the work environment and business/IT processes. The applied dimensions of B/IT-SU regarding the research stream are summarized in Figure 5.

Research field:	Strategic alignment (22)	Information systems development (17)	IS change & operations (10)
Role of IT	11	0	2
Future role of IT	6	0	0
Objectives	3	2	0
Shared business/IT knowledge	8	7	6
Business knowledge of IT unit	0	4	1
IT knowledge of kusiness unit	0	0	0
Language	0	5	0
Culture	0	3	2
Not specified	1	2	0
Others	2	0	0

Figure 5. B/IT-SU dimension applied in relation to the research domains

[2] Jentsch, C., and Beimborn, D. 2014. "Shared Understanding among Business and IT - a Literature Review and Research Agenda," *European Conference on Information Systems*, Tel Aviv, Israel.

Based on an analysis of differences and commonalities among the research articles, Figure 6 presents a map of the current state of business/IT shared understanding in the respective research streams and exposes areas of insufficient or at least underdeveloped research related to the specific domain.



(The darker the shade of grey, the more frequently the SU concept has been considered in previous research)

Figure 6. Map of state of previous research into B/IT-SU

In summary, Paper I identifies strong differences across and within different research domains regarding the conceptualization of B/IT-SU (RQ1), finding that most studies analyze single aspects of shared understanding but miss the "big picture". The findings point to a lack of conceptualization of B/IT-SU within various research domains as well as a comprehensive B/IT-SU construct, which would enable findings to be shared across domain borders and support comprehensive investigation into B/IT-SU and its role in effective collaboration among business and IT professionals.

5.2. Paper II: What matters in business/IT shared understanding? Development of a unified construct[3]

Based on Paper I, which analyzes and structures previous related research articles, Paper II develops a comprehensive construct of B/IT-SU that can be applied across various IS research contexts. Most previous research has only considered certain aspects of B/IT-SU. Such often single-dimensional studies result in an incomplete picture of shared business/IT understanding and thus can potentially lead to wrong or incomplete findings and implications. Taking a constructional approach, this paper presents a discussion of current conceptualizations of B/IT-SU and integrates them into a unified multidimensional construct. The result of this discussion is summarized in Figure 7.

[3] Jentsch, C., and Beimborn, D. 2014. "What Matters in Business/IT Shared Understanding? Development of a Unified Construct," *European Conference on Information Systems*, Tel Aviv, Israel.

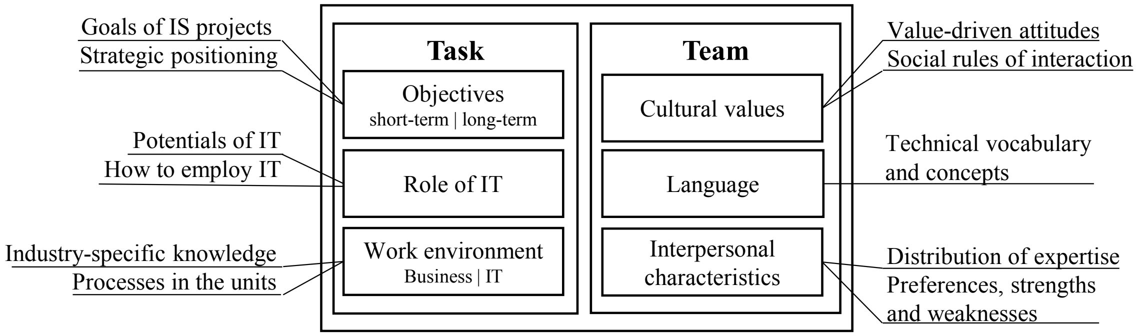


Figure 7. Framework of business/IT shared understanding

The holistic framework of B/IT-SU distinguishes between three task-specific and three team-specific attributes that are important to capture B/IT-SU in its entirety. B/IT-SU exists if partners understand the respective positions related to the six dimensions of B/IT-SU.

The framework developed in Paper II serves as the foundation for the subsequent research steps. First, the framework is applied in operationalizing the construct while ensuring content validity by a cognitive research approach (repertory grid), which can then be used to measure B/IT-SU in a unified manner in quantitative, survey-based research (Paper III). Second, the framework provides flexibility for contextual adjustment so that the concept can be applied in comprehensive research of business/IT collaboration in various contexts (e.g., strategic and project level) (Paper IV and Paper V). Third, the framework serves as a basis for determining a set of goal-oriented mechanisms that can be applied to improve specific dimensions of business/IT shared understanding in organizational contexts (Papers VI – IX).

5.3. Paper III: How to measure shared understanding among business and IT[4]

Paper III aims to develop a B/IT-SU survey instrument which covers the entirety of the concept across different dimensions considered mainly in isolation so far (see Paper I and Paper II) and which has proven content validity. Previous research calls for more cognitive-based measurement approaches to ensure a high level of content validity (e.g Tan and Gallupe 2006). This paper applies the repertory grid technique (RGT), which it identifies as a strong instrument for determining the level of B/IT-SU. However, the technique is very time-consuming compared to alternative instruments, like structured surveys, and therefore often impractical in organizational research. For that reason, this paper compares the results of RGT-based data and survey-based data, arguing that a high correlation between the results indicates high content validity (ensured by RGT) as well as practicability (ensured by survey).

The conceptual framework was adopted from Paper II with minor changes in wording. For example, the dimension *work environment* was replaced by *(business/IT) process knowledge*, the dimension *role of IT* was expanded to *attitude towards role of IT* and the dimension *objectives* was

[4] Jentsch, C., Beimborn, D., Jungnickel. Christoph, and Renner, G.-S. 2014. "How to Measure Shared Understanding among Business and IT" *Best Paper Proceedings of the 2014 Academy of Management Meeting*, Philadelphia, PA.

narrowed to *vision of IT and vision of partnership*. The dimensions *cultural values* and *interpersonal characteristics* were subsumed into the dimension *attitude towards partnership*.

In this study, I developed a structured survey that needs to be validated by the RGT to ensure content validity. After both approaches were developed, they were tested in two settings, first, in a lab experiment with 44 business and IT students and, second, in a field study with 57 employees and middle managers of a large IT and software solution company. In an initial step, the reliability and validity of both measurement instrument is evaluated separately. Next, the fit of the instrument is tested by applying a correlation analysis between the results of the survey and the results of the RGT. Table 9 summarizes the significant differences between the absolute difference among loadings, cronbach's alpha, and correlations of the results of the lab experiment and the field study, which underscore the need to assess content validity.

Table 9. Comparison between results of experiment and field study

B/IT-SU dimension	Item	Δ FL	Min FL	Δ CA	Min CA	Δ correlations	Min correlation
Business process knowledge	BPK1	.024	.861	.005	.898	.086	.572
	BPK2	.145	.820				
	BPK3	.251	.620				
	BPK4	.085	.820				
	BPK5	.015	.894				
IT process knowledge	ITPK1	.022	.778	.075	.822		
	ITPK2	.058	.744				
	ITPK3	.048	.838				
	ITPK4	.027	.903				
	ITPK5	.380	.557				
Attitude towards role of IT	AIT1	.001	.796	.054	.774	.361	.335
	AIT2	.111	.822				
	AIT3	.002	.866				
Vision of role of IT	VIT1	.218	.699	.340	.556	.282	.241
	VIT2	.036	.840				
	VIT3	.295	.647				
Attitude towards partnership	APA1	.025	.748	.193	.623	.158	.362
	APA2	.052	.832				
	APA3	.180	.730				
Vision of partnership	VPA1	.084	.833	.034	.846	.093	.578
	VPA2	.034	.884				
	VPA3	.046	.861				
(Technical) Language	TL1	.065	.878	.063	.879	.090	.601
	TL2	.081	.797				
	TL3	.066	.900				
	TL4	.054	.853				

(Δ = deviation; FL = factor loadings; CA = cronbach's alpha)

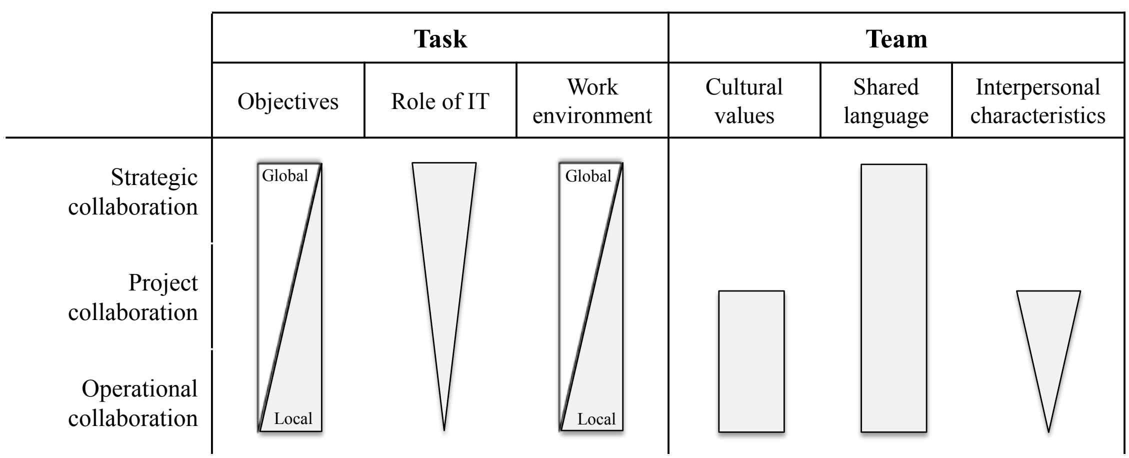
By accepting a correlation coefficient of above .5 as sufficient fit between survey and RGT results, the findings emphasize the great importance for detailed analyses of content validity. For three out of seven dimensions of B/IT-SU, the survey measures do not sufficiently reflect the dimension they are intended to measure (i.e. the respondents answer differently when using the RGT for the same dimension). Even though the results of the dimensions *attitude towards role of IT* in the lab experiment and *attitude towards partnership* in the field study prove statistically valid, the correlations are insufficiently strong, yielding unacceptable results in terms of content validity and underscoring the need for further research.

This paper contributes by providing an initial recommendation for the process of developing a measurement instrument that takes content validity into account in a statistically testable way. In addition, it provides a more sound and more comprehensive measurement of B/IT-SU and, thus, offers a substantial conceptualization and operationalization of B/IT-SU, which has been used on the subsequent studies of this dissertation.

5.4. Paper IV: From strategic to operational collaborations: The divergent nature of business/IT shared understanding[5]

Paper IV combines the findings of Paper I, which identified different research streams and merges the perspectives in the holistic framework developed in Paper II. While most research on B/IT-SU focuses on strategic collaborations between top managers, operational-level collaborations are widely overlooked. Nevertheless, current research highlights the great importance of analyzing B/IT-SU across hierarchies in order to ensure effective organization-wide business/IT collaboration. In response to this need, Paper IV organizes the findings of prior research by examining and comparing different conceptualizations of B/IT-SU across organizational hierarchical levels. Previous research addresses shared understanding either among top management (strategic collaboration), within IS development projects (project collaboration), or – in just a few cases – among general business and IT professionals (operational collaboration). This paper demonstrates the importance of considering the collaborative context in conceptualizing B/IT-SU.

In order to achieve this, Paper IV presents the results of an analysis of 51 papers focusing on B/IT-SU with regard to the research context and the applied conceptualization of B/IT-SU. The result is presented in Figure 8.



(width of the boxes represents the importance of the dimensions)

Figure 8. Contextual business/IT shared understanding

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[5] Jentsch, C., Schlosser, F., and Beimborn, D. 2014. "From Strategic to Operational Collaborations: The Divergent Nature of Business/IT Shared Understanding," Americas Conference on Information Systems, Savannah, GA.

The results of the analysis show that the meaning and importance of single dimensions of B/IT-SU vary depending on the context of the collaboration. The results also suggest that the primary interest of previous research studies on B/IT-SU dimensions changes as the focus shifts from top management level (strategic collaboration) to middle/lower management (project collaboration) and to business and IT professionals (operational collaboration). Based on 28 related research papers focusing on ISD and operational collaborations, this paper additionally confirms Wagner et al.'s (2014) claim "that alignment is not merely a strategic or executive-level issue, but that it is probably even more important at an operational level, in particular when it comes to actual IT utilization and organizational performance in business operations" (p. 262). Thus, this study applies findings from previous studies and assembles them into a single enterprise-wide conception of B/IT-SU, which can be adjusted to fit the underlying research interest.

5.5. Paper V: IT is all about the game - An exploratory study on the impact of task characteristics on the dimensions of business/IT shared understanding[6]

Based on the previously conducted literature analysis and contextual conceptualization of Paper IV, Paper V explores the contextual formation of B/IT-SU in a field setting. In this paper, I apply the degree of organizational complexity and strategic task relevance as contextual characteristics to compare different types of collaborations. The objective is to identify shifting characteristics of the dimensions of shared understanding depending on the type of business/IT collaboration, attributed by the level of complexity, and the strategic relevance. This paper contributes by providing detailed recommendations for future research into B/IT-SU by highlighting the importance of precisely determining the relevant contextual characteristics.

I adopt an open research design, focusing solely on the task-related B/IT-SU dimensions of the collaborative objectives (incl. the role of IT) and the work environment, as well as the meaning of words (e.g. symbols and concepts used in a collaboration). The dimensions of interpersonal characteristics and cultural values were excluded due to insufficient findings.

The results are based on 21 cases interviews in companies located in Germany from different industries. The research method adopts a theoretical case sampling approach, ensuring that enough cases for each combination of high/low-complexity tasks and strategic/operational relevance are considered. The cases were drawn from various IT contexts ranging from infrastructure management in a large multi-national enterprise to innovative software development in a medium-size firm. Figure 9 visualizes the key findings from the case studies.

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[6] Jentsch, C., and Beimborn, D. 2016. "IT Is All About the Game - An Exploratory Study on the Impact of Task Characteristics on the Dimensions of Business/IT Shared Understanding," European Conference on Information Systems, Istanbul, Turkey.

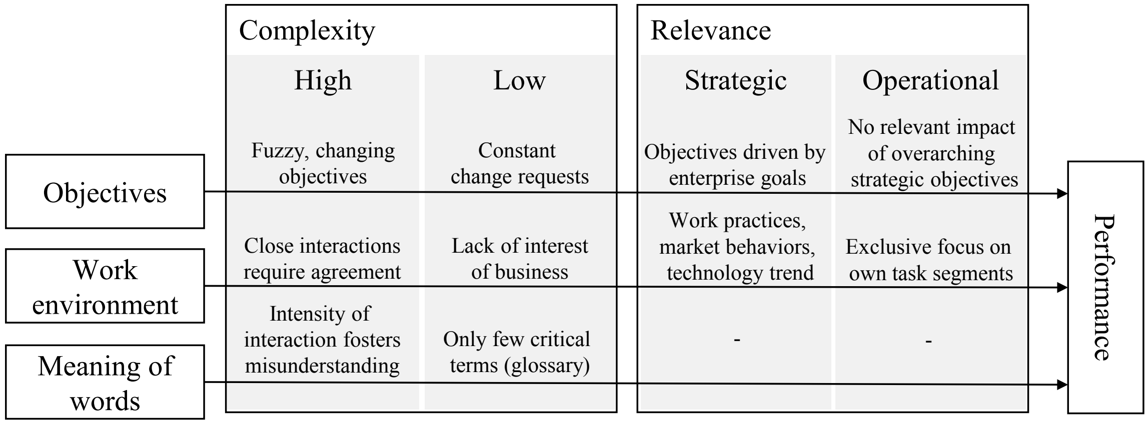


Figure 9. Impact of context factors on the formation of B/IT-SU

In summary, the findings highlight very distinctive collaborative settings – like complex innovation development or standardized data center management – in which business and IT professionals interact to jointly achieve sometimes more and sometimes less clearly predefined objectives. While the IT system is the focal component in all of these collaborations, the settings defined by the complexity and relevance of the task highly impacts the actions and interaction behaviors of the collaboration partners.

5.6. Paper VI: Templates for joined work systems – increasing shared business knowledge between business and IT units in a modular environment[7]

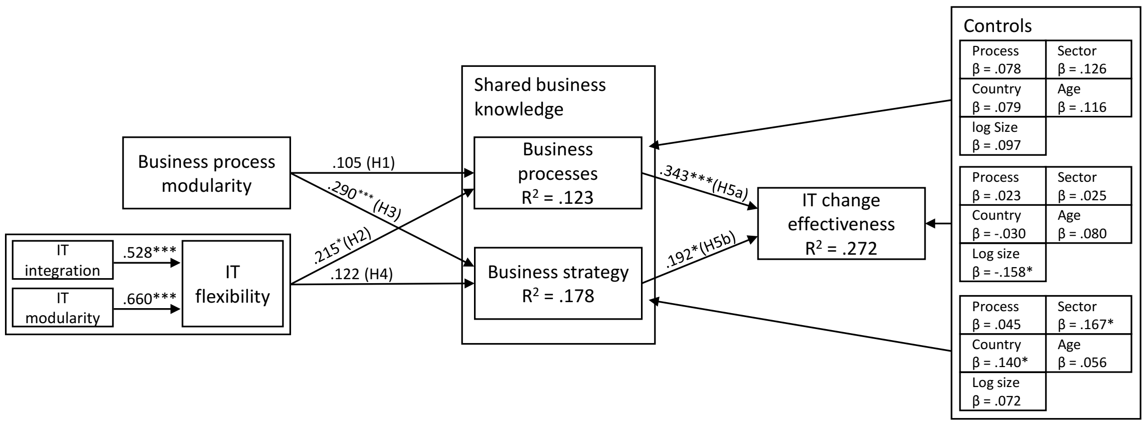
Paper VI addresses the *complexity*-related findings of Paper V by structurally analyzing the role of complexity as a barrier or enabler for the development of business/IT shared understanding. The motivation for this research arises from the combination of two contradicting research streams. The fist research stream argues that shared understanding loses relevance in a low-complexity environment and can even threaten team efficiency due to resource overkill. The second research stream argues that organizational complexity is a barrier to the development of shared understanding among business and IT professionals, which is critical for the success of team collaborations in high- and low-complexity environments alike.

To address these contradicting research findings, this research analyzes the causal effects between complexity, shared understanding and IT change effectiveness (i.e. IT success) by combining two theories – namely template theory and work system theory. Shared understanding has been conceptualized focusing (only) on the level of business/IT shared knowledge in the business domain (i.e. process and strategy), which mirrors the underlying research focus. The concept of modularity acts as an enabler to reduce complexity, which has been discussed as a barrier for the development

[7] Jentsch, C., Beimborn, D., and Reitz, A. “Templates for joined work systems –Increasing shared business knowledge between business and IT units in a modular environment” – under review for publication in the European Journal of Information Systems. - Based on a previous publication: Jentsch, C., Beimborn, D., and Reitz, A. 2017. "Templates for Joined Work Systems – How Business Process Modularity and IT Flexibility Enable Mutual Understanding among Business and IT," *International Conference on Information Systems*, Seoul, South Korea.

of shared knowledge. Shared knowledge in turn enables change effectiveness to address changing business needs.

The results of the survey study are based on 171 responses of business managers responsible for crediting processes in the banking sector, which is considered highly susceptible to frequent market changes due to an increasing number of regulations and competitors.



*Notes: N=171. ***: p <.001; **: p <.01; *: p <.05. (one-sided t-tests, based on 5,000 bootstraps)*

Figure 10. Estimation results (standardized path coefficients with sig. levels, R^2)

The results highlighted in Figure 10 suggest a significant mediation effect, highlighting the importance of shared business knowledge as an enabler of change effectiveness in a modularized and non-modularized environment. As a major contribution of this paper, this finding contradicts previous research arguing that the need for knowledge sharing decreases in a modularized (i.e. low complexity) environment by highlighting the importance of shared business knowledge in enabling change effectiveness in a modularized environment. In addition, the results indicate that modular systems do not per se facilitate shared business knowledge, but rather that the combination of functional and technical modularization facilitates operational and strategic aspects of shared business knowledge. Finally, this study also indicates that shared understanding (or at least shared business knowledge) positively impact IT change effectiveness in modular (low-complexity) and non-modular environments.

5.7. Paper VII: Development patterns of shared understanding among IT and business professionals across an IT project life cycle[8]

The second research focus of this dissertation is the analysis of the time-dependent evolution of B/IT-SU. As outlined in the introduction of this dissertation, the finding of previous research with regard to the time-dependent effects of shared understanding in business/IT collaborations are quite contradictory. To determine mechanisms that cause changes in the level of B/IT-SU, I explore the development of B/IT-SU over time by applying an explanatory cross-case approach. The results are presented in Paper VII. I structure the mechanisms based on the social capital framework (see Nahapiet and Ghoshal 1998) to elaborate the mechanisms that trigger changes in B/IT-

[8] Jentsch, C. and Beimborn, D. "Analyzing Development Patterns of Shared Understanding among IT and Business in an IT Project Life Cycle" – under review for publication in The DATA BASE for Advances in Information Systems.

SU in four IT projects and among twenty team members. Empirical survey data was collected on an individual level at four points in time during the respective project. At the end of each project, qualitative interview data provides insights into applied management actions and critical events in each project. The results of the four cases were consolidated and analyzed in a cross-case analysis. The findings are highlighted in Figure 11, which provides an overview of common development patterns found in the cases.

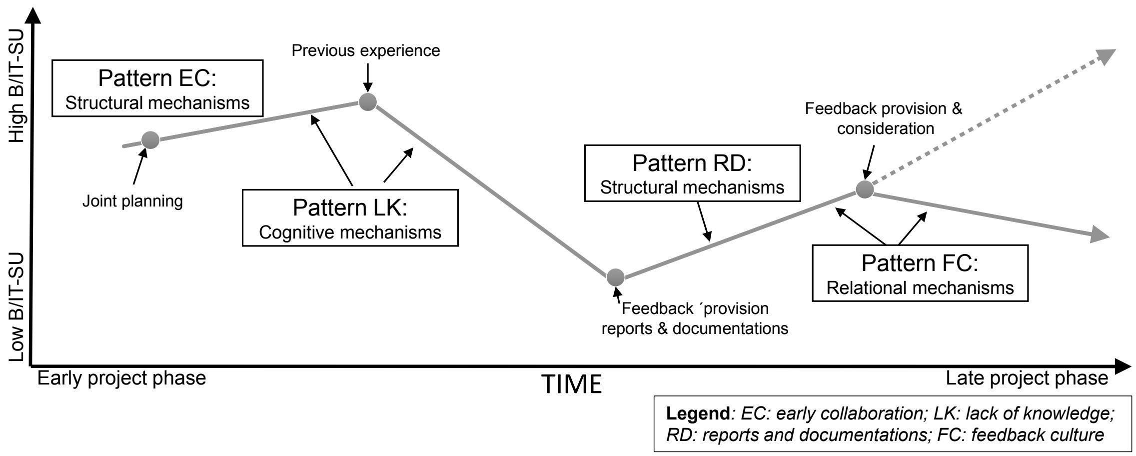


Figure 11. Cross-case findings in Paper VII

Structural mechanisms for enabling B/IT-SU need to be implemented across the whole project life cycle. Joint planning (as an mechanism for Pattern EC) facilitates a high level of B/IT-SU at the beginning of the project but does not necessarily establish a high level of B/IT-SU across all stages of the project. The level of B/IT-SU can only stay high in the later phases given frequent reports and documentation (Pattern RD). A drop in B/IT-SU after the first phase seems to be quite common when there is a lack of knowledge and experience in the team (Pattern LK). These insufficiencies can be absorbed by frequent structural mechanisms such as reports and documentation that provide an information platform for business and IT. However, these structural mechanisms are a necessary but not sufficient condition to achieve a high level of B/IT-SU. If the information transferred by structural mechanisms is not processed and absorbed by the recipients of the information, a gap between perceptions will occur, leading to a drop of shared understanding. Our results indicate that the level of information sharing and processing is a critical component of relational mechanisms in which most of our cases exhibit weaknesses. This mechanism is frequently cited as one of the final and most important mechanisms to build shared understanding and to successfully complete the project (Pattern FC).

This study provides initial in-depth insights into the organizational development of shared understanding across an IT project life cycle and contributes to literature by unveiling the effects of certain drivers of B/IT-SU.

5.8. Paper VIII: The Impact of agile practices on team interaction quality – insights into a longitudinal case study[9]

Based on the findings of Paper VII, I apply an expanded poll instrument to measure the mechanisms enabling B/IT-SU, as well as the dimensions of B/IT-SU and team success in a business/IT project. The mechanisms are again categorized into structural, relational and cognitive mechanisms. The objective of Paper VIII is to qualitatively evaluate and corroborate the empirical findings. Longitudinal empirical data was collected in a four-month software development project with eight team members. At three times during the project, quantitative data at the team member level was collected to identify the antecedents, status and outcome of B/IT-SU.

The findings of this paper indicate that structural mechanisms such as daily meetings are a necessary condition to ensure a sufficient level of information currency, shared understanding of the distribution of knowledge and the quality of conflict resolution in a team. However, daily meetings alone do not guarantee the benefits of colocation in achieving and sustaining a high level of information flow. Second, the appropriate cognitive-related approach to describing project objectives and requirements depends on the degree of formalization of the requirements. More 'formal' requirements favor detailed description of the functionalities, while fuzzier requirements should be organized by more abstract description of requirements, so they do not get lost in the details. Third, staff turnover does not necessarily influence team success negatively. Depending on the amount of documentation and tasks specifically associated with the individuals leaving the project team, personnel changes in a team might not affect the overall level of shared understanding.

In summary, this research applies the social capital framework to confirm and expand the current understanding of the contextual role of structural, relational and cognitive mechanisms in the time-dependent evolution of B/IT-SU and links the level of B/IT-SU to team success. The expanded findings will be applied to analyze the results of the last paper in this dissertation.

5.9. Paper IX: When a lack of shared understanding is beneficial – A longitudinal analysis of the evolution and relevance of business/IT shared understanding to team success in IT-driven projects

The last paper in this dissertation empirically analyzes the time-dependent evolution of B/IT-SU on team success in IT projects. As outlined in the introduction as well as the development of the research questions 3.1. and 3.2. of this introductory paper, previous (empirical) findings on the evolution of B/IT-SU have been remarkably contradictory. In addition, most research in this domain either presents qualitative, (single) case study results or quantitative results of student workgroups on the development of B/IT-SU. The risk of these limitations was discussed in the previous sections. Given these limitations, the objective of this last study is to provide quantitative evidence of the evolution of B/IT-SU in an organizational context. Survey data was collected in 14 IT project teams at three times over 13 months across the project life cycle, providing 278 data

[9] Jentsch C. (2017) "The impact of agile practices on team interaction quality - insights into a longitudinal case study" *Americas Conference on Information Systems,* Boston, MA, USA.

points in total. The underlying research framework and some empirical findings are presented in Figure 12.

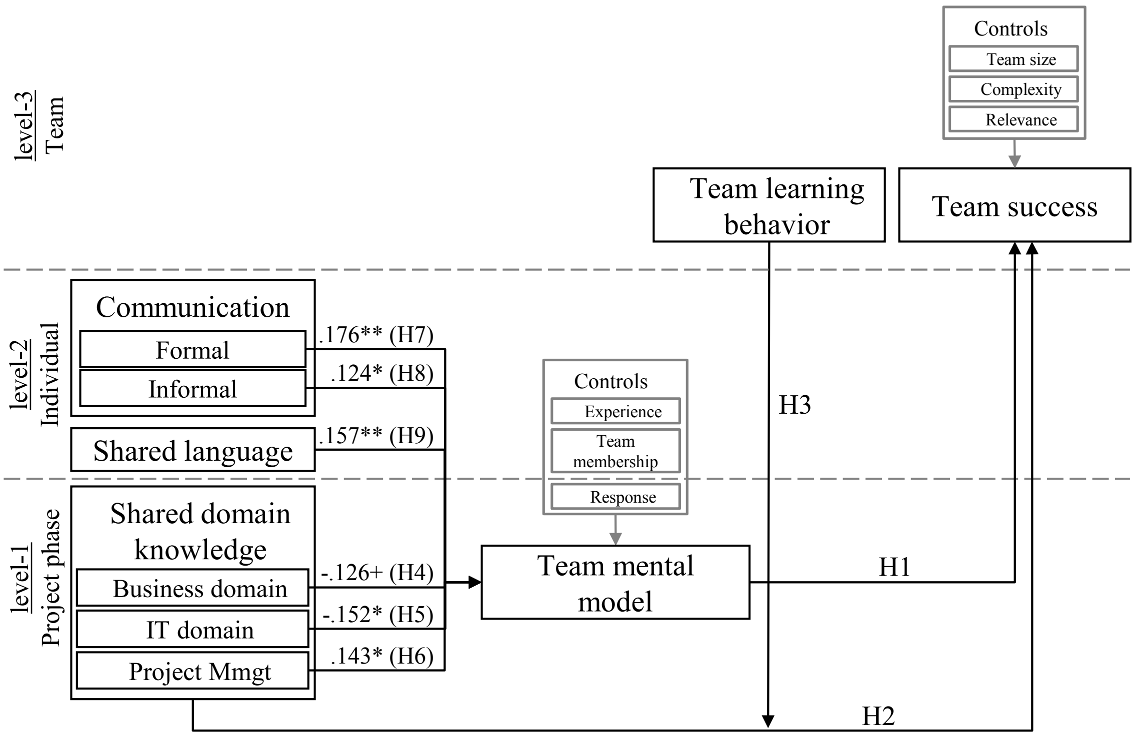


Figure 12. Research framework of Paper IX

B/IT-SU is split into the two sub-constructs: 1) shared domain knowledge (SDK) refers to understanding the daily business, the challenges of the business and IT units, and the general procedures in an IT project, and 2) team mental models (TMM) refer to a shared understanding of project-related tasks and the team. Accordingly, the analysis is split into two operational models. First, the intertemporal effects of shared domain knowledge and team mental models on team success are analyzed in a *time point* analysis (H1-3), including three points in time, using HLM. Second, the longitudinal effects of communication, shared language and shared domain knowledge on team mental models are analyzed in a *time series* analysis (H4-6) using HMLM. Due to the large amount of time-dependent results (4x3 direct effects + 3x3 moderation effects), the inclusion of the results for H1-3 in Figure 12 would severely limit the legibility of the figure. The results will be briefly introduced in the following.

In interpreting the results, it is important to note that shared understanding has been measured in terms of the distance between how "I understand XY" and how "my business/IT partners understand XY". A high level of SDK means that the respondents believe that business and IT have a *similar* understanding of the business or IT domain. The results of H1-3 suggest that a team mental model is a significant enabler for team success (β=.289 at t=2 and β=.594 at t=3) which decreases as the project evolves (the impact of time on team mental models is β= –.118). Shared domain knowledge has a significant impact on the development of team mental models and team success. While shared IT knowledge has a positive impact on team success at t=1 (β=.319) and t=2 (β=.258), shared business knowledge has a strong negative impact on team success at t=3 (β= –.439). Lastly, shared project management knowledge has a significant negative impact at t=2 (β= –.205) on team success.

As illustrated in Figure 13 and Figure 14, the results indicate that these effects are less relevant if strong team learning behavior (TLB) (see H3) is established.

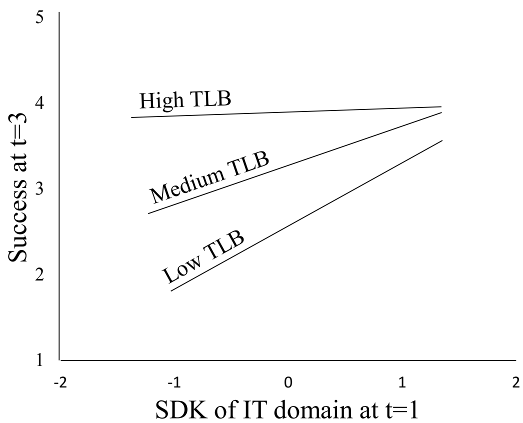


Figure 13. Moderation effect of TLB on SDK of IT domain at t=1 and team success at t=3

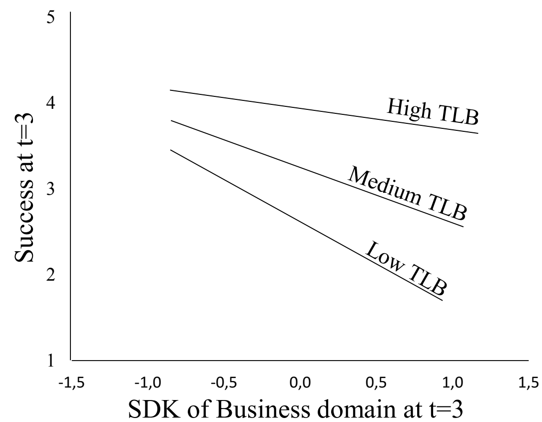


Figure 14. Moderation effect of TLB on SDK of business domain at t=3 and team success at t=3

This study contributes by providing evidence of the multidimensional effects of B/IT-SU. First, the findings show that different perspectives of B/IT-SU are relevant at different times during a project (e.g., SDK of IT domain at the beginning and SDK of the business domain at the end). Second, by applying the different meanings of “shared” (as outlined in the theoretical background of this introductory paper) this study proves the importance of similar understanding of IT-related topics because it helps to structure the project to increase *efficiency*. In contrast, a distributed understanding of the business domain helps the team to combine different areas of expertise, ensure qualitative outcomes and increase *effectivity*. Third, the effects of SDK of business and IT domain can be substituted by strong team learning behavior. Forth, team mental models, which have a highly significant impact on team success, decrease over time. Fifth, shared knowledge of project management helps the team form TMM, while a high level of shared business and IT domain knowledge has the potential to limit the development of TMM.

In summary, this study shows that different perspectives of B/IT-SU can have very different positive as well as negative effects on team success across the duration of an IT project. An overly general recommendation regarding the relevance of shared understanding would be misleading because the relevance of the different perspectives changes over time and can be substituted by management mechanisms.

6. CONTRIBUTION AND IMPLICATIONS

This chapter summarizes the theoretical contribution and practical implications of this cumulative dissertation.

6.1. CONTRIBUTION TO THEORY

This section is structured along the three research fields in which this thesis is situated: foundation of B/IT-SU, analysis of the contextual formation of B/IT-SU, and analysis of the time-dependent evolution of B/IT-SU. The three major contributions of this dissertation are summarized in Figure 15 and described along with additional contributions in detail below.

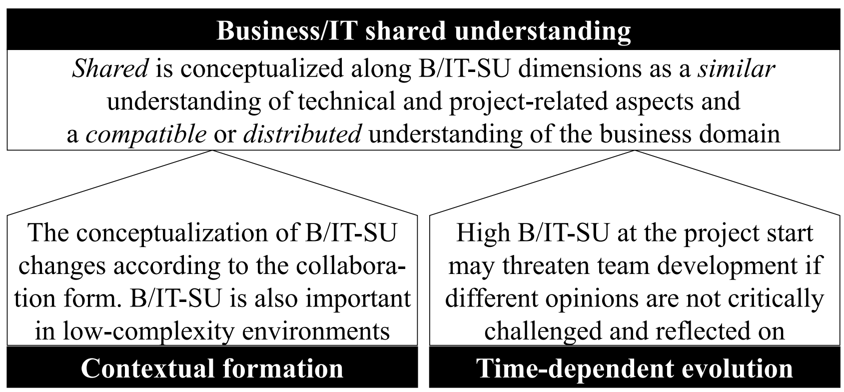


Figure 15. Major contributions of this dissertation

6.1.1. Foundation of business/IT shared understanding

The first part of this dissertation investigates and consolidates the foundational aspects of B/IT-SU discussed in previous literature, consolidating various perspectives from different research streams (Paper I) into a comprehensive concept of B/IT-SU (Paper II) and providing recommendations for operationalization (Paper III). It contributes to previous research on B/IT-SU by elucidating diverse conceptualizations of B/IT-SU and providing a plausible explanation for contradicting findings regarding the role of B/IT-SU in organizations. The major contributions are summarized in Table 10 and will be described in the following.

Table 10. Research question 1 – Contribution to the foundation of B/IT-SU		
Research strand	**Existing research / research gap**	**Contribution of this dissertation**
Investigation of research streams involving B/IT-SU	Divergent discussions about the role of B/IT-SU in different IS research streams	Map of characteristics and similarities/differences between research streams regarding the role of B/IT-SU (Paper I)
		Development of a detailed research agenda (Paper I)
Conceptualization of B/IT-SU	Previous research presents diverse conceptualizations of B/IT-SU, often covering only single dimensions of the complex concept	Conceptualization of a holistic concept of B/IT-SU including six key dimensions (Paper II)
		Major contribution: "Shared" can refer to similar, compatible or distributed understanding. In IT projects, the team should have a similar understanding of technical aspects, but a distributed understanding of functional business aspects (Paper XI)
Operationalization of B/IT-SU	Previous studies capture only single aspects of a multidimensional construct and often fail to ensure content validity	Recommendation for the development of an instrument to measure complex cognitive variables like B/IT-SU (Paper III)
		Development of an instrument to measure the multidimensional concept of B/IT-SU (Paper III)

First, previous research can be categorized into three research streams, namely strategic alignment (e.g. Preston and Karahanna 2009), IT projects (e.g. Rosenkranz et al. 2014) and IT daily operations (e.g. Wagner et al. 2014). In this dissertation I investigate the characteristics as well as similarities and differences of B/IT-SU within and across these research streams. The outcome of this analysis is a detailed research agenda which provides guidelines for further research to close the research gaps identified.

Second, previous research presents very different and partly diverging recommendations for conceptualizing B/IT-SU (Bittner and Leimeister 2014; Cannon-Bowers and Salas 2001; Mohammed et al. 2010). This dissertation helps illuminate these diverse conceptualizations by developing a comprehensive concept including the key dimensions derived in previous research on B/IT-SU covering task-related aspects like shared understanding of the joint work objectives and team-related aspects like shared understanding of the knowledge distribution in a team. The term "shared "has been conceptualized in various ways in previous research, referring to similar, compatible and/or distributed understanding in a group of individuals (Cannon-Bowers and Salas 2001). This dissertation presents evidence that the meaning of shared depends on the perspective of B/IT-SU in focus. Paper IX finds that shared understanding of the IT domain and task/team-related aspects should be conceptualized as *similar* understanding, since it helps the business/IT team to structure and organize joint collaboration approaches. In contrast, shared understanding of the business domain should be conceptualized as *distributed* or *compatible* understanding, since the challenge in most business/IT collaborations is to draw on the expertise of various individuals and to create novel ideas and approaches (Tiwana 2012).

Third, even though research agrees on the cognitive complexity of the concept of B/IT-SU, many studies fail to ensure content validity (Tan and Gallupe 2006) and often only capture single aspects of this very rich and multidimensional construct (Cannon-Bowers and Salas 2001). To fill this gap, this dissertation operationalizes the concept of B/IT-SU as a holistic survey instrument. It ensures content validity of this instrument using a unique interview method – the repertory grid-technique. In doing so, this dissertation provides an initial recommendation for the development of a measurement instrument that takes content validity into account in a statistically testable way. In addition, it provides a more sound and more comprehensive measurement of B/IT-SU.

6.1.2. Contextual formation of business/IT shared understanding

Based on the theoretical foundation in the first part of this dissertation, I analyzed previous research on B/IT-SU and consolidated the context-related conceptualizations and findings into a comprehensive framework (Paper IV). Then I undertook an exploratory cross-case analysis to derive empirical evidence for the impact of the context of a business/IT collaboration on the formation of B/IT-SU (Paper V). Finally, I conducted an empirical study to collect statistical data on the role of organizational complexity (as one dimension of organizational context) on the formation and relevance of B/IT-SU. This step reflects hypotheses from previous research that shared understanding becomes irrelevant or even a threat in standardized (i.e. low-complexity) work environments.

My findings indicate that B/IT-SU does not lose relevance in general, but rather that different facets of B/IT-SU gain or lose relative importance, which can and must be captured in a comprehensive multidimensional conceptualization of B/IT-SU. For example, this dissertation provides empirical evidence of the impact of organizational complexity on the formation of B/IT-SU. The major contributions are highlighted in Table 11 and will be briefly summarized in the following.

Table 11. Research question 2 – Contribution to the contextual formation of B/IT-SU		
Research strand	**Existing research / research gap**	**Contribution of this dissertation**
Contextual formation of B/IT-SU	Most previous studies are limited to a specific context of collaboration	The conceptualization of B/IT-SU changes depending on the context in which it evolves. The dissertation provides an empirically tested framework supporting a context-specific conceptualization (Paper IV and Paper V)
Organizational complexity and its influence on B/IT-SU	Previous research suggests that B/IT-SU loses relevance or can even threaten team success in low-complexity environments.	Major contribution: B/IT-SU shows a statistical significant effect on collaboration success also in low-complexity environments (Paper VI) but the conceptualization of B/IT-SU changes in respect to the complexity (Paper V)
	From previous research one can infer that work system modularity, which reduces organizational complexity, enables B/IT-SU.	This dissertation (partly) confirms previous research, but also shows that modularity (or low complexity) does not enable B/IT-SU per se. Rather, the mix of technical and functional modularity of the work environment is key (Paper VI)

First, this dissertation shows that most research studies on shared understanding are limited to a specific context, making it difficult to compare the role of B/IT-SU in different situations. As a step toward overcoming this limitation, this dissertation proposes describing shared understanding as a function of the context in which it is developed, including the degree of complexity and the (strategic) task relevance. Especially in low-complexity projects it is not enough to analyze the shared understanding of the predefined objectives. Rather, the shared understanding of change requests affecting facets of the objectives must also be assessed. In contrast, joint objectives might be fuzzier in complex projects, requiring the focus of B/IT-SU to shift to team process to discover and exploit potential outcomes. The framework of B/IT-SU developed in this dissertation helps to determine what aspects of B/IT-SU are most relevant in a given situation (Paper IV and Paper V).

Second, this dissertation contributes to the discussion of the relevance of shared understanding for team success in a standardized (or low-complexity) environment. My results contradict previous research arguing that the need for knowledge sharing decreases in a non-complex environment, which is the result of managed complexity (Henfridsson et al. 2014). My results show that low-complexity environments do not make shared understanding redundant or threaten team success (as suggested by Grand et al. 2016; Mani et al. 2010; Resick et al. 2014), but rather that a structured environment enables knowledge sharing, which in turn increases team success – even in a low-complexity environment (Paper VI).

Third, previous research argues that B/IT-SU is difficult to achieve especially in complex environments (Bittner and Leimeister 2014; Rosenkranz et al. 2014; Zelt et al. 2014), implying that

B/IT-SU is easier to achieve in a low-complexity environment. This dissertation analyzes the impact of complexity on the development of B/IT-SU, focusing on modularity as a tool to reduce complexity, which in turn has been discussed as a barrier for the development of B/IT-SU (Ko et al. 2005). My findings suggest that modular systems do not per se facilitate B/IT-SU. Rather, the combination of functional and technical modularization facilitating operational and strategic aspects of B/IT-SU is key (Paper VI).

6.1.3. Time-dependent evolution of business/IT shared understanding

The last part of this dissertation concentrates on the evolution of B/IT-SU. Even though plenty of theories have been developed to describe the evolution of shared understanding in organizations (e.g. Dennis et al. 2008; Grand et al. 2016; Wegner 1987), empirical longitudinal evidence is rare. In addition, most previous longitudinal research either relies on qualitative data like interviews and documents (e.g. Vermerris et al. 2014) or collects data about student groups (e.g. Levesque et al. 2001). To my knowledge, this dissertation is the first empirical research to include a statistically analysis of the longitudinal evolution of B/IT-SU in an organizational business environment[10]. Table 12 summarizes the theoretical contributions of this dissertation with regard to the time-dependent evolution of B/IT-SU.

[10] An exception might be Wagner and Weitzel (2012), even though their study does not present statistical analysis procedures or results.

Table 12. Research question 3 – Contributions regarding the time-dependent evolution of B/IT-SU		
Research strand	**Existing research / research gap**	**Contribution of this dissertation**
Time-dependent effects of B/IT-SU on team success	Contradicting findings about optimal time-dependent implementation of B/IT-SU ("As soon as possible"?)	Major contribution: Early B/IT-SU risks superficiality. A team that believes everything is fine might fail to address real problems. Teams need time to build profound B/IT-SU (Paper VII and Paper VIII)
		Major contribution: Early shared (i.e. similar) understanding of IT domain and task/team-related aspects helps to structure and maintain joint procedures. Shared (i.e. distributed) understanding of the business domain in the later phases helps to combine expertise and create something unique (Paper IX).
	No consensus on whether an increasing, decreasing or stable level of B/IT-SU is associated with high team success	Task/team-related B/IT-SU commonly decreases over time in IT projects. However, since this type of B/IT-SU has a significant positive effect on team success, a decreasing level is associated with a negative effect on team success (Paper IX)
Time-dependent effects of antecedents of B/IT-SU	To date, limited quantitative research findings on the longitudinal effects of antecedents on B/IT-SU, commonly based on student experiments	Five common development patterns of B/IT-SU identified which illustrate the longitudinal effects of structural, cognitive and relational mechanisms (Paper VII and Paper VIII)
		B/IT-SU of the business and IT domain (as antecedent) have a negative effect on task/team related shared understanding (as outcome) (Paper IX)
		Strong learning behavior in the team has the potential to fully compensate the effects of BIT-SU of business and IT domains (Paper IX)

The contributions are structured along the underlying research questions RQ3.1 focusing on the time-dependent effects of B/IT-SU on team success and RQ3.2. analyzing the time-dependent effects of antecedents of B/IT-SU. In terms of RQ3.1, this dissertation contributes in three ways.

First, I provide evidence that a high level of (perceived) B/IT-SU at early stages during the project may be a threat for team success. That result contradicts previous research stressing the importance of B/IT-SU at the early stages in the team formation (e.g. van der Haar et al. 2015; Vermerris et al. 2014), finding instead that teams commonly underestimate project complexity or misjudge the level of understanding of their partners (Paper VII and Paper VIII). An increasing gap between the perception of own understanding and the understanding of business/IT partners can be overcome by frequent structural mechanisms (e.g. reports) as well as the provision and consideration of feedback in the team.

Second, I provide evidence, that a universal recommendation for the perfect timing of B/IT-SU implementation in a project is not possible. Rather, the timing depends on the conceptualization of B/IT-SU. Different perspectives of B/IT-SU (team/task-related, business domain and IT domain; see page 14) affect team success at very different stages during a project (Paper IX). A shared (i.e. similar) understanding of the IT domain at the beginning of a project helps the team to jointly structure the project procedure, while a shared (i.e. similar) understanding of task/team-related aspects in the second half of the project helps the team to stay on the track and not lose focus on joint project objectives. A shared (i.e. distributed or compatible) understanding in the later project phases contributes to team success by helping the team to consolidate their expertise and create something new. A team that fails to leverage the business understanding and expertise of all team members by falsely assuming a homogeneous business understanding risks failing to achieve maximum success. Thus, a time-dependent combination of the different perspective of B/IT-SU is important to maximize team success. Simply said, an ideal IT project roadmap should contain the following steps with respect to B/IT-SU: (1) Ensure similar technical understanding at the beginning of the project; (2) Maintain task/team-related understanding during entire project execution; (3) Achieve a high degree of compatible business understanding towards the second half of project execution.

A third contribution addresses the contradicting discussions about whether an increasing, a decreasing or a stable level of B/IT-SU is associated with team success (He et al. 2007; Levesque et al. 2001; van der Haar et al. 2015). I provide evidence that task/team-related B/IT-SU is likely to decrease over time in IT projects. This findings confirm previous research which states that shared understanding in a team decreases over time as team members' work becomes more specialized (Levesque et al. 2001; van der Haar et al. 2015). However, the findings also suggest that task/team-related shared understanding has a significant positive effect on team success for which reason a decreasing level of task-related B/IT-SU has a negative effect on team success (Levesque et al. 2001).

Next, focusing on time-dependent effects of antecedents of B/IT-SU (RQ3.2), this dissertation contributes in three ways.

First, it provides profound insights into common development patterns of B/IT-SU in IT projects based on the effects of structural, relational and cognitive mechanisms (Paper VII). The findings can be applied in future research to categorize and further understand the effects of different mechanisms. In addition, the findings underline the importance of the careful implementation of these mechanisms, such as formal and informal communication channels (structural mechanism) or shared language (cognitive mechanism) (see Paper VIII and Paper IX).

Second, previous qualitative research assumes that a shared understanding of each other's work domains (here: business and IT domain) positively impact the development of task/team-related shared understanding (Yang et al. 2008). Indeed, my analysis reveals just the opposite. Consider a team whose members believe they perfectly understand the work domain of their colleagues on the one side and a fully misaligned team on the other side. The need for knowledge exchange in the second team is much higher than in the first team. Knowledge exchange is enabled by intense communication and shared language, which also potentially uncovers profound misunderstandings. Teams whose members assume perfect shared domain understanding might minimize their communication or fail to ensure shared language. However, as the project evolves, the work performed by team members grows significantly more complex, testing the profoundness of shared understanding. This dissertation finds that teams perceiving a high level of shared business/IT domain understanding at the beginning of the project will invest less time in building task/team-related understanding. The significant negative causal effects of B/IT-SU of the business and IT domain on task/team-related B/IT-SU were found in Paper IX and are supported by the findings of Paper VII and Paper VIII in which the informants frequently identified misjudging the level of understanding among IT and business unit team members as a major threat to team processes.

The third and last contribution of this dissertation focusses on the effects of a strong team learning behavior, which can be achieved and sustained by mechanisms like team member involvement, joint coordination of respective responsibilities or frequent updating sessions. As mentioned above, B/IT-SU of the IT domain and B/IT-SU of the business domains have significant (positive and negative) effects on team success. However, the findings in this dissertation suggest that a high level of team learning behavior can almost completely make up for this direct effect (Paper IX), rendering the level of shared (i.e. similar) business and IT domain understanding less relevant to team success. In fact, Paper IX finds that the strongest B/IT teams do not necessarily have the highest possible shared understanding of the business or IT domain, but rather draw on a wide range of expertise while maintaining a high level of team learning behavior.

6.2. PRACTICAL IMPLICATIONS

The findings presented in this cumulative dissertation have important implications for practitioners in terms of the role and management of business/IT shared understanding in an organizational business context. This section structures these practical implications according to conceptualization, operationalization and management of B/IT-SU.

6.2.1. Comprehensive framework of shared understanding

This cumulative dissertation demonstrates that the concept of shared understanding varies widely in scholarship and in practice (see Paper I, IV and V), ranging from understanding a partner's business processes to having joint objectives and strategies. As a step toward overcoming this divergence, I developed a unified and detailed conceptualization of business/IT shared understanding which incorporates all relevant dimensions identified in extant research (see Paper II) and in practice (see Paper V). The framework may help practitioners to identify and better address the "real" pain points in a collaboration, rather than attributing shortcomings to a low level of shared understanding in general.

The findings from the research studies on the contextual formation of B/IT-SU (Paper IV to VI) provide flexibility to adjust the concept to fit the context so that practitioners can consider different level of collaboration (i.e. strategic, project-related or operational) when analyzing the level of shared understanding in the present collaboration. In practical terms, this dissertation underscores the need for project managers to understand the relevance of various dimensions of B/IT-SU with respect to time and maximize the benefits of resources investments by addressing the proper dimensions at the proper point in time during a project.

6.2.2. Measuring shared understanding

This dissertation develops a comprehensive instrument for measuring shared understanding (Paper III), which was also adjusted and enhanced for measuring specific aspects of business/IT shared understanding related to a specific domain of interest – e.g. IT projects (Paper IX) or business process management (Paper VI). Practitioners can use this instrument as a tool to identify ways to make cooperation between business and IT professionals more effective. By that, this dissertation contributes to the conventional wisdom: if you cannot measure it, you cannot manage it.

6.2.3. Taking management action to maintain shared understanding

This cumulative dissertation derives detailed recommendations for managers about measures they can implement to maintain a high level of shared understanding between business and IT professionals, including goal-oriented mechanisms that can be applied to improve specific dimensions of business/IT shared understanding in organizational contexts. The design of management mechanisms related to specific collaboration types (e.g. IT projects, infrastructure services or strategic alliances) is discussed in Paper IV and Paper V while Paper VII to Paper IX focus on management practices in IT projects.

The impact of management actions taken to create and maintain shared understanding – like implementing a glossary or establishing regular meetings – might vary depending on the collaboration form. Building on studies outlining ways to achieve shared understanding (e.g. Schlosser et al. 2015; Smith and McKeen 2010; Wagner and Weitzel 2012), this dissertation illustrates the importance of accounting for the specific context when providing recommendations for governance mechanisms. For example, Paper V indicates that in low-complexity projects it might be sufficient to implement a glossary of key terms and definitions, while more complex projects demand further investment in language and communication skills.

By concentrating on IT projects, this dissertation additionally provides recommendations about when management practices should best be introduced. Based on three longitudinal studies, this dissertation provides a deeper understanding into how to design management actions to facilitate shared understanding. For instance, the findings in Paper VII indicate that a lack of experience can limit the development of B/IT-SU at the beginning of a project, while this limitation can be overcome over time by a culture of giving and receiving feedback in an eye-to-eye partnership.

7. LIMITATIONS AND FURTHER RESEARCH

While this multi-method thesis offers several contributions to theory and practice, as with any empirical research it is also limited in some ways, which also point to opportunities for further research. The most notable overarching limitations are discussed below, while more specific limitations can be found in the respective papers.

Methodological issues

The literature review is limited in two ways. First, it only covers research from the years 1996 to 2014 and concentrates on articles published in top-rated journals and most important conferences.

Although I conducted a forward and backward search (Webster and Watson 2002), it cannot be ruled out that relevant articles were not considered. However, given the comparatively large number of initial papers as well as the number of those used in the analysis, I expect to have covered the majority of studies relevant to this research. Additional articles published after 2014 were reviewed for the detailed research model development in the seven other papers.

Second, the literature review focuses on collaborations between business and IT professionals and does not include research on any other type of collaboration, such as student work groups. I set this focus in an attempt to reduce complexity of the research field. Also, my primary research interest lies on characteristics and problems common in business/IT collaborations. Some research from other disciplines, like applied psychology or philosophy, was also considered in the subsequent studies. Future research might compare research on business/IT shared understanding with research on shared understanding in other disciplines.

Next, the case study approach is limited in several ways. It cannot be guaranteed that all relevant mechanisms and antecedents of B/IT-SU were raised in the case interviews. Interview respondents may have misinterpreted or forgotten critical aspects that would have been insightful for the findings. Future research should broaden the scope of data collected to include objective data such as reports and increase the number of interviews per case. Furthermore, in the coding process of the case interviews, the statements of the respondents were commonly categorized in a meta-construct. Certainly, there might be other possibilities to combine and describe the different case-specific findings. More data from different cases might minimize this limitation.

Finally, structured survey studies such as those conducted in Paper VI and Paper IX prevent detailed interpretation of causal effects and the inclusion of other factors to interpret the findings apart from the operationalized construct. However, since the design of the survey instrument is based on three case studies (Paper V, Paper VII and Paper VIII), exploring and interpreting the causal effects between the research variables as well as the discussion of the results delivers valuable and valid insights into research on B/IT-SU.

Sampling of the research respondents

Two major limitations arise from the sampling procedure applied in this dissertation – the single-respondent bias and generalization issues.

First, in the case interviews of Paper V, VII and VIII as well as the survey study in Paper VI, single respondents were used as key informants. Exclusively surveying relationship managers (Paper V), credit process owners (Paper VI) or team leaders (Paper VII and Paper VIII), who presumably have the best information regarding the role of B/IT-SU in their organization, may impact the results of this dissertation. Nonetheless, the respondents were carefully selected in accordance with the underlying research design. For example, process owners (Paper VI) were considered the most appropriate informants since the owner is the only person who knows how well the structure of the IT architecture fits the business processes he or she owns. The last study reported in Paper IX attempts to consider the perception of all members of the researched organization (here: IT project team) to overcome the problem of a single-respondent bias.

Second, the generalizability of the empirical studies is limited since the research analysis and interpretation is based on a representative sample of the target population. In the survey study of Paper VI, for example, I focus on only one specific business segment, while in the cross-case study

(Paper VII) I interpret the results based on only four cases. The selection of the research participant results from the underlying research design (for details please see description in the papers). However, the focus on particular business segments in German, Austrian and Swiss organizations limits the potential for generalization from empirical findings to theoretical statements that apply to a larger population (Lee and Baskerville 2003). On the other hand, similar contextual characteristics improve comparability of the findings, which increases confidence in the significance of the theoretical statements. While there is no reason to assume that the results cannot be generalized to comparable subject groups of other industries, future studies will be necessary to increase generalizability of the findings.

Subjective vs. objective evaluation of business/IT shared understanding

The majority of the papers comprising this dissertation analyze business/IT shared understanding from a subjective perspective by using structured survey or poll items asking the respondents for their perception of B/IT-SU (Paper IV and Paper VI to Paper IX). The perception of indicators like communication intensity, partners' technical understanding or team success are used to determine the formation and effects of shared understanding in the underlying business/IT collaboration. Some objective measures were applied in Paper IX to measure the number of official meetings or the degree of colocation. Nonetheless, none of the papers evaluates business/IT shared understanding or outcome variables – like IT change effectiveness – in an objective manner. That these subjective measures can be troublesome could be proven in Paper VII and Paper VIII. The papers provide evidence that respondents commonly misjudged the "real" level of shared understanding. Several interviewees mentioned that they either misjudged the level of complexity of the collaborative task or the level of their partners' understanding, most commonly at the beginning of the project.

In order to address these subjective misjudgments, previous research on team mental models introduced the concept of accuracy. Accurate team mental models reflect the "true state of the world" (Edwards et al. 2006, p. 728). However, matching individual perception with the "true state of the world" can be troublesome in an organizational business context. Previous research which studied the level of accuracy of mental models in a team most commonly designs experiments in which the optimal outcome can be precisely describes before the experiment starts. Examples for these experiments are student teams performing PC-based command and control simulations (e.g. Mathieu et al. 2000) or air traffic control towers (e.g. Smith-Jentsch et al. 2005) in which the optimal state can be clearly described or simulated. Thus, a promising future research direction is the development and evaluation of measuring *accuracy* of business/IT shared understanding in an organizational business context.

Another research direction to solve this problem might be found in alternative ways for assessing B/IT-SU. Some studies attempted to corroborate their findings by screening documents (e.g. Reich and Benbasat 2000) or observing team meetings and other interactions (e.g. Rosenkranz et al. 2013). Nonetheless, these techniques are very time intensive for the researchers as well as participants and are difficult to generalize. Other more automated forms of assessing B/IT-SU can be found in the analysis of social networks or communication content. In a previous study, some colleagues and I analyzed the applicability of social network analysis to assess the level of shared understanding, which is not part of the main body of this dissertation (Lüders et al. 2015). The study analyzes network characteristics like structural holes, tie intensity or homophily as potential sources to assess the level of shared understanding. Another automated approach is sentiment analysis, which allows the assessment and categorization of written text, like e-mails, chats, or protocols. Future research might implement and test these techniques in order to collect objective real time data about business/IT collaboration and the "real" level of shared understanding.

Research on the contextual formation of B/IT-SU

The research regarding the contextual formation of B/IT-SU determines the concept of complexity as well as task relevance as crucial contingency factors influencing the formation of B/IT-SU. However, for the subsequent focus study reported in Paper VI, I only focus on organizational complexity and its effects on the formation of B/IT-SU. A study presenting statistical valid findings for the role of task relevance is lacking. An adequate study design for this research assignment might focus on the role of governmental regulations in the banking industry, as exemplified by Reitz et al. (2018). While the governmental regulations are the same for all banks in a specific country, different banks perceive the pressure of the governmental regulations very differently. The more pressure the respective bank feels to meet the governmental requirements, the more likely the bank will perceive the task as strategically relevant, since a failure to comply the requirements will be penalized. My colleagues and I found in this research that business agility as a dependent variable is lower for higher regulatory pressure and that this effect is fully mitigated by a flexible IT. A subsequent study might include the role of B/IT-SU on whether pressure helps or hinder the development of B/IT-SU.

8. CONCLUSION

The objective of this dissertation was to analyze the contextual formation and time-dependent evolution of B/IT-SU. Building on prior research on B/IT-SU, the research studies comprising this dissertation empirically support deeper insights into the formation and effects of B/IT-SU in different collaboration contexts and at different points in time. The results suggest that B/IT-SU is a multi-dimensional concept which evolves according to the context. The frameworks I developed can be applied in research and practice to gain a deeper understanding of the effects of B/IT-SU within and across different collaboration forms. The comprehensive analysis brings together the ideas of different research streams and consolidates them into a holistic concept. My results indicate that B/IT-SU needs to be *similar* when it comes to technical and task/team-related understanding (e.g., as suggested by the theory of team mental models) but *distributed* in case of business-related understanding (e.g., as suggested by the transactive memory theory). Especially in temporal collaborations, like IT projects, timing plays a critical role. At the beginning the team needs to build a similar technical understanding and overcome potential false beliefs about the true level of shared understanding. Next, the team needs to understand project-related aspects as team members' work grows more specialized. As a last critical step, the team needs to be aware of and leverage the business domain understanding and expertise of all team members. In summary, this dissertation underscores the need for a more deliberate discussion of the formation and effects of B/IT-SU in research in order to unite seemingly contradictory research findings on B/IT-SU and apply and provide consistent and concrete practical advice. This dissertation adds depth and specificity to previously overly generic recommendations, which are easily misinterpreted and risky, and therefore opens new doors in the ongoing research into B/IT-SU.

References

Adler, P. S., and Kwon, S.-W. 2002. "Social Capital: Prospects for a New Concept," *Academy of Management Review* (27:1), pp. 17-40.
Ågerfalk, P. J. 2013. "Embracing Diversity through Mixed Methods Research," *European Journal of Information Systems* (22:3), pp. 251-256.
Armstrong, J. S., and Overton, T. S. 1977. "Estimating Nonresponse Bias in Mail Surveys," *Journal of Marketing Research* (14:3), pp. 396-402.
Avgerou, C. 2013. "Social Mechanisms for Causal Explanation in Social Theory Based IS Research," *Journal of the Association for Information Systems* (14:8), pp. 399-419.
Bandura, A. 1986. *Social Foundations of Thought and Action : A Social Cognitive Theory.* . Englewood Cliffs, N.J.: Prentice-Hall.
Banker, R. D., Datar, S. M., and Kemerer, C. F. 1991. "A Model to Evaluate Variables Impacting the Productivity of Software Maintenance Projects," *Management Science* (37:1), pp. 1-18.
Bassellier, G., and Benbasat, I. 2004. "Business Competence of Information Technology Professionals: Conceptual Development and Influence on IT-Business Partnerships," *MIS Quarterly* (28:4), pp. 673–694.
Bélanger, F., Cefaratti, M., Carte, T., and Markham, S. E. 2014. "Multilevel Research in Information Systems: Concepts, Strategies, Problems, and Pitfalls," *Journal of the Association for Information Systems* (15:9), pp. 614-650.
Benbasat, I., Goldstein, D. K., and Mead, M. 1987. "The Case Research Strategy in Studies of Information Systems," *MIS Quarterly* (11:3), pp. 369-385.
Benlian, A., and Haffke, I. 2016. "Does Mutuality Matter? Examining the Bilateral Nature and Effects of CEO–CIO Mutual Understanding," *The Journal of Strategic Information Systems* (25:2), pp. 104-126.
Bittner, E., and Leimeister, J. M. 2014. "Creating Shared Understanding in Heterogeneous Work Groups: Why It Matters and How to Achieve It," *Journal of Management Information Systems* (31:1), pp. 111-143.
Bliese, P. D. 2000. "Within-Group Agreement, Non-Independence, and Reliability: Implications for Data Aggregation and Analyses," in *Multilevel Theory, Research, and Methods in Organizations: Foundations, Extensions, and New Directions,* K.J. Klein and S.W.J. Kozlowski (eds.). San Francisco, CA: Jossey-Bass., pp. 349-381.
Bliese, P. D., and Hanges, P. J. 2004. "Being Both Too Liberal and Too Conservative: The Perils of Treating Grouped Data as Though They Were Independent," *Organizational Research Methods* (7:4), pp. 400-417.
Bühl, A. 2012. *Spss 20*, (13 ed.). München [u.a.]: Pearson.
Burns, T., and Stalker, G. M. 1961. *The Management Innovation*. London: Tavistock Publications.
Campbell, D. J. 1988. "Task Complexity: A Review and Analysis," *The Academy of Management Review* (13:1), pp. 40-52.
Cannon-Bowers, J. A., and Salas, E. 2001. "Reflection on Shared Cognition," *Journal of Organizational Behavior* (22:2), pp. 195–202.
Caya, O., Bassellier, G., and Pinsonneault, A. 2008. "Virtual Team Common Knowledge: Construct Specification and Effect on Knowledge Integration Effectiveness," *International Conference on Information Systems*. Paris, France.
Cenfetell, R. T., and Bassellier, G. 2009. "Interpretation of Formative Measurement in Information Systems Research," *MIS Quarterly* (33:4), pp. 689-707.
Chakraborty, S., Sarker, S., and Sarker, S. 2010. "An Exploration into the Process of Requirements Elicitation: A Grounded Approach," *Journal of the Association for Information Systems* (11:4), pp. 212-249.
Chandler, A. D. 1969. *Strategy and Structure: Chapters in the History of the American Industrial Enterprise*. Cambridge MIT Press.
Charaf, M. C., Rosenkranz, C., and Holten, R. 2013. "The Emergence of Shared Understanding: Applying Functional Pragmatics to Study the Requirements Development Process," *Information Systems Journal* (23:2), pp. 115–135.
Chen, Y., Wang, Y., Nevo, S., Jin, J., Wang, L., and Chow, W. S. 2014. "IT Capability and Organizational Performance: The Roles of Business Process Agility and Environmental Factors," *European Journal of Information Systems* (23:3), pp. 326-342.

Chin, W. W. 1998. "The Partial Least Squares Approach to Structural Equation Modeling," in *Modern Methods for Business Research,* G.A. Marcoulides (ed.). Mahwah, N.J: Lawrence Erlbaum Associates, pp. 295-336.

Chiravuri, A., Nazareth, D., and Ramamurthy, K. 2011. "Cognitive Conflict and Consensus Generation in Virtual Teams During Knowledge Capture: Comparative Effectiveness of Techniques," *Journal of Management Information Systems* (28:1), pp. 311–350.

Cho, S., Mathiassen, L., and Nilsson, A. 2008. "Contextual Dynamics During Health Information Systems Implementation: An Event-Based Actor-Network Approach," *European Journal of Information Systems* (17:6), pp. 614-630.

Chou, H.-W., Lin, Y.-H., and Chou, S.-B. 2012. "Team Cognition, Collective Efficacy, and Performance in Strategic Decision-Making Teams," *Social Behavior and Personality* (40:3), pp. 381-394.

Chua, C. E. H., Lim, W.-K., Soh, C., and Sia, S. K. 2012. "Enacting Clan Control in Complex IT Projects: A Social Capital Perspective," *MIS Quarterly* (36:2), pp. 577–600.

Clark, M. E. 2002. *In Search of Human Nature*. London; New York: Routledge.

Cohen, J. 1992. "A Power Primer," *Psychological Bulletin* (112:1), pp. 155-159.

Cooke, N. J., Salas, E., Cannon-Bowers, J. A., and Stout, R. 2000. "Measuring Team Knowledge," *Human Factors* (42:1), pp. 151-173.

Cornelius, C., and Boos, M. 2003. "Enhancing Mutual Understanding in Synchronous Computer-Mediated Communication by Training: Trade-Offs in Judgmental Tasks," *Communication Research* (30:2), pp. 147-177.

Craik, K. 1963. *The Nature of Explanation*, (New Impression ed.). Cambridge University Press.

Davis, J. M., Kettinger, W. J., and Kunev, D. G. 2009. "When Users Are IT Experts Too: The Effects of Joint IT Competence and Partnership on Satisfaction with Enterprise-Level Systems Implementation," *European Journal of Information Systems* (18:1), pp. 26–37.

Dennis, A. R., Fuller, R. M., and Valacich, J. S. 2008. "Media, Tasks, and Communication Processes: A Theory of Media Synchronicity," *MIS Quarterly* (32:3), pp. 575-600.

Dennis, A. R., and Valacich, J. S. 1999. "Rethinking Media Richness: Towards a Theory of Media Synchronicity," *Proceedings of the 32nd Hawaii International Conference on System Sciences*. Maui, Hawaii, USA.

Donaldson, L. 2001. *The Contingency Theory of Organizations*. Sage Publications.

Dubé, L., and Paré, G. 2003. "Rigor in Information Systems Positivist Case Research: Current Practices, Trends, and Recommendations," *MIS Quarterly* (27:4), pp. 597-635.

Duffy, M. K., Shaw, J. D., and Stark, E. M. 2000. "Performance and Satisfaction in Conflicted Interdependent Groups: When and How Does Self-Esteem Make a Difference?," *Academy of Management Journal* (43:3), pp. 772-782.

Edwards, B. D., Day, E. A., Arthur, W., and Bell, S. T. 2006. "Relationships among Team Ability Composition, Team Mental Models, and Team Performance," *Journal of Applied Psychology* (91:3), pp. 727-736.

Eisenhardt, K. M. 1989. "Building Theories from Case Study Research," *Academy of Management Review* (14:4), pp. 532-550.

Espinosa, J., Slaughter, S., Kraut, R., and Herbsleb, J. 2007. "Team Knowledge and Coordination in Geographically Distributed Software Development," *Journal of Management Information Systems* (24:1), pp. 135–169.

Firebaugh, G. 1978. "A Rule for Inferring Individual-Level Relationships from Aggregate Data," *American Sociological Review* (43:4), pp. 557-572.

Fitzmaurice, G. M., Laird, N. M., and Ware, J. H. 2011. *Garrett M. Fitzmaurice, Nan M. Laird, James H. Ware*, (2nd ed.). Hoboken, New Jersey: John Wiley & Sons.

Fornell, C., and Larcker, D. F. 1981. "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research* (18:1), pp. 39-50.

Gable, G. G. 1994. "Integrating Case Study and Survey Research Methods: An Example in Information Systems," *European Journal of Information Systems* (3:2), pp. 112-126.

Garson, G. D. 2013. "Fundamentals of Hierarchical Linear and Multilevel Modeling," in *Hierarchical Linear Modeling: Guide and Applications,* G.D. Garson (ed.). Sage Publications Inc, pp. 3-25.

Gefen, D., Rigdon, E., and Straub, D. 2011. "An Update and Extension to Sem Guidelines for Administrative and Social Science Research," *MIS Quarterly* (35:2), pp. iii-A7.

Gerring, J. 2008. *Case Study Research: Principles and Practices*. Cambridge: Cambridge University Press.

Gill, J. 2005. "Hierarchical Linear Models. In Kimberly Kempf-Leonard (Ed.), Encyclopedia of Social Measurement. New York: Academic Press.," in: *Encyclopedia of Social Measurement,* K.K. Leonard (ed.). Elsevier Inc., pp. 209-214.

Gobet, F., and Simon, H. A. 1996. "Templates in Chess Memory: A Mechanism for Recalling Several Boards," *Cognitive Psychology* (31:1), pp. 1-40.

Götz, O., Liehr-Gobbers, K., and Krafft, M. 2010. "Evaluation of Structural Equation Models Using the Partial Least Squares (Pls) Approach," in *Handbook of Partial Least Squares - Concepts, Methods and Applications,* V.E. Vinzi, W.W. Chin, J. Henseler and H. Wang (eds.). Heidelberg Berlin: Springer, pp. 655-690.

Grand, J. A., Braun, M. T., Kuljanin, G., Kozlowski, S. W. J., and Chao, G. T. 2016. "The Dynamics of Team Cognition: A Process-Oriented Theory of Knowledge Emergence in Teams," *Journal of Applied Psychology* (101:10), pp. 1353-1385.

Guchait, P., Lei, P., and Tews, M. J. 2016. "Making Teamwork Work: Team Knowledge for Team Effectiveness," *The Journal of Psychology* (150:3), pp. 300-317.

Habermas, J. (ed.) 1985. *Theory of Communicative Action*. Boston, Massachusetts: Beacon Press.

Hair, J. F., Hult, G. T. M., Ringle, C. M., and Sarstedt, M. 2016. *A Primer on Partial Least Squares Structural Equations Modeling (Pls-Sem)*, (2 ed.). Los Angeles: Sage.

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., and Thiele, K. O. 2017. "Mirror, Mirror on the Wall: A Comparative Evaluation of Composite-Based Structural Equation Modeling Methods," *Journal of the Academy of Marketing Science* (45:5), pp. 616-632.

He, J., Butler, B. S., and King, W. R. 2007. "Team Cognition: Development and Evolution in Software Project Teams," *Journal of Management Information Systems* (24:2), pp. 261-292.

Hedges, L. V., and Hedberg, E. C. 2007. "Intraclass Correlation Values for Planning Group-Randomized Trials in Education," *Educational Evaluation and Policy Analysis* (29:1), pp. 60-87.

Henfridsson, O., Mathiassen, L., and Svahn, F. 2014. "Managing Technological Change in the Digital Age: The Role of Architectural Frames," *Journal of Information Technology* (29:1), pp. 27-43.

Henseler, J., Ringle, C. M., and Sarstedt, M. 2015. "A New Criterion for Assessing Discriminant Validity in Variance-Based Structural Equation Modeling," *Journal of the Academy of Marketing Science* (43:1), pp. 115-135.

House, R. J., Rousseau, D. M., and Thomas-Hunt, M. 1995. "The Meso Paradigm: A Framework for the Integration of Micro and Macro Organizational Behavior," *Research in Organizational Behavior* (17), pp. 71-114.

Hulland, J. 1999. "Use of Partial Least Squares (Pls) in Strategic Management Research: A Review of Four Recent Studies," *Strategic Management Journal* (20:2), pp. 195-204.

James, L. R., Demaree, R. G., and Wolf, G. 1984. "Estimating within-Group Reliability with and without Response Bias," *Journal of Applied Psychology* (69), pp. 85-98.

Jarvenpaa, S. L., and Majchrzak, A. 2008. "Knowledge Collaboration among Professionals Protecting National Security: Role of Transactive Memories in Ego-Centered Knowledge Networks," *Organization Science* (19:2), pp. 260-279.

Jarvenpaa, S. L., Shaw, T. R., and Sandy, S. D. 2004. "Toward Contextualized Theories of Trust: The Role of Trust in Global Virtual Teams," *Information Systems Research* (15:3), pp. 250-267.

Jiang, J. J., and Klein, G. 1999. "Information System Project-Selection Criteria Variations within Strategic Classes," *IEEE Transactions on Engineering Management* (46:2), pp. 171-176.

Johnson, A. M., and Lederer, A. L. 2007. "The Impact of Communication between Ceos and Cios on Their Shared Views of the Current and Future Role of IT," *Information Systems Management* (24:1), pp. 85–90.

Johnson, A. M., and Lederer, A. L. 2010. "CEO/CIO Mutual Understanding, Strategic Alignment, and the Contribution of IS to the Organization," *Information & Management* (47:3), pp. 138–149.

Kant, I. 1788. *Kritik Der Urteilskraft (English: Critique of Practical Reason)*. Stuttgart: Philipp Reclam jun.

Kaplan, B., and Duchon, D. 1988. "Combining Qualitative and Quantitative Methods in Information Systems Research: A Case Study " *MIS Quarterly* (12:4), pp. 571-586.

Karahanna, E., and Preston, D. S. 2013. "The Effect of Social Capital of the Relationship between the CIO and Top Management Team on Firm Performance," *Journal of Management Information Systems* (30:1), pp. 15–56.

Kelly, G. A. 1955. *A Theory of Personality*, (1 ed.). New York, NY: Norton.

Klein, K. J., and Kozlowski, S. W. J. 2000. "From Micro to Meso: Critical Steps in Conceptualizing and Conducting Multilevel Research," *Organizational Research Methods* (3:3), pp. 211-236.

Ko, D.-G., and Dennis, A. R. 2011. "Profiting from Knowledge Management: The Impact of Time and Experience," *Information Systems Research* (22:1), pp. 134-152.

Ko, D.-G., Kirsch, L. J., and King, W. R. 2005. "Antecedents of Knowledge Transfer from Consultants to Clients in Enterprise System Implementation," *MIS Quarterly* (29:1), pp. 59–85.

Kock, N., and Lynn, G. S. 2012. "Lateral Collinearity and Misleading Results in Variance-Based Sem: An Illustration and Recommendations," *Journal of the Association for Information Systems* (13:7), pp. 546-580.

Kotlarsky, J., Van den Hooff, B., and Huysman, M. 2009. "Bridging Knowledge Boundaries in Cross-Functional Groups: The Role of a Transactive Memory System," in: *International Conference on Information Systems*. Phoenix, AZ, USA.

Kudaravalli, S., Faraj, S., and Johnson, S. L. 2017. "A Configural Approach to Coordinating Expertise in Software Development Teams " *MIS Quarterly* (41:1), pp. 43-64.

Lawrence, P. R., and Lorsch, J. W. 1967. *Organization and Environment: Managing Differentiation and Integration. : Harvard University*. Boston, Massachusetts: Harvard University Press.

Lee, A. S., and Baskerville, R. L. 2003. "Generalizing Generalizability in Information Systems Research," *Information Systems Research* (14:3), pp. 221-243.

Lee, G., and Xia, W. 2010. "Toward Agile: An Integrated Analysis of Quantitative and Qualitative Field Data," *MIS Quarterly* (34:1), pp. 87-114.

Leidner, D. E., Lo, J., and Gonzalez, E. 2010. "An Empirical Investigation of IT Strategy and IS Contribution to Firm Performance," *International Conference on Information Systems*, St. Louis, USA.

Levesque, L. L., Wilson, J. M., and Wholey, D. R. 2001. "Cognitive Divergence and Shared Mental Models in Software Development Project Teams," *Journal of Organizational Behavior* (22:1), pp. 135-144.

Liao, H., and Chuang, A. 2004. "A Multilevel Investigation of Factors Influencing Employee Service Performance and Customer Outcomes," *Academy of Management Journal* (47:1), pp. 41-58.

Lindell, M. K., and Whitney, D. J. 2001. "Accounting for Common Method Variance in Cross-Sectional Research Designs," *Journal of Applied Psychology* (86:1), pp. 114-121.

Lüders, P., Jentsch, C., and Beimborn, D. 2015. "Measuring Outsourcing Relationship Quality: Towards a Social Network Analysis Approach," *Americas Conference on Information Systems*, Savannah (GA), USA.

Mani, D., Barua, A., and Whinston, A. 2010. "An Empirical Analysis of the Impact of Information Capabilities Design on Business Process Outsourcing Performance," *MIS Quarterly* (34:1), pp. 39-62.

Marks, M. A., Zaccaro, S. J., and Mathieu, J. E. 2000. "Performance Implications of Leader Briefings and Team-Interaction Training for Team Adaptation to Novel Environments," *Journal of Applied Psychology* (85:6), pp. 971-986.

Marshall, N., and Brady, T. 2001. "Knowledge Management and the Politics of Knowledge: Illustrations from Complex Products and Systems," *European Journal of Information Systems* (10:2), pp. 99–112.

Maruping, L. M., and Magni, M. 2015. "Motivating Employees to Explore Collaboration Technology in Team Contexts," *MIS Quarterly* (39:1), pp. 1-16.

Maruping, L. M., Venkatesh, V., and Agarwal, R. 2009. "A Control Theory Perspective on Agile Methodology Use and Changing User Requirements," *Information Systems Research* (20:3), pp. 377-399.

Mathiassen, L., Saarinen, T., Tuunanen, T., and Rossi, M. 2007. "A Contingency Model for Requirements Development," *Journal of the Association for Information Systems* (8:11), pp. 569-597.

Mathieu, J. E., Heffner, T. S., Goodwin, G. F., Salas, E., and Cannon-Bowers, J. A. 2000. "The Influence of Shared Mental Models on Team Process and Performance," *Journal of Applied Psychology* (85:2), pp. 273–283.

Miles, M. B., and Huberman, A. M. 1994. *Qualitative Data Analysis: An Expanded Sourcebook*, (2 ed.). Sage Publications, Inc.

Miller, G. A. 1956. "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," *Psychological Review* (63:2), pp. 81-97.

Mingers, J. 2001. "Combining IS Research Methods: Towards a Pluralist Methodology," *Information Systems Research* (12:3), pp. 240-259.

Mingers, J. 2004. "Real-izing Information Systems: Critical Realism as an Underpinning Philosophy for Information Systems," *Information and Organization* (14:2), pp. 87-103.

Mohammed, S., Ferzandi, L., and Hamilton, K. 2010. "Metaphor No More: A 15-Year Review of the Team Mental Model Construct," *Journal of Management* (36:4), pp. 876-910.

Nahapiet, J., and Ghoshal, S. 1998. "Social Capital, Intellctual Capital, and the Organizational Advantage," *Academy of Management Review* (23:2), pp. 242–266.

Nelson, K. M., and Cooprider, J. G. 1996. "The Contribution of Shared Knowledge to IS Group Performance," *MIS Quarterly* (20:4), pp. 409–432.

Oertel, R., and Antoni, C. H. 2015. "Phase-Specific Relationships between Team Learning Processes and Transactive Memory Development," *European Journal of Work an d Organizational Psychology* (24:5), pp. 726-741.

Okhuysen, G. A., and Eisenhardt, K. M. 2002. "Integrating Knowledge in Groups: How Formal Interventions Enable Flexibility," *Organization Science* (13:4), pp. 370-386.

Olson, E. M., Walker, O. C. J., and Ruekert, R. W. 1995. "Organizing for Effective New Product Development: The Moderating Role of Productinnovativeness," *Journal of Marketing* (59:1), pp. 48-62.

Paré, G., Tate, M., Johnstone, D., and Kitsiou, S. 2016. "Contextualizing the Twin Concepts of Systematicity and Transparency in Information Systems Literature Reviews," *European Journal of Information Systems* (25:6), pp. 493-508.

Petter, S. 2018. ""Haters Gonna Hate": PLS and Information Systems Research," *The DATABASE for Advances in Information Systems* (49:1), pp. 10-13.

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., and Podsakoff, N. P. 2003. "Common Method Biases in Behavioral Research: A Critical Review and Recommended Remedies," *Journal of Applied Psychology* (83:5), pp. 879-903.

Preston, D. S., and Karahanna, E. 2009. "Antecedents of IS Strategic Alignment: A Nomological Network," *Information Systems Research* (20:2), pp. 159–179.

Pugh, D. S., Hickson, D. J., Hinings, C. R., and Turner, C. 1969. "The Context of Organization Structures," *Administrative Science Quarterly* (14:1), pp. 91-114.

Rai, A., Maruping, L. M., and Venkatesh, V. 2009. "Offshore Information Systems Projekt Success: The Role of Social Embeddedness and Cultural Characteristics," *MIS Quarterly* (33:3), pp. 617–641.

Raudenbush, S. W., and Bryk, A. S. 2006. *Hierarchical Linear Models: Applications and Data Analysis Methods*, (2nd ed.). London: Sage Publications.

Ray, G., Muhanna, W. A., and Barney, J. B. 2005. "Information Technology and the Performance of the Customer Service Process: A Resource-Based Analysis," *MIS Quarterly* (29:4), pp. 625–652.

Reich, B. H., and Benbasat, I. 2000. "Factors That Influence the Social Dimension of Alignment between Business and Information Technology Objectives," *MIS Quarterly* (24:1), pp. 81–113.

Reitz, A., Jentsch, C., and Beimborn, D. 2018. "How to Decompress the Pressure – the Moderating Effect of IT Flexibility on the Negative Impact of Governmental Pressure on Business Agility," *Hawaii International Conference on System Sciences*, Big Island, Hawaii.

Resick, C. J., Murase, T., Randall, K. R., and DeChurch, L. A. 2014. "Information Elaboration and Team Performance: Examining the Psychological Origins and Environmental Contingencies," *Organizational Behavior and Human Decision Processes* (124:2), pp. 165-176.

Ringle, C. M., Wende, S., and Becker, J-M. 2015. SmartPLS 3. Bönningstedt: SmartPLS. Retrieved from http://www.smartpls.com.

Robert, L. P., Dennis, A. R., and Ahuja, M. K. 2008. "Social Capital and Knowledge Integration in Digitally Enabled Teams," *Information Systems Research* (19:3), pp. 314–334.

Roberts, T. L., Cheney, P. H., Sweeney, P. D., and Hightower, R. T. 2004. "The Effects of Information Technology Project Complexity on Group Interaction," *Journal of Management Information Systems* (21:3), pp. 223-247.

Rosenkranz, C., Charaf, M. C., and Holten, R. 2013. "Language Quality in Requirements Development: Tracing Communication in the Process of Information Systems Development," *Journal of Information Technology*).

Rosenkranz, C., Vranesic, H., and Holten, R. 2014. "Boundary Interactions and Motors of Change in Requirements Elicitation," *Journal of the Association for Information Systems* (15:6), pp. 306-345.

Rowe, F. 2014. "What Literature Review Is Not: Diversity, Boundaries and Recommendations," *European Journal of Information Systems* (23), pp. 241-255.

Samaha, S. A., Palmatier, R. W., and Dant, R. P. 2011. "Poisoning Relationships: Perceived Unfairness in Channels of Distribution," *Journal of Marketing* (75), pp. 99-117.
Sasidharan, S., Santhanam, R., Brass, D. J., and Sambamurthy, V. 2012. "The Effects of Social Network Structure on Enterprise Systems Success: A Longitudinal Multilevel Analysis," *Information Systems Research* (23:3), pp. 658-678.
Schlosser, F., Beimborn, D., Weitzel, T., and Wagner, H.-T. 2015. "Achieving Social Alignment between Business and IT – an Empirical Evaluation of the Efficacy of IT Governance Mechanisms," *Journal of Information Technology* (30:2), pp. 119-135.
Schmidt, C., T., Kude, T., Heinzl, A., and Mithas, S. 2014. "Software Development Teams: The Role of Shared Mental Models and Backup," *International Conference on Information Systems*. Auckland.
Schwarz, A., Mehta, M., Johnson, N. A., and Chin, W. W. 2006. "Understanding Frameworks and Reviews: A Commentary to Assist Us in Moving Our Field Forward by Analyzing Our Past," *The DATABASE for Advances in Information Systems* (38:3), pp. 29-50.
Shieh, G. 2016. "Choosing the Best Index for the Average Score Intraclass Correlation Coefficient," *Behavior Research Methods* (48:3), pp. 994-1003.
Smith-Jentsch, K. A., Mathieu, J. E., and Kraiger, K. 2005. "Investigating Linear and Interactive Effects of Shared Mental Models on Safety and Efficiency in a Field Setting," *Journal of Applied Psychology* (90:3), pp. 523-535.
Smith, H. A., and McKeen, J. D. 2010. "Developments in Practice Xxxvi: How to Talk So Business Will Listen … and Listen So Business Will Talk," *Communications of AIS* (27), pp. 207–216.
Snijders, T., and Bosker, R., J. 2012. *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling* (2 ed.). Los Angeles: Sage.
Straub, D., Boudreau, M.-C., and Gefen, D. 2004. "Validation Guidelines for IS Positivist Research," *Communication of the Association for Information Systems* (13), pp. 380–427.
Subramani, M. R., Henderson, J. C., and Cooprider, J. G. 1999. "Linking IS-User Partnerships to IS Performance: A Socio-Cognitive Perspective," *MISRC Working Paper WP99-01*).
Tallon, P. P. 2013. "Do You See What I See? The Search for Consensus among Executives' Perceptions of IT Business Value," *European Journal of Information Systems*).
Tan, F. B., and Gallupe, R. B. 2006. "Aligning Business and Information Systems Thinking: A Cognitive Approach," *IEEE Transactions on Engineering Management* (53:2), pp. 223–237.
Tan, F. B., and Hunter, M. G. 2002. "The Repertory Grid Technique: A Method for the Study of Cognition in Information Systems," *MIS Quarterly* (26:1), pp. 39–57.
Thomas, G., and Fernández, W. 2008. "Success in IT Projects: A Matter of Definition?," *International Journal of Project Management* (26), pp. 733-742.
Tiwana, A. 2012. "Novelty-Knowledge Alignment: A Theory of Design Convergence in Systems Development," *Journal of Management Information Systems* (29:1), pp. 15–52.
Tiwana, A., Bharadwaj, A., and Sambamurthy, V. 2003. "The Antecedents of Information Systems Development Capability in Firms: A Knowledge Integration Perspective," *International Conference on Information Systems*, Seattle, Washington, USA.
Tsang, E. W. K. 2014. "Case Studies and Generalization in Information Systems Research: A Critical Realist Perspective.," *The Journal of Strategic Information Systems* (23:2), pp. 174-186.
van den Hooff, B., and de Winter, M. 2011. "Us and Them: A Social Capital Perspective on the Relationship between the Business and IT Departments," *European Journal of Information Systems* (20:3), pp. 255–266.
van der Haar, S., Li, J., Segers, M., Jehn, K. A., and Van den Bossche, P. 2015. "Evolving Team Cognition: The Impact of Team Situation Models on Team Effectiveness," *European Journal of Work and Organizational Psychology* (24:4), pp. 596-610.
van Deth, J. W. 2003. "Measuring Social Capital: Orthodoxies and Continuing Controversies," *International Journal of Social Research Methodology* (6:1), pp. 79-92.
Venkatesh, V., Brown, S., and Bala, H. 2013. "Bridging the Qualitative-Quantitative Divide: Guidelines for Conducting Mixed Methods Research in Information Systems" *MIS Quarterly* (37:1), pp. 21-54.
Vermerris, A., Mocker, M., and Heck, E. v. 2014. "No Time to Waste: The Role of Timing and Complementarity of Alignment Practices in Creating Business Value in IT Projects," *European Journal of Information Systems* (23:6), pp. 629-654.
Vlaar, P. W. L., van Fenema, P. C., and Tiwari, V. 2008. "Cocreating Understanding and Value in Distributed Work: How Members of Onsite and Offshore Vendor Teams Give, Make, Demand, and Break Sense," *MIS Quarterly* (32:2), pp. 227–255.

Voorhees, C. M., Brady, M. K., Calantone, R. J., and Ramirez, E. 2016. "Discriminant Validity Testing in Marketing: An Analysis, Causes for Concern, and Proposed Remedies," *Journal of the Academy of Marketing Science* (11:1), pp. 119-134.

Wagner, H.-T., Beimborn, D., and Weitzel, T. 2014. "How Social Capital among IT and Business Units Drives Operational Alignment and IT Business Value," *Journal of Management Information Systems* (31:1), pp. 241-272.

Wagner, H.-T., and Weitzel, T. 2012. "How to Achieve Operational Business-IT Alignment: Insights from a Global Aerospace Firm," *MIS Quarterly Executive* (11:1), pp. 25–36.

Waller, M. J., Gupta, N., and Giambatista, R. C. 2004. "Effects of Adaptive Behaviors and Shared Mental Models on Control Crew Performance," *Management Science* (50:11), pp. 1534-1544.

Webster, J., and Watson, R. T. 2002. "Analyzing the Past to Prepare for the Future: Writing a Literature Review," *MIS Quarterly* (26:2), pp. 13–23.

Wegner, D. M. 1987. "Transactive Memory: A Contemporary Analysis of the Group Mind," in *Theories of Group Behavior,* B. Mullen and G.R. Goethals (eds.). New York, NY: Spinger, pp. 185-208.

Weick, K. E. 2005. "Managing the Unexpected: Complexity as Distributed Sensemaking," in *Uncertainty and Surprise in Complex Systems: Questions on Working with the Unexpected,* R.R. McDaniel and D. Driebe (eds.). Heidelberg: Springer Berlin, pp. 51-66.

Windeler, J., Maruping, L. M., Robert, L. P., and Riemenschneider, C. K. 2015. "E-Profiles, Conflict, and Shared Understanding in Distributed Teams," *Journal of the Association for Information Systems* (16:7), pp. 608-645.

Woodward, J. 1965. *Industrial Organization: Theory and Practice*. Oxford, UK: Oxford University Press.

Yang, H.-D., Kang, H.-R., and Mason, R. M. 2008. "An Exploratory Study on Meta Skills in Software Development Teams: Antecedent Cooperation Skills and Personality for Shared Mental Models," *European Journal of Information Systems* (17:1), pp. 47–61.

Yin, R. K. 2014. *Case Study Research: Design and Methods*, (5 ed.). SAGE Publications.

Zelt, S., Wulf, J., Neff, A., A., Übernickel, F., and Brenner, W. 2014. "Succeeding in Application Service Outsourcing Strategies - a Contingency Perspective," *European Conference on Information Systems*, Tel Aviv, Israel.

Zhang, X. 2017. "Knowledge Management System Use and Job Performance: A Multilevel Contingency Model," *MIS Quarterly* (41:3), pp. 811-840.

CHAPTER 1

FOUNDATION OF B/IT-SU

Paper I

Shared Understanding among Business and IT - a Literature Review and Research Agenda

Christian Jentsch
University of Bamberg

Daniel Beimborn
Frankfurt School of Finance & Management

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PAPER II

WHAT MATTERS IN BUSINESS/IT SHARED UNDERSTANDING? DEVELOPMENT OF A UNIFIED CONSTRUCT

Christian Jentsch
Department of Information Systems and Services
University of Bamberg
christian.jentsch@uni-bamberg.de

Daniel Beimborn
Frankfurt School of Finance & Management
d.beimborn@fs.de

In: Proceedings of the 22nd European Conference on Information Systems (ECIS 2014), Tel Aviv, Israel.

The final publication is available at:
http://aisel.aisnet.org/ecis2014/proceedings/track15/17

Appendix
Paper II

PAPER III

HOW TO MEASURE SHARED UNDERSTANDING AMONG BUSINESS AND IT

Christian Jentsch

University of Bamberg

Daniel Beimborn

Frankfurt School of Finance & Management

Christoph Jungnickl,

University of Bamberg

Georg Sebastian Renner

University of Bamberg

In: Best Paper Proceedings of the 2014 Academy of Management Meeting (AOM 2014), Philadelphia (PA) USA.

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CHAPTER 2

CONTEXTUAL FORMATION OF B/IT-SU

Appendix
Chapter 2

PAPER IV

FROM STRATEGIC TO OPERATIONAL COLLABORATIONS: THE DIVERGENT NATURE OF BUSINESS/IT SHARED UNDERSTANDING

Christian Jentsch
University of Bamberg

Frank Schlosser
University of Bamberg

Daniel Beimborn
Frankfurt School of Finance & Management

In: Proceedings of the 20th Americas Conference on Information Systems (AMCIS 2014), Savannah (GA), USA

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PAPER V

IT IS ALL ABOUT THE GAME - AN EXPLORATORY STUDY ON THE IMPACT OF TASK CHARACTERISTICS ON THE DIMENSIONS OF BUSINESS/IT SHARED UNDERSTANDING

Christian Jentsch

University of Bamberg

Daniel Beimborn

Frankfurt School of Finance & Management

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PAPER VI

TEMPLATES FOR JOINED WORK SYSTEMS – THE ROLE OF SHARED KNOWLEDGE BETWEEN BUSINESS AND IT UNITS IN A MODULAR ENVIRONMENT

Christian Jentsch

University of Bamberg

Daniel Beimborn

Frankfurt School of Finance & Management

Andreas Reitz

Frankfurt School of Finance & Management

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TEMPLATES FOR JOINED WORK SYSTEMS – THE ROLE OF SHARED KNOWLEDGE BETWEEN BUSINESS AND IT UNITS IN A MODULAR ENVIRONMENT

ABSTRACT

In this study, we focus on the differing effects of business process modularity and IT flexibility on shared business knowledge among business and IT professionals. We combine two theoretical lenses to describe this linkage: we apply template theory to explain the sense-making process and work system theory to consider different perspectives on a business system. Based on 171 survey responses, we find that modularity does not enable shared business knowledge between business and IT professionals per se. Rather, a strong match between functional and technical aspects is critical. We investigate the differentiated effects of architecture management on shared business knowledge to gain a richer understanding of the antecedents of shared business knowledge, which can help practitioners improve business-IT communication processes.

Keywords: shared business knowledge; modularity; template theory; work system theory

INTRODUCTION

To stay flexible and competitive in rapidly changing markets, more and more firms are currently restructuring their business organization, and the concept of modularity is undergoing a revival – this time not only in IT, but also in the business organization. A modular business organization structure and an aligned IT infrastructure promises to provide the ideal foundation for rapid change because modules can be quickly exchanged or updated without changing the whole business structure (Henfridsson et al. 2014). Studies indicate that an important driver for business operational and strategic flexibility is a match of the modular structures between different organizational units (Malhotra et al. 2005). Karim (2006) found that a modular business environment is able to "make organizations more flexible, creative, and dynamic by providing more modular pieces to experiment with" (p. 821) while Tiwana and Konsynski (2010) present evidence of the positive effect of IT modularity to address changing business needs. Empirical studies like these postulate a direct effect of the degree of modularity on change effectiveness.

Building on that idea, research frequently states that modularity of a respective business or IT system reduces the level of complexity of the system, which has many implications for team collaboration. For example, Grand et al. (2016) conclude that knowledge sharing in a team loses importance when collaborative tasks are clearly described and formulated as it is the case in modular environments. Resick et al. (2014) even warn that putting too much effort into knowledge sharing in a modular environment "may even impede progress or decision-making efficiencies for some teams" (p. 173). Similarly, Mani et al. (2010) argue that a high level of information sharing in a modular system leads to low performance and resource overkill. This research stream argues that modularity decreases the relevance of shared knowledge in a collaboration between business and IT.

In contrast, another research stream indicates that shared knowledge does *not* become irrelevant in general (e.g. Dennis et al. 2008; Tiwana 2012). This research stream directly contradicts research supporting the irrelevance of shared knowledge in low-complexity environments by arguing that it is not the relevance of shared knowledge in general which changes, but rather the content in which shared knowledge should be implemented. For example, Tiwana (2012) finds that low complexity of joint processes with high complexity of business objectives requires a high level of shared business knowledge, but low complexity of joint business objectives with high process complexity requires a high level of shared technical knowledge. Studies like these indicate the importance of enriching the discussion of shared knowledge by including different dimensions of shared knowledge in various situational contexts.

To shed further light on these competing discussions, we pose the following research question:

How does modularity influence shared knowledge between business and IT units?

To answer this question, we combine two theoretical lenses – template theory and work system theory. Together with the concepts of modularity and shared business knowledge between business and IT, these two theories are introduced in the following chapter. Afterwards, we use these theories to derive our research model, which we then test using data collected in a survey-based study conducted in the banking industry. Finally, we discuss the results, the limitations of our study, and the theoretical and practical implications of our research.

THEORETICAL BACKGROUND

MODULARITY

Modularity is a well-known concept from general systems theory (Schilling 2000). Basically, it describes the decomposition of a complex system into separated loosely coupled constructs called subsystems or modules, which may themselves consist of smaller and smaller subsystems or modules until they are no longer decomposable (Simon 1962). The connections between the modules, called interfaces, enable the modules to function like a black box, revealing as little information as necessary to work together (Parnas 1972). Through this loose coupling, changes to one module have only little or no impact on other modules (Fowler 2001; Nambisan 2002). Thus, the function of a module can be understood without the need to understand its sub-modules. The quality of the interfaces determines the level of independence among the modules, i.e. how tightly or loosely they are coupled (Schilling 2000). Based on these theoretical principles, different strands of modularity research have evolved. The oldest strand of modularity research emerged in product design, where modularity has been found to influence, among others, sourcing decisions (Ernst and Kamrad 2000; Momme et al. 2000; Schilling 2000), effectiveness of R&D of physical products (Takeishi 2002), the alignment of modularized product manufacturing as well as the modularized product itself (Henfridsson et al. 2014; Hoetker 2006; Langlois 2002) and production efficiency (Baldwin and Clark 2000).

However, modularity is not limited to physical products. Basically, everything can be designed in a modular way, including processes and organizations. In an enterprise, business processes (e.g. credit evaluation and approval) and supporting IT systems (in the following in their entirety called 'IT infrastructure') are organized as different, interconnected layers. The IT systems layer supports or executes different parts of the business processes (Brown and Karamouzis 2001). The following paragraphs discusses how business processes and IT infrastructure can be organized in a modular way.

Business processes are structured tasks that help a business achieve a business outcome (Davenport and Short 1990). When such processes are split into sub-processes (Basu and Blanning 2003), these can be considered modular if they are loosely coupled and only interact through interfaces (Tiwana and Konsynski 2010). Furthermore, overall business processes can be modular in relation to other business processes (Tanriverdi et al. 2007). This means that instead of the single steps of a process, the processes themselves are loosely coupled (Sanchez and Mahoney 1996). A modular process or sub-process encapsulates all the information required and conceals it from other modules, revealing only the necessities through its interfaces. It is therefore self-contained (Tanriverdi et al. 2007) and behaves like a black box (Parnas 1972). Modularizing business processes has many potential benefits. Based on clearly defined interfaces between modules, modularization allows modules to be benchmarked and supports standardization (Langlois 2002). A modular process or sub-process can also be easily replaced by another (sub-)process without altering the remaining process or processes, as long as it has compatible interfaces.

Many elements of this modular architecture concept can be applied to the technical layer that supports the business processes, i.e. IT infrastructure, which includes business applications and other required components such as middleware and additional supporting technologies (Byrd and Turner 2000). IT infrastructure modularity can be described as the "degree of decomposition of an organization's IT portfolio into loosely coupled subsystems that communicate through standardized interfaces" (Tiwana and Konsynski 2010, p. 290). Close alignment between IT infrastructure and business process is needed to ensure that a modular IT infrastructure is able to support corresponding business processes. Furthermore, research into IT integration indicates that IT infrastructure can only optimally support business processes if IT systems are integrated into business processes and work together seamlessly (Byrd and Turner 2000). Taken together, IT modularity and IT integration have been described as complementary facets of IT flexibility (Byrd and Turner 2000).

IT flexibility is the ability of something to be easily modified – e.g. the alignment of the IT system and the business process. Duncan (1995) defines IT flexibility as "the ability of the IS department to respond quickly and cost-effectively to systems demands, which evolve with changes in business practices or strategies" (p. 4). Based on Duncan's work, Byrd and Turner (2000) conceptualized technical IT infrastructure flexibility, which we adopt in this paper, focusing on two key characteristics: IT integration and IT modularity. We define IT infrastructure flexibility as the arrangement of software applications and the linkages between them and their corresponding subsystems. Integration means that "different components can be connected and are able to exchange information" (Joachim et al. 2011, p. 4), while modularity is the "degree of decomposition of an organization's IT portfolio into loosely coupled subsystems that communicate through standardized interfaces" (Tiwana and Konsynski 2010, p. 290). The modules of the IT architecture support business processes but are not the same as these business processes.

SHARED BUSINESS KNOWLEDGE BETWEEN BUSINESS AND IT

Shared business knowledge (SBK) plays a crucial role in many different strands of information systems research. Some examples are business/IT alignment research, in which SBK represents a key factor in enabling social alignment between business and IT (e.g. Reich and Benbasat 2000; Tan and Gallupe 2006; Vermerris et al. 2014), or IS development research, which identifies SBK as a critical factor in requirements engineering (e.g. Charaf et al. 2013; van den Hooff and de Winter 2011; Yang et al. 2008) and system implementation (e.g. Davis et al. 2009).

In many research fields, SBK between business and IT units has been found to be a crucial success factor. It enables strategic alignment (Johnson and Lederer 2010; Preston and Karahanna 2009) as well as operational alignment (Vermerris et al. 2014; Wagner et al. 2014), it improves performance in globally distributed teams (Vlaar et al. 2008) and optimizes the process of requirements elicitation in IS development projects (Yang et al. 2008). Thus, there is no doubt as to the importance of SBK between business and IT professionals in companies. However, previous research identifies the need for a clear definition of SBK, its dimensions and related concepts (e.g. Bittner and Leimeister 2014). Conceptualizations of SBK are tightly linked to the respective research stream in which they are embedded (Jentsch and Beimborn 2016). Thus, for example, SBK in business/IT alignment research mainly focuses on the shared business knowledge of business and IT objectives or strategies (Reich and Benbasat 2000) and the role of IT in the firm (Johnson and Lederer 2010; Preston and Karahanna 2009). Research into operational fit in IT projects, in contrast, analyzes SBK at the level of the business (and IT) processes (Davis et al. 2009; Ray et al. 2005; Wagner et al. 2014) or linguistics (Charaf et al. 2013; van den Hooff and de Winter 2011).

Using the work system theory to conceptualize shared business knowledge

To overcome such context-based conceptualizations, we take a more theoretical approach by determining the dimensions of SBK through the lens of the work system theory developed by Alter (1999) to describe the different perspectives of an organizational system. Alter proposes viewing an organization as a set of work systems containing artifacts that can be aligned in a comprehensive work system framework. Basically, this theory differentiates between artefacts which are inside the work system and those which are outside the work system. The work system itself consists of *processes and activities* among *participants* to perform a task using *information* and *technologies*. These artefacts are inside the work system because they are necessary conditions to complete the underlying task. Artefacts outside the work system include *environment*, *infrastructure* and *strategies*. Depending on the context of the respective work system, the artefacts *products/services* and *customer* can be either inside or outside the work system. In research on shared business knowledge, we find many parallels between the conceptualization of SBK and the artefacts of the work system theory. Artefacts inside a work system (like processes, activities or technologies) have been conceptualized as work environment related problems, tasks and roles (Nelson and Cooprider 1996) or business processes (Wagner et al. 2014, p. 268). Artefacts outside the work system have been discussed as IT and business strategy (Chan et al. 2006), strategic business plans (Cohen and Toleman 2006) or a “firm’s present and future products, markets, business strategies, and business” (Preston and Karahanna 2009, p. 176).

The linkage between conceptualizations of shared knowledge and the work system framework is highlighted in Figure 1.

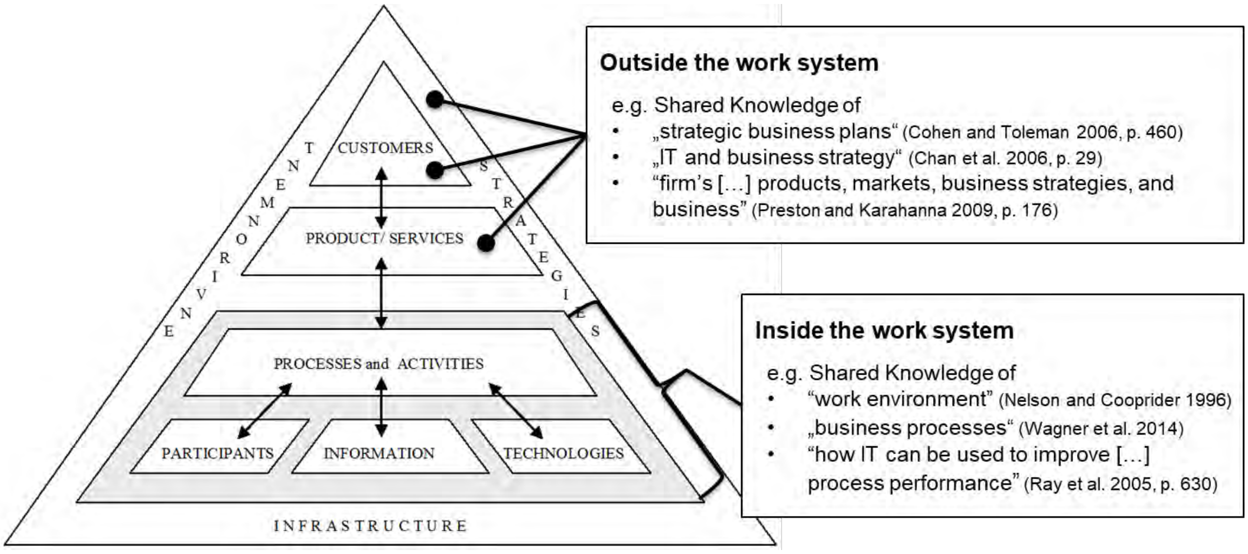

Figure 1. Relationship between shared knowledge concept and work system framework

In this paper, we thus conceptualize SBK as a two-dimensional framework, differentiating between elements which are inside the work system – such as shared knowledge of business processes and activities – and elements that are outside the work system – such as business strategies.

Template theory

Another theoretical lens for our research on the mechanisms of SBK is the template theory introduced by Gobet and Simon (1996)), which has its foundations in epistemological discourse. Following Kant (1788)), the epistemological discussion changed from the objective formation of the world to the individuals' perceptions of their social surrounding, arguing that humans interpret the same objects differently. This individual 'world view' consists of "...beliefs and assumptions by which an individual makes sense of experiences that are hidden deep within the language and traditions of the surrounding society" (Clark 2002, p. 5). Kelly (1955)) states in the theory of personal construct that every individual tries to make sense of his or her social surroundings through a personal construct, which can be interpreted as a filter system used to categorize and combine information. This idea has been expanded in other theories like the template theory (Gobet and Simon 1996), which argues that individuals possess several cognitive 'templates' to recognize different patterns in their environment.

The template theory has originally been developed as an extension of the chunking theory introduced by Miller (1956). Chunking refers to the process of (cognitive) information sorting, where a chunk is a bundle of information. The chunking theory (as well as the template theory) is often researched in the context of chess (e.g. Freyhoff 1992; Holding 1992). For someone learning how to play chess, every figure is a chunk or bundle of information. The information includes aspects like the starting position and possible movements of each figure. When the players become better in chess, they start thinking in a series of movements – like Castling or the King's Gambit. This bundling of information process is called chunking. As a player's skill develops, the smallest bundle of information changes from single figures to a series of movements of several figures.

By employing this idea, the template theory argues that individuals are able to cluster chunks into larger frameworks, which are the cognitive templates. The advanced chess player, for example, will recognizes different possible scenarios and strategies depending on the positions of the chess figures. This is because the player has stored many different templates of chess scenarios. The player perceives the positions of the figures and tries to interpret the situation by applying a stored template. In a business context, an executive team may try to find the perfect positioning between different business units to address challenges presented by the digital age (Malhotra et al. 2005). Every executive already has a set of cognitive templates, of how the business units could be structured – like line, matrix, team organizations and so forth. Based on these cognitive templates the executives will decide which organizational structure they believe will best support a successful digital strategy.

By combining template theory and work system theory, we define SBK between business and IT units as the intersection of cognitive templates between business and IT professionals along operational and strategic dimensions. In doing so, we distinguish dimensions which are inside the work systems (like work environment or business processes) and dimensions which are outside the work system (like business strategy or plans).

RESEARCH MODEL

This research aims to determine whether and to what degree business process modularity and IT flexibility combined with IT modularity and IT integration support SBK between business and IT units and thus contribute to IT's ability to adjusting quickly to changing business needs. We thereby challenge prior research outlined in the introduction finding that shared knowledge's relevance to performance in the business/IT collaboration will decrease and might even be a threat in a modularized environment (e.g. Mani et al. 2010; Resick et al. 2014). Figure visualizes the research model developed in the following section. As stated before, we differ between SBK of business processes (SBK inside the work system) and SBK of business strategies (SBK outside the work system). Our antecedents include business process modularity and IT flexibility as a second-order construct consisting of IT modularity and integration of the different components of the IT infrastructure.

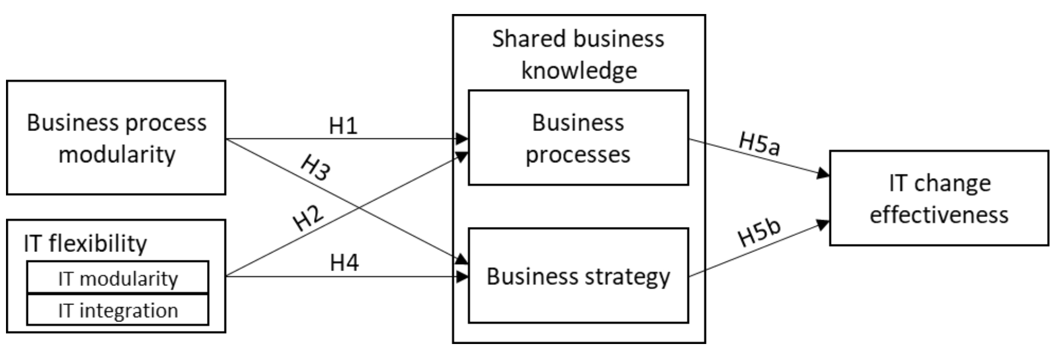

Figure 2. Research framework

Our definition of business process modularity draws on Tanriverdi et al. (2007): "the extent to which a business process is loosely coupled, mature, and standardized enough to be separated from a firm's other business processes, executed independently, and recombined without loss of functionality" (p. 283). Research shows that business process modularity increases structure of and between processes and uncovers redundancies and inefficiencies (Basu and Blanning 2003). Especially in research on IT projects, scholars generally agree that “well-designed modules and interfaces benefit team coordination by economizing on the need to communicate and the need to develop a deep, shared common ground” (Kudaravalli et al. 2017, p. 48). Mani et al. (2010) argue that modular structured business processes enable knowledge transfer between individuals because information that needs to be processed has likewise become modular. This enables structured ‘piece-by-piece’ information processing. Based on these ideas of modularity, we argue that reduced complexity and the potential of piece-by-piece information processing facilitate the development of individuals’ understanding of the business process.

In our research domain, the involved individuals are members of the business or IT unit. While the main work domain of business professionals is the business process itself, IT professionals interpret the business process through the lens of the IT infrastructure. We argue that IT professionals possess a larger set of templates in the IT domain than in the business domain, which they are less familiar with. Nevertheless, since modularity is a very common approach in the IT domain – e.g. in software engineering (Booch et al. 2007; Booch et al. 2005) or related to IT architecture (Joachim et al. 2013) – many IT professionals are experienced with the concepts of modularity and may therefore find it easier to understand the business side if their processes are organized in a modular way. Thus, our first hypothesis is:

Hypothesis 1: Modular business processes lead to a higher level of shared knowledge of business processes between business and IT professionals.

As discussed above, we posit that an IT module can only realize its full potential when it is integrated within a larger enterprise architecture. This combination of modularity and integration enables a flexible IT infrastructure (Byrd and Turner 2000; Chanopas et al. 2006). In combining IT’s experience with modularity and IT infrastructure flexibility, we argue that an IT architecture which flexibly supports the modular structure of the firm’s business processes especially facilitates business understanding among IT professionals. Malhotra et al. (2005) found that modular structures of two or more collaborating organizations enable the exchange of knowledge and improved joint operational performance. Likewise, by enabling knowledge exchange within business/IT collaboration, IT professionals gain a better understanding of the business process while aligning the IT architecture with the business process. This, in turn, contributes to greater SBK of the business process between business and IT professionals. This assumption is supported by previous studies showing that individuals working together in a team achieve a higher level of shared business knowledge when their environment is organized in a modular structure (Kudaravalli et al. 2017). Thus, we hypothesize:

Hypothesis 2: IT flexibility in terms of IT modularity and IT integration leads to a higher level of shared knowledge of business processes among business and IT professionals.

The possibility of hierarchical encapsulation of modules enables a ’scrolling’ through different levels of abstraction. Thus, an object can be composed of different modules while the same object can be a module itself in a larger system. By transferring this idea of modularity to the creation of knowledge explained by the template theory, we argue that individuals draw on several multiple cognitive templates to interpret the environment. Depending on the perceived (set of) modules in the environment, the individual will apply different templates to interpret them. That enables a *cognitive* hierarchical scrolling through different abstraction levels, as described in the concept of modularity. Our argument is supported by Henfridsson et al. (2014), who describe the different levels of abstraction as patterns (or modules) that are combined to form a network of patterns, which can be flexibly adjusted to a changing environment. Thus, an individual will use different hierarchical templates to abstract general understanding about a business system (network of patterns) from a concrete step in a business process (pattern). We argue that individuals experienced in abstracting perceptions of single work systems (inside the work system) to a larger network of work systems are able to interpret the strategy of the network of business systems (outside the work system). Initial evidence for this assumption has been provided by Malhotra et al. (2005), who found that modular business processes across different units enable strategic knowledge exchange among the collaboration partners. Based on this finding, we argue that structuring single business elements modularly improves the understanding of the intent (or strategy) of a larger business system. We state the third hypothesis as followed:

Hypothesis 3: Modular business processes lead to a higher level of shared knowledge of business strategies among business and IT professionals.

Similar to our argumentation for Hypothesis 2, we argue that the IT professionals interpret business processes through the lens of the IT architecture. Thus, if the IT architecture – which is an integrated system of IT modules – flexibly supports the system of business processes, the IT personnel will develop an understanding of the strategic intent of the business much faster than in an environment with a non-modular (i.e., monolithic or spaghetti-like interwoven) IT architecture.

Hypothesis 4: IT flexibility in terms of IT modularity and IT integration leads to a higher level of shared knowledge regarding the business strategies among business and IT professionals.

Of course, SBK among business and IT professionals is not an end to itself. Earlier research indicates that SBK of business processes and strategy among business and IT professionals improves IT performance. For example, Ray et al. (2005) found that SBK of business processes mediates the positive effects of IT spending on process performance. Other research focusing on the strategic alignment between business and IT argues that SBK about the business strategies helps the IT unit to deploy appropriate IT architecture to support the realization of these strategies (Chan et al. 2006; Cohen and Toleman 2006; Preston and Karahanna 2009). Thus, it is not the (flexible) IT architecture itself which helps improve strategic IT performance, but rather IT's understanding of how to leverage and improve this flexible IT architecture to optimally support the work and processes of the business unit.

More specifically, research found that a high level of business/IT shared knowledge, enables the IT unit to react quickly and flexibly in addressing upcoming business needs (Tiwana et al. 2003; Vermerris et al. 2014; Wagner et al. 2014). An optimal IT infrastructure is designed to support organizational knowledge creation, which, in turn, results in an increased organizational agility to stay competitive in changing markets (Queiroz et al. 2018). Similarly, Chen et al. (2014) found strong alignment of an IT infrastructure to the business environment significantly impacts the level of business process agility, in terms of change ability and effectiveness. Furthermore, a closely aligned business/IT infrastructure will be achieved by a high level of shared business knowledge (Reich and Benbasat 2000). Based on this previous research, we hypothesize:

Hypothesis 5a: Shared knowledge of business processes facilitates IT change effectiveness.

Hypothesis 5b: Shared knowledge of business strategy facilitates IT change effectiveness.

RESEARCH METHODOLOGY

We tested our research model using data collected in a survey-based process-level study in the banking industry. In 2016, we conducted a survey of participants from the banking industry in Germany, Austria and Switzerland. In particular, we analyzed two banking-specific business processes, namely the process of granting and managing loans for investments of small and medium-sized enterprises (SMEs) and the process of granting and managing private real estate loans. We restricted our study to these processes, as a measurement on firm level would diffuse the net effect of our antecedent variables on any performance measures because of the variation between too different and diverse business segments within the firm. To reduce further contingency effects that are not in the interest of our study but stem from industry-specific factors, we further decided to focus on a single industry, as suggested by Chiasson and Davidson (2005).

As a first step, we identified the 1,000 largest banks and the two managers responsible for the two credit handling processes in focus. In total, we contacted 1,868 senior managers by phone. If the person contacted agreed to participate in the study, we sent out the questionnaire. After 10 and 20 days, we sent out reminder emails and called each manager who had not yet replied. In total, we received 202 questionnaires (response rate of 10.8%).

We involved three researchers and four consultants from the banking industry in the development of the survey. In addition, we pre-tested the final questionnaire with three banking managers. Our questionnaire starts with a brief introduction which describes the business process (credit handling process) in focus in the survey. As outlined above, we targeted the processes owner, thus taking a key informant approach, ensuring that we had the most appropriate responses to evaluate the related business environment. Since we focused on single business processes, we were able to ensure that key informants were very knowledgeable about the interaction between business and IT units regarding that particular process (Schlosser et al. 2015). Most measures in our survey were adopted from previous empirical research studies. Minor adaptations based on the insights from pre-tests and interviews were made in order to reflect the banking domain and the particularities of loans processes. To measure business process and IT modularity, we adapted the items provided by Tanriverdi et al. (2007). Shared business knowledge was operationalized using items from various related studies, like Cohen and Toleman (2006), Nelson and Cooprider (1996), Preston and Karahanna (2009), Ray et al. (2005) and Wagner et al. (2014). Items measuring integration were self-developed based on the logic of IT integration in Ross's seminal article on IT architecture maturity (Ross 2003). Finally, IT change effectiveness was operationalized by measuring the efficiency, quality and change responsiveness of the IT unit in building IT solutions for the business unit. The items and original sources are listed in the appendix. Our controls included process type (type of credit), country, firm size (log of balance sheet total), bank sector (commercial banks, cooperatives, public savings banks), and work experience (in years).

MEASUREMENT VALIDITY AND RELIABILITY

To ensure that our data does not suffer from non-response bias, we compared the answers provided by individuals responding immediately with those answering after one or more reminders. We did this as suggested by Armstrong & Overton (1977), who argue that the answers given by individuals after being reminded share properties with those who did not response at all. Since indicators revealed no significant difference, we do not expect non-response bias to present a major problem.

Another potential issue threatening the validity of the survey-based empirical results is common method bias (CMB). We applied three procedures to uncover indications of CMB. First, we applied the Harman single-factor test, which did not uncover a single component explaining the majority of overall variance (the largest component explained 36.5%). Further, we included a theoretically unrelated marker variable ("Competition in our loans market is very strong.") in our model that was linked to each construct of the original model. The resulting model test results did not show any structural differences in levels and significance of path coefficients or in the level of R^2 of the dependent variables. As a last step to assess the CMB, we did a collinearity diagnostic as suggested by Kock (2015). Our highest factor-level variance inflation factor (VIF) is 1.8. Therefore, all our factors are far below the suggested threshold of 3.3, which indicates that our data does not suffer from CMB.

Table 1shows that the common criteria with regard to construct validity and reliability are fulfilled. The composite reliability values are above 0.8, the average variances extracted are well above 0.5 and the discriminant statistics show that the inter-construct correlations are always lower than the square root of the respective construct's AVE. More detailed results (indicator loadings, indicator cross-loadings, and results of the HTMT analysis) are presented in the appendix.

Table 1. Construct-based quality criteria

Construct	C.R.	AVE	Discriminant statistics (inter-construct correlations and square root of AVE in shaded cells)					
			#1	#2	#3	#4	#5	#6
Business process modularity (#1)	.904	.759	.871					
IT flexibility – modularity (#2)	.895	.739	.538	.860				
IT flexibility – integration (#3)	.861	.675	.321	.412	.822			
SBK of business processes (#4)	.930	.815	.212	.272	.155	.903		
SBK of business strategy (#5)	.915	.782	.353	.256	.190	.603	.884	
IT change effectiveness (#6)	.905	.760	.284	.357	.272	.465	.402	.872

(n=171, the results for the conservative sample of 119 can be found in the appendix)

RESULTS

MODEL EVALUATION AND MISSING VALUES

We evaluated the research model using Partial Least Squares (PLS), which has been proven to be an adequate instrument when the sample size is greater than 100 responses or the number of indicators is less than six variables (Hair et al. 2017). In addition, PLS is the preferred method when the measurement model includes formatively measured constructs and when the primary goal is to explain the variance of the dependent variables, rather than test an overall model fit (Petter 2018). We used the smartPLS software package developed by Ringle et al. (2015).

Of the 202 surveys, 83 had missing values, resulting in a conservative sample of 119. Of the 202, we dropped 31 responses that had one or more construct(s) with all indicator variables missing, retaining 171 surveys. For the remaining 52 surveys with missing values, we used a multiple imputation approach to estimate single missing values. Multiple imputation is the method of choice when it is unclear whether data is missing completely at random (Jensen and Roy 2008). We chose multiple imputation by fully conditional specification (FCS-MI), which allows imputation of categorical and continuous variables using a set of conditional densities to create a multivariate imputation model for every missing variable (Van Buuren 2007). This makes it especially powerful when no fitting multivariate distribution exists and a perfect complement to SEM-PLS. We used the R-package 'mice' by Van Buuren (2007), following the suggestions to generate five datasets in 50 iterations. For each of those five datasets, the imputed value was chosen using predictive mean matching (Morris et al. 2014). We then applied smartPLS to each of the five imputed datasets and pooled the obtained estimates (Barnard and Rubin 1999). In addition, we computed the model using a conservative case-wise deletion approach. The results were not structurally different. We therefore used the imputed datasets for our subsequent model tests, but also report the results for case-wise deletion, so that readers can comprehend our results easily.

TEST OF THE RESEARCH MODEL

The results of testing the structural model with PLS (based on 5,000 bootstraps) are presented in Figure 3. The results for the highly conservative model (N=119) can be found in the appendix.

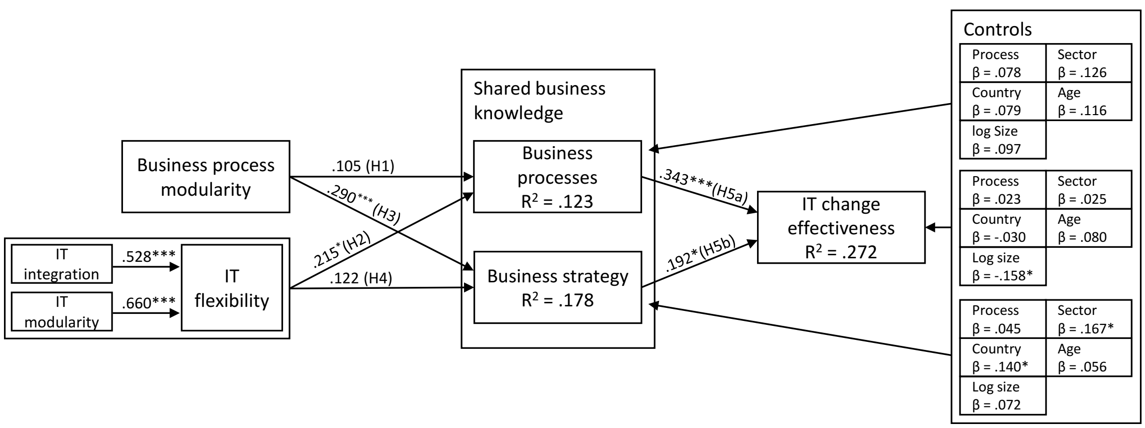

Figure 3. Estimation results (standardized path coefficients with sig. levels, R^2)

Notes: N=171; ***: p <.001; **: p <.01; *: p <.05; +: p<.1. (one-sided t-tests, based on 5,000 bootstraps)

The findings show a strong relationship between business process modularity and shared business knowledge of business strategy as well as between IT flexibility and shared business knowledge of business processes. Accordingly, H2 and H3 are supported, while H1 and H4 have to be rejected – the path coefficients of .105 and .122 are also rather low so that the threat of a type-II error due to a possibly insufficient statistical power is highly unlikely. Finally, both dimensions of shared business knowledge – inside and outside the work system – are strongly related to IT change effectiveness.

The following tests of model variations take into account that there is obviously also an effect of modularity and flexibility on IT change effectiveness which is *not* mediated by shared business knowledge, which has been postulated by previous research (e.g. Henfridsson et al. 2014; Karim

2006; Tiwana and Konsynski 2010). Hence, we add direct edges between the independent variables and IT change effectiveness to the model (called 'mediation model') while the original model (Figure 2) is labeled as 'full mediation model'. To provide complete reporting, we also include the 'direct model' (SBK, as the mediator removed from the full model) and the controls-only model. The results are presented in Table 2.

Table 2. Model test results (standardized path coefficients with sig. levels, R2)

		Mediation model			Full mediation model *(=original model, cf. Figure 3)*			Direct model	Controls-only
	Dependent variable: / Independent variable:	IT change effective-ness	SBK of business processes	SBK of business strategy	IT change effective-ness	SBK of business processes	SBK of business strategy	IT change effective-ness	IT change effective-ness
	SBK of bus. processes	**.303*****			**.343*****				
	SBK of bus. strategy	.138			**.192***				
	Bus. process modularity	.045	.106	**.287*****		.105	**.290*****	.123	
	IT flexibility	**.234*****	**.216****	.124		**.215***	.122	**.308*****	
Controls	Country	-.022	.079	.140*	-.030	.079	.140*	.017	.019
Controls	Firm size	-.125*	.097	.072	-.158*	.097	.072	-.078	-.113
Controls	Sector	.016	.126	.166*	.025	.126	.167*	.076	.096
Controls	Process type	.054	.079	.045	.023	.078	.045	.095	.040
Controls	Work experience	.090	.115	.056	.080	.116	.056	.133*	.142*
	R^2	.331	.125	.178	.272	.123	.178	.262	.070

(Notes: N=171, the results for the conservative sample of 119 is attached in the appendix; ***: p <.001; **: p <.01; *: p <.05). (one-sided t-tests, based on 5,000 bootstraps)

We can see that shared business knowledge plays a significant role in explaining IT change effectiveness. The importance of IT flexibility is demonstrated by the strength of the path directly from IT flexibility to IT change effectiveness in all analyses (mediation model, direct model) and by the substantial increase of R^2 from 0.272 to 0.331 when this direct path is added. We see that flexible IT infrastructure is the foundation for high IT change effectiveness, but there is also a substantial mediation effect by shared business knowledge (particularly by shared knowledge of business processes). A bootstrap-based post-hoc mediation analysis revealed that the variance accounted for (VAF) by SBK about the business process is 0.148, significant at $p<0.05$. Finally, the additional tests show that business process modularity does not significantly affect IT change effectiveness.

In our alternative models, we retested the original model and the mediation model *without* the second-order construct of IT flexibility, instead linking integration and IT modularity directly to the dependent variables. The structural results remain the same, but the results indicate that it is mainly IT modularity rather than integration that accounts for the significant impact of IT flexibility on IT change effectiveness (mediation model) and SBK of business process (both models) while the paths from integration to these variables are mostly insignificant (only integration → IT change effectiveness is significant at p<.05 in the mediated model). We observe that integration and modularity are theoretically highly interrelated and statistically correlated, representing two sides of the same coin since a modular system can only work effectively if the modules are properly integrated via the modules' interfaces.

Further, to rule out an alternative theorization, we tested a moderation model where we assumed that flexibility and SBK are causally unrelated but impact IT change effectiveness, which might be complementary or substitutive. A complementary relationship would be reflected by a positive interaction effect while a negative interaction effect would indicate a substitutive relationship. We found none of the interaction effects to be significant.

DISCUSSION

The empirical findings reflect that organizations can achieve a higher level of SBK of the business processes and strategy if the business processes are modular and the implemented IT architecture is flexible in order to support the modular structure of the system of business processes. This result supports previous research findings that modular systems enable knowledge sharing (e.g. Ko et al. 2005; Mani et al. 2010). However, while arguing that business process modularity and a flexible IT infrastructure reduce complexity within the architecture of the organization (Reijers and Mendling 2008; Schilling 2000) and thereby facilitate the development of SBK, the empirical analyses also show results diverging from our original hypotheses. While business process modularity facilitates SBK of business strategy, our results indicate no effect on SBK of business processes. Rather, SBK of business processes can be achieved when the organization has an IT infrastructure which flexibly supports the modular business processes and thus facilitates change. Although a flexible IT infrastructure does not contribute to SBK of business strategy, it affects the level of SBK of business processes. To interpret these findings, we use a combination of the two theories introduced above in the hypothesis development: the theory of templates and the theory of work systems.

THEORY-DRIVEN INTERPRETATION OF THE RESULTS

Business process modularity can explain the development of SBK of business strategy but does not contribute to SBK of business processes. As presented in the theoretical background, individuals apply different cognitive templates to interpret their environment. With regard to business process modularity, the single modules (or chunks) can either be interpreted *within* the respective business process (i.e. inside the work system; the business process consists of several modules) or *across* different business processes (i.e. outside the work system; a module is represented by a business process in a larger system of business processes). Our results indicate that individuals apply similar templates in a modularized business process environment regarding the overall business strategy (i.e. H3 supported) but not regarding the modularity within a specific business process (i.e. H1 rejected). According to the work system theory, in a modularized system, each business unit (procurement, production or sales) can be interpreted as a single work system itself. The IT unit, however, is typically part of a more global work system which supports all the business units in a larger organization. For the IT unit (which is not *necessarily* directly involved in a work system such as procurement, production or sales) it is much easier to develop an understanding of their own work system on a higher abstraction level (like the purpose of the module 'customer relationship management' within the system 'sales') than in a more specialized system (like the purpose of the module 'risk evaluation' in the system 'crediting process'). If the IT unit's work system supports all business units, business process modularity helps structure the big picture and align the cognitive template with strategic patterns. Business process modularity does not imply that the shared business knowledge of every business process in the system will increase because not every business process is part of the *joint* work system of business and IT professionals.

This interpretation also helps explain the findings for IT flexibility, where we found a positive impact on SBK of business processes (H2 supported), but not on SBK of the business strategy (H4 rejected). Since the IT architecture, which flexibly supports the modular system of business processes, is part of the IT unit's work system, the business process itself becomes a critical component in IT's work system. However, this does not automatically imply that the IT professionals' understanding of the business strategy on a global level will also increase. The reason can be again found in different hierarchical work systems. Focusing on the flexible IT architecture, the work system is the respective business process which is supported by the flexible IT architecture; but not the entirety of business processes of the overall organization (i.e., H4 rejected).

IMPLICATIONS FOR THEORY

In our study, we combined two research streams focusing on the antecedents of successful IT systems which flexibly addresses changing business needs. The first stream analyzes the concept of modularity as an enabler and argues that new combinations of modules represents an effective change mechanism to stay competitive in a volatile market (e.g. Henfridsson et al. 2014; Karim 2006; Tiwana and Konsynski 2010). The second stream focuses on shared business knowledge and argues that organizations which achieve a high level of shared business knowledge among business and IT units are more likely to detect and react to changing markets (Chen et al. 2014; Tiwana et al. 2003). Our study combines these two streams by assuming a mediation effect of shared business knowledge. Based on our results, we determine the following implications for theory.

First, in our research, we shed further light on the relationship of business/IT modularity and IT change effectiveness. The results support the findings of previous research that modularity is a major antecedent of IT change effectiveness. However, our results also suggest a significant mediation effect, highlighting the importance of SBK in enabling change effectiveness in a modularized environment. This finding complements previous research finding that the need for shared knowledge decreases in a modularized environment (Mani et al. 2010), which is the result of managed complexity (Henfridsson et al. 2014). Indeed, we could show that modular systems do not make SBK redundant or threaten performance, as suggested in previous research (e.g. Grand et al. 2016; Mani et al. 2010; Resick et al. 2014), but rather that it enables knowledge sharing in a structured environment.

Second, focusing on the link between modularity and SBK, our findings highlight the relative importance of complexity on the different dimensions of SBK. Previous research suggests the importance of SBK in complex environments (Ko et al. 2005; Nelson and Cooprider 1996; Schmidt et al. 2014). In our study, we apply the concept of modularity as a mechanism to reduce complexity, which in turn facilitates the creation of SBK. However, previous conceptualizations of SBK are linked to a specific research stream, focusing on strategic or operational aspects of SBK (Jentsch and Beimborn 2014). In our study, we found that modular systems do not per se facilitate SBK. Rather, a combination of functional and technical modularization facilitates operational as well as strategic aspects of shared business knowledge.

Third, focusing on the link between SBK and IT change effectiveness, we found that the comprehensive construct of SBK can explain IT performance in the sense of change effectiveness also in modular (i.e. reduced-complexity) environments. However, we can also see that the relationship between SBK of business processes and IT change effectiveness is much stronger than between SBK of business strategy and IT change effectiveness. This may be influenced in part by the nature of the construct. Our operationalization of IT change effectiveness measures the operational performance (time and quality of responses to change requirements) more than the strategic business value (or: fit) of IT.

Fourth, focusing on the role of an IT unit in volatile business environments, we found that a flexible IT system enables the SBK for operational business processes, which in turn enables change effectiveness of the IT unit to flexibly support the needs of the business unit. Our findings supports previous research finding that a flexible IT infrastructure in combination with shared business knowledge of business strategy enables business process agility (Queiroz et al. 2018). In contrast, SBK of business strategy can be achieved through a modularized business environment.

IMPLICATIONS FOR PRACTICE

From a practical perspective, our study shows that business process modularization supports SBK between business and IT professionals about strategic aspects of the organization, but it does not automatically increase SBK of business processes. This SBK of operational processes can be achieved if the IT unit builds a flexible IT infrastructure to support the respective business processes. Where business process modularity is lacking, the IT unit can develop SBK of business processes, but has limited leverage to develop SBK of strategic aspects of the organization.

As for the template theory, we can confirm that modularization enables shared knowledge. Modularization is an adequate instrument to manage organizational complexity because every module only draws on certain information. Further implementation-related information, which makes the information more complex, is not included in the module (Henfridsson et al. 2014), so the amount of information that needs to be transferred among collaboration partners decreases significantly (Mani et al. 2010). Thus, research assumes that there is a difference between complex and non-complex systems regarding governance structures such as knowledge transfer mechanisms (Blomquist and Müller 2006). Indeed, practitioners might design knowledge transfer mechanism as a gradual sequence of trainings per module. The potentials of this piece-by-piece or chunk-by-chunk approach are supported by the template theory, which suggests that individuals start the learning process by making sense of single modules in their environment. When they proceed, they start cognitively combining different modules and building a cognitive template of the work environment.

This leads to the following practical recommendations: First, management should understand modularization (and integration) of the business and IT environment as a tool to increase shared business knowledge and enable IT to react quickly to changing business needs. Only when both environments are structured in a modular sense the full potentials for enabling knowledge sharing can be achieved.

Second, management can support the process of knowledge sharing by implementing knowledge transfer mechanisms aligned with the modular structure of the organizational environment. Trainings sessions, documentation and other forms of knowledge transfer should, whenever possible, focus on single modules. By transferring the concept of encapsulation to knowledge transfer mechanisms, a set of trainings or a handbook of documentations can therefore comprise knowledge transfer mechanisms for a whole business process, which consists of several modules. The positive effects of this chunk-by-chunk knowledge transfer design is supported by template theory, and thus enables the scrolling through different hierarchical templates.

Third, with regard to work system theory, our findings suggest that management should invest in trainings and related mechanisms that enable knowledge sharing in a *joined* work environment. The benefit of trainings offered to a larger set of merely potential stakeholders are unlikely to be as great.

LIMITATIONS AND FURTHER RESEARCH

A first limitation might be the potential for reversed causality. However, the argument of reversed causality, i.e., shared business knowledge driving modularity instead of the originally hypothesized effect, is highly unlikely in our case, as most of the banks use standardized banking IT architectures or application suites, often provided and operated by external vendors, which they can only customize to a certain degree. Thus, large parts of the modularity in the processes and in the IT infrastructure are externally pre-determined. Another potential limitation might be that we did not imply the perceptions of the IT unit but solely focused on the owners of the credit processes as respondents of our survey. However, our research design makes the business managers the most suitable respondents. As already outlined above, we argue that only process owners as key informants can determine how well the structure of the IT architecture *fits* the business processes. Finally, the generalizability of the study is limited since the model was tested with data from one industry and one business segment only. While we have no reason to assume that the results cannot be generalized to comparable processes of other service industries, future studies will be necessary to increase the statistical generalizability of our findings. We can conclude that profound shared business knowledge is facilitated by business process modularity only in combination with a flexible IT architecture. These results can be used for further research regarding a more differentiated view on the modularity as a driver of SBK.

CONCLUSION

Our study contributes by investigating the link between modularity (structured business processes and IT flexibility) and shared knowledge of business processes and strategy to achieve higher IT change effectiveness to stay competitive in the digital age. The results, which show that different facets of shared business knowledge are affected by business process modularity vs. IT flexibility (including IT modularity), can be explained by a combination of two theories. The template theory indicates why modularity can potentially impact shared business knowledge. Viewing this impact through the lens of the work system theory explains why business process modularity does not enable shared knowledge of business *processes* (H1) but does enable shared knowledge of business *strategy* (H3). This research shows that a modular business system is an important antecedent of shared business knowledge, and that it is essential to include both units (business and IT) in one work system.

References

Alter, S. 1999. "A General, yet Useful Theory of Information Systems," *Communication of the Association for Information Systems* (13:1).

Armstrong, J. S., and Overton, T. S. 1977. "Estimating Nonresponse Bias in Mail Surveys," *Journal of Marketing Research* (14:3), pp. 396-402.

Baldwin, C. Y., and Clark, K. B. 2000. *Design Rules: The Power of Modularity*. Cambridge (MA): MIT Press.

Barnard, J., and Rubin, D. B. 1999. "Small-Sample Degrees of Freedom with Multiple Imputation," *Biometrika* (86:4), pp. 948-955.

Basu, A., and Blanning, R. W. 2003. "Synthesis and Decomposition of Processes in Organizations," *Information Systems Research* (14:4), pp. 337-355.

Bittner, E., and Leimeister, J. M. 2014. "Creating Shared Understanding in Heterogeneous Work Groups: Why It Matters and How to Achieve It," *Journal of Management Information Systems* (31:1), pp. 111-143.

Blomquist, T., and Müller, R. 2006. "Practices, Roles, and Responsibilities of Middle Managers in Program and Portfolio Management.," *Project Management Journal* (37:1), pp. 52-66.

Booch, G., Maksimchuk, R., Engle, M., Young, B., Conallen, J., and Houston, K. 2007. *Object-Oriented Analysis and Design with Applications*, (Third ed.). Addison-Wesley Professional.

Booch, G., Rumbaugh, J., and Jacobson, I. 2005. *The Unified Modeling Language User Guide*, (Second ed.). Addison-Wesley Professional.

Brown, R. H., and Karamouzis, F. 2001. "The Services Value Chain: Forging the Links of Services and Sourcing," *Gartner Research*).

Byrd, T. A., and Turner, D. E. 2000. "Measuring the Flexibility of Information Technology Infrastructure: Exploratory Analysis of a Construct," *Journal of Management Information Systems* (17:1), pp. 167-208.

Chan, Y. E., Sabherwal, R., and Thatcher, J. B. 2006. "Antecedents and Outcomes of Strategic IS Alignment: An Empirical Investigation," *IEEE Transactions on Engineering Management* (53:1), pp. 27–47.

Chanopas, A., Krairit, D., and Ba Khang, D. 2006. "Managing Information Technology Infrastructure: A New Flexibility Framework," *Management Research News* (29:10), pp. 632-651.

Charaf, M. C., Rosenkranz, C., and Holten, R. 2013. "The Emergence of Shared Understanding: Applying Functional Pragmatics to Study the Requirements Development Process," *Information Systems Journal* (23:2), pp. 115–135.

Chen, Y., Wang, Y., Nevo, S., Jin, J., Wang, L., and Chow, W. S. 2014. "IT Capability and Organizational Performance: The Roles of Business Process Agility and Environmental Factors," *European Journal of Information Systems* (23), pp. 326-342.

Chiasson, M. W., and Davidson, E. 2005. "Taking Industry Seriously in Information Systems Research," *MIS Quarterly* (29:4), pp. 591-605.

Clark, M. E. 2002. *In Search of Human Nature*. London; New York: Routledge.

Cohen, J. F., and Toleman, M. 2006. "The IS–Business Relationship and Its Implications for Performance: An Empirical Study of South African and Australian Organisations," *International Journal of Information Management* (26:6), pp. 457–468.

Davenport, T. H., and Short, J. E. 1990. "The New Industrial Engineering: Information Technology and Business Process Redesign," *Sloan Management Review* (31:4), pp. 11-27.

Davis, J. M., Kettinger, W. J., and Kunev, D. G. 2009. "When Users Are IT Experts Too: The Effects of Joint IT Competence and Partnership on Satisfaction with Enterprise-Level Systems Implementation," *European Journal of Information Systems* (18:1), pp. 26–37.

Dennis, A. R., Fuller, R. M., and Valacich, J. S. 2008. "Media, Tasks, and Communication Processes: A Theory of Media Synchronicity," *MIS Quarterly* (32:3), pp. 575-600.

Duncan, N. B. 1995. "Capturing Flexibility of Information Technology Infrastructure: A Study of Resource Characteristics and Their Measure," *Journal of Management Information Systems* (12:2), pp. 37-57.

Ernst, R., and Kamrad, B. 2000. "Evaluation of Supply Chain Structures through Modularization and Postponement," *European Journal of Operational Research* (124:3), pp. 495-510.

Fowler, M. 2001. "Reducing Coupling," *IEEE Software* (18:4), p. 102.

Freyhoff, H., Gruber, H., Ziegler, A. 1992. "Expertise and Hierarchical Knowledge Representation in Chess," *Psychological Research* (54:1), pp. 32-37.

Gobet, F., and Simon, H. A. 1996. "Templates in Chess Memory: A Mechanism for Recalling Several Boards," *Cognitive Psychology* (31:1), pp. 1-40.

Grand, J. A., Braun, M. T., Kuljanin, G., Kozlowski, S. W. J., and Chao, G. T. 2016. "The Dynamics of Team Cognition: A Process-Oriented Theory of Knowledge Emergence in Teams," *Journal of Applied Psychology* (101:10), pp. 1353-1385.

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., and Thiele, K. O. 2017. "Mirror, Mirror on the Wall: A Comparative Evaluation of Composite-Based Structural Equation Modeling Methods," *Journal of the Academy of Marketing Science* (45:5), pp. 616-632.

Henfridsson, O., Mathiassen, L., and Svahn, F. 2014. "Managing Technological Change in the Digital Age: The Role of Architectural Frames," *Journal of Information Technology* (29:1), pp. 27-43.

Hoetker, G. 2006. "Do Modular Products Lead to Modular Organizations?," *Strategic Management Journal* (27:6), pp. 501-518.

Holding, D. H. 1992. "Theories of Chess Skill," *Psychological Review* (54), pp. 10-16.

Jensen, M., and Roy, A. 2008. "Staging Exchange Partner Choices: When Do Status and Reputation Matter?," *The Academy of Management Journal* (51:3), pp. 495-516.

Jentsch, C., and Beimborn, D. 2014. "Shared Understanding among Business and IT - a Literature Review and Research Agenda," *European Conference on Information Systems*, Tel Aviv, Israel.

Jentsch, C., and Beimborn, D. 2016. "IT Is All About the Game - an Exploratory Study on the Impact of Task Characteristics on the Dimensions of Business/IT Shared Understanding," *European Conference on Information Systems*, Istanbul, Turkey.

Joachim, N., Beimborn, D., Schlosser, F., and Weitzel, T. 2011. "Does Soa Create or Require IT/Business Collaboration? Investigating Soa's Potential to Reduce the Gap between IT and Business," *Proceedings of the 32th International Conference on Information Systems (ICIS)*, Shanghai; China.

Joachim, N., Beimborn, D., and Weitzel, T. 2013. "The Influence of Soa Governance Mechanisms on IT Flexibility and Service Reuse," *The Journal of Strategic Information Systems* (22), pp. 86-101.

Johnson, A. M., and Lederer, A. L. 2010. "CEO/CIO Mutual Understanding, Strategic Alignment, and the Contribution of IS to the Organization," *Information & Management* (47:3), pp. 138–149.

Kant, I. 1788. *Kritik Der Urteilskraft (English: Critique of Practical Reason)*. Stuttgart: Philipp Reclam jun.

Karim, S. 2006. "Modularity in Organizational Structure: The Reconfiguration of Internally Developed and Acquired Business Units," *Strategic Management Journal* (27:9), pp. 799-823.

Kelly, G. A. 1955. *A Theory of Personality*, (1 ed.). New York, NY: Norton.

Ko, D.-G., Kirsch, L. J., and King, W. R. 2005. "Antecedents of Knowledge Transfer from Consultants to Clients in Enterprise System Implementation," *MIS Quarterly* (29:1), pp. 59–85.

Kock, N. 2015. "Common Method Bias in Pls-Sem: A Full Collinearity Assessment Approach," *International Journal of e-Collaboration* (11:4), pp. 1-10.

Kudaravalli, S., Faraj, S., and Johnson, S. L. 2017. "A Configural Approach to Coordinating Expertise in Software Development Teams " *MIS Quarterly* (41:1), pp. 43-64.

Langlois, R. N. 2002. "Modularity in Technology and Organization," *Journal of Economic Behavior & Organization* (49:1), pp. 19-37.

Malhotra, A., Gosain, S., and El Sawy, O. A. 2005. "Absorptive Capacity Configurations in Supply Chains: Gearing for Partner-Enabled Market Knowledge Creation," *MIS Quarterly* (29:1).

Mani, D., Barua, A., and Whinston, A. 2010. "An Empirical Analysis of the Impact of Information Capabilities Design on Business Process Outsourcing Performance," *MIS Quarterly* (34:1), pp. 39-62.

Miller, G. A. 1956. "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," *Psychological Review* (63:2), pp. 81-97.

Momme, J., Moeller, M. M., and Hvolby, H.-H. 2000. "Linking Modular Product Architecture to the Strategic Sourcing Process: Case Studies of Two Danish Industrial Enterprises," *International Journal of Logistics* (3:2), pp. 127-146.

Morris, T. P., White, I. R., and Royston, P. 2014. "Tuning Multiple Imputation by Predictive Mean Matching and Local Residual Draws," *BMC Medical Research Methodology* (14:75), pp. 1-13.

Nambisan, S. 2002. "Complementary Product Integration by High-Technology New Ventures: The Role of Initial Technology Strategy," *Management Science* (48:3), pp. 382-398.

Nelson, K. M., and Cooprider, J. G. 1996. "The Contribution of Shared Knowledge to IS Group Performance," *MIS Quarterly* (20:4), pp. 409–432.

Parnas, D. L. 1972. "On the Criteria to Be Used in Decomposing Systems into Modules," *Communications of the ACM* (15:12), pp. 1053-1058.

Petter, S. 2018. ""Haters Gonna Hate": Pls and Information Systems Research," *ACM SIGMIS Database* (49:1), pp. 10-13.

Preston, D. S., and Karahanna, E. 2009. "Antecedents of IS Strategic Alignment: A Nomological Network," *Information Systems Research* (20:2), pp. 159–179.

Queiroz, M., Tallon, P. P., Sharma, R., and Coltman, T. 2018. "The Role of IT Application Orchestration Capability in Improving Agility and Performance," *The Journal of Strategic Information Systems* (27:1), pp. 4-21.

Ray, G., Muhanna, W. A., and Barney, J. B. 2005. "Information Technology and the Performance of the Customer Service Process: A Resource-Based Analysis," *MIS Quarterly* (29:4), pp. 625–652.

Reich, B. H., and Benbasat, I. 2000. "Factors That Influence the Social Dimension of Alignment between Business and Information Technology Objectives," *MIS Quarterly* (24:1), pp. 81–113.

Reijers, H., and Mendling, J. 2008. "Modularity in Process Models: Review and Effects," *6th International Conference on Business Process Management*, Milan, Italy, pp. 20-35.

Resick, C. J., Murase, T., Randall, K. R., and DeChurch, L. A. 2014. "Information Elaboration and Team Performance: Examining the Psychological Origins and Environmental Contingencies," *Organizational Behavior and Human Decision Processes* (124:2), pp. 165-176.

Ringle, C. M., Wende, S., and Becker, J.-M. 2015. "Smartpls 3. Bönningstedt: Smartpls,").

Ross, J., W. 2003. "Creating a Strategic IT Architecture Competency: Learning in Stages," *MIS Quarterly* (2:1), pp. 31-43.

Sanchez, R., and Mahoney, J. T. 1996. "Modularity, Flexibility, and Knowledge Management in Product and Organization Design," *Strategic Management Journal* (17:S2), pp. 63-76.

Schilling, M. A. 2000. "Toward a General Modular Systems Theory and Its Application to Interfirm Product Modularity," *Academy of Management Review* (25:2), pp. 312-334.

Schlosser, F., Beimborn, D., Weitzel, T., and Wagner, H.-T. 2015. "Achieving Social Alignment between Business and IT – an Empirical Evaluation of the Efficacy of IT Governance Mechanisms," *Journal of Information Technology* (30), pp. 119-135.

Schmidt, C., T., Kude, T., Heinzl, A., and Mithas, S. 2014. "Software Development Teams: The Role of Shared Mental Models and Backup," in: *International Conference on Information Systems*. Auckland.

Simon, H. A. 1962. "The Architecture of Complexity," *Proceedings of the American Philosophical Society*.

Takeishi, A. 2002. "Knowledge Partitioning in the Inter-Firm Division of Labor: The Case of Automotive Product Development," *Organization Science* (13:3), pp. 321-338.

Tan, F. B., and Gallupe, R. B. 2006. "Aligning Business and Information Systems Thinking: A Cognitive Approach," *IEEE Transactions on Engineering Management* (53:2), pp. 223–237.

Tanriverdi, H., Konana, P., and Ge, L. 2007. "The Choice of Sourcing Mechanisms for Business Processes," *Information Systems Research* (18:3), pp. 280-299.

Tiwana, A. 2012. "Novelty-Knowledge Alignment: A Theory of Design Convergence in Systems Development," *Journal of Management Information Systems* (29:1), pp. 15–52.

Tiwana, A., Bharadwaj, A., and Sambamurthy, V. 2003. "The Antecedents of Information Systems Development Capability in Firms: A Knowledge Integration Perspective," *International Conference on Information Systems*, Seattle, Washington, USA.

Tiwana, A., and Konsynski, B. 2010. "Complementarities between Organizational IT Architecture and Governance Structure," *Information Systems Research* (21:2), pp. 288-304.

Van Buuren, S. 2007. "Multiple Imputation of Discrete and Continuous Data by Fully Conditional Specification," *Statistical Methods in Medical Research* (16:3), pp. 219-242.

van den Hooff, B., and de Winter, M. 2011. "Us and Them: A Social Capital Perspective on the Relationship between the Business and IT Departments," *European Journal of Information Systems* (20:3), pp. 255–266.

Vermerris, A., Mocker, M., and Heck, E. v. 2014. "No Time to Waste: The Role of Timing and Complementarity of Alignment Practices in Creating Business Value in IT Projects," *European Journal of Information Systems* (23:6), pp. 629-654.

Vlaar, P. W. L., van Fenema, P. C., and Tiwari, V. 2008. "Cocreating Understanding and Value in Distributed Work: How Members of Onsite and Offshore Vendor Teams Give, Make, Demand, and Break Sense," *MIS Quarterly* (32:2), pp. 227–255.

Wagner, H.-T., Beimborn, D., and Weitzel, T. 2014. "How Social Capital among IT and Business Units Drives Operational Alignment and IT Business Value," *Journal of Management Information Systems* (31:1), pp. 241-272.

Yang, H.-D., Kang, H.-R., and Mason, R. M. 2008. "An Exploratory Study on Meta Skills in Software Development Teams: Antecedent Cooperation Skills and Personality for Shared Mental Models," *European Journal of Information Systems* (17:1), pp. 47–61.

APPENDIX

Table 3. Survey items		
ID	Item	Adapted from
SBK of business processes		
SBKbp1	Our IT unit understands the business operations of the business unit.	Ray et al (2005)
SBKbp2	Our IT unit understands the requirement to optimize our business processes.	
SBKbp3	Our IT unit has a good level of understanding of the work environment (business related problems, tasks, etc.) of the business.	Nelson & Cooprider (1996)
SBK of business strategy		
SBKbs1	Our IT unit has a good level of understanding of strategic business plans.	Preston & Karahanna (2009)
SBKbs2	Our IT unit understands the direction in the financial market we are attempting to follow in the coming years.	
SBKbs3	The IT unit understands what support we need to realize our business plans.	
Business process modularity		
BPMod1	It is very easy to detach this business process from our other processes.	Tanriverdi et al (2007)
BPMod2	This business process has very well-defined interfaces with our other processes.	
BPMod3	Changing this business process does not affect our other processes.	
IT modularity		
ITMod1	The processes are well reflected in the modular structure of the IT architecture.	Tanriverdi et al (2007)
ITMod2	The structure of the business process and IT architecture are closely aligned.	
ITMod3	The design of the business process and IT architecture are designed based on a common reference model.	
IT integration		
ITInt1	All sub-processes of our crediting process data from the same database.	Self-developed, based on Ross (2003)
ITInt2	Data maintained in our business unit is also used in other business units.	
ITInt3	All business units use the same underlying database.	
IT change effectiveness		
ITEff1	The IT unit is able to quickly implement the business requirements.	Wagner et al (2014)
ITEfff2	The IT unit is always able to meet the requirements of the business units.	
ITEff3	The IT unit reacts flexibly to change requests specified by the business side.	

Table 4. Discriminant analysis: Cross-item correlations						
	IT change effective-ness	SBK of business processes	SBK of business strategy	Business process modularity	IT integration	IT modularity
ITEff1	**.887 (.909)**	.435 (.477)	.350 (.419)	.230 (.197)	.227 (.341)	.335 (.405)
ITEff2	**.818 (.854)**	.316 (.399)	.266 (.293)	.216 (.227)	.226 (.314)	.248 (.382)
ITEff3	**.895 (.918)**	.454 (.492)	.435 (.472)	.297 (.316)	.216 (.279)	.345 (.430)
SBKbp1	.438 (.483)	**.915 (.920)**	.522 (.566)	.224 (.205)	.164 (.196)	.246 (.293)
SBKbp2	.387 (.425)	**.896 (.907)**	.524 (.521)	.180 (.141)	.105 (.095)	.252 (.287)
SBKbp3	.440 (.473)	**.892 (.879)**	.577 (.604)	.215 (.173)	.127 (.183)	.222 (.253)
SBKbs1	.377 (.415)	.573 (.619)	**.866 (.856)**	.270 (.244)	.158 (.123)	.158 (.118)
SBKbs2	.375 (.417)	.465 (.498)	**.917 (.932)**	.397 (.394)	.195 (.137)	.290 (.274)
SBKbs3	.340 (.359)	.570 (.580)	**.869 (.892)**	.300 (.268)	.150 (.062)	.219 (.193)
BPMod1	.216 (.209)	.165 (.098)	.345 (.290)	**.868 (.860)**	.325 (.298)	.396 (.408)
BPMod2	.239 (.199)	.205 (.165)	.328 (.281)	**.882 (.870)**	.280 (.277)	.459 (.468)
BPMod3	.293 (.302)	.226 (.228)	.289 (.328)	**.859 (.902)**	.236 (.288)	.567 (.593)
ITInt1	.201 (.259)	.115 (.103)	.014 (.014)	.267 (.230)	**.761 (.774)**	.432 (.416)
ITInt2	.253 (.335)	.137 (.176)	.280 (.233)	.315 (.337)	**.802 (.824)**	.262 (.371)
ITInt3	.180 (.283)	.112 (.168)	.163 (.090)	.214 (.258)	**.895 (.918)**	.316 (.381)
ITMod1	.289 (.386)	.230 (.336)	.211 (.233)	.454 (.467)	.332 (.408)	**.829 (.838)**
ITMod2	.406 (.484)	.301 (.292)	.242 (.198)	.504 (.533)	.341 (.400)	**.871 (.886)**
ITMod3	.229 (.313)	.149 (.175)	.197 (.152)	.441 (.482)	.384 (.399)	**.855 (.882)**

(N=171; numbers in parentheses are the original loading before missing value treatment (N=119))

Table 5. Discriminant analysis: HTMT ratios					
	IT change effective-ness	IT integra-tion	IT modu-larity	SBK of business processes	SBK of business strategy
IT integration	.344 (.421)				
IT modularity	.426 (.530)	.517 (.571)			
SBK of bus. process	.532 (.578)	.190 (.209)	.319 (.358)		
SBK of bus. strategy	.462 (.504)	.240 (.168)	.300 (.256)	.697 (.717)	
Bus. process modularity	.332 (.312)	.406 (.401)	.645 (.660)	.244 (.212)	.409 (.388)

(N=171; N=119 in parenthesis)

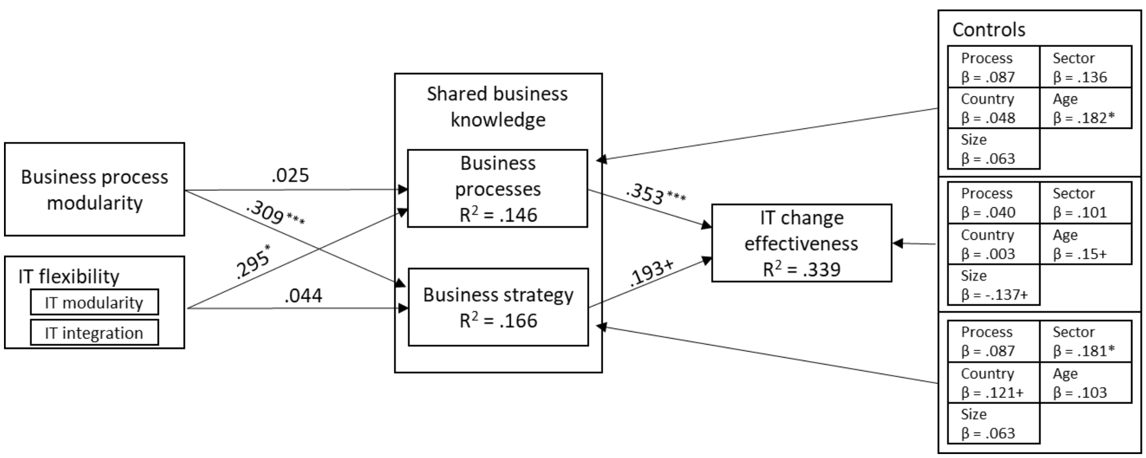

Figure 4. Estimation results (standardized path coefficients with sig. levels, R^2)
Notes: N=119. ***: p <.001; **: p <.01; *: p <.05; +: p<.1. (one-sided t-tests, based on 2,000 bootstraps)

Table 6. Construct-based quality criteria before missing value treatment (N=119)

Construct	C.R.	AVE	Discriminant statistics (inter-construct correlations and square root of AVE in shaded cells)					
			#1	#2	#3	#4	#5	#6
Business process modularity (#1)	.923	.771	.878					
IT flexibility – modularity (#2)	.903	.755	.568	.869				
IT flexibility – integration (#3)	.878	.707	.327	.463	.841			
SBK of business processes (#4)	.929	.814	.193	.308	.178	.902		
SBK of business strategy (#5)	.922	.799	.343	.223	.122	.627	.894	
IT change effectiveness (#6)	.923	.799	.276	.454	.347	.513	.448	.894

Table 7. Model test results (standardized path coefficients with sig. levels, R^2)

	Model:	Mediation model			Full mediation model *(=original model, cf. Figure 4)*			Direct model	Controls-only
	Dependent variable: / Independent variable:	IT change effectiveness	SBK of business processes	SBK of business strategy	IT change effectiveness	SBK of business process	SBK of business strategy	IT change effectiveness	IT change effectiveness
	SBK of business process	**.237***			**.353*****				
	SBK of business strategy	**.194***			**.193+**				
	Bus. process modularity	-.055	.024	**.309*****		.025	**.309*****	.059	
	IT flexibility	**.405*****	**.298****	.045		**.295***	.044	**.457*****	
Controls	Country	-.013	.047	.121*	,003	.048	.121+	-.012	.003
Controls	Firm size	-.114	.064	.062	-.137+	.063	.063	-.112	-.191*
Controls	Sector	.055	.136+	.180*	.101	.136	.181*	.072	.078
Controls	Process type	.100+	.087	.087	.040	.087	.087	.126+	.004
Controls	Work experience	.208***	.181*	.104+	.150+	.182*	.103	.237***	.211*
	R^2	.458	.147	.166	.339	.146	.166	.313	.078

(Notes: N= 119; ***: p <.001; **: p <.01; *: p <.05; +: p<.1). (one-sided t-tests, based on 5,000 bootstraps)

CHAPTER 3

TIME-DEPENDENT EVOLUTION OF B/IT-SU

Appendix
Chapter 3

Paper VII

Analyzing Development Patterns of Shared Understanding among IT and Business in an IT Project Life Cycle

Christian Jentsch
University of Bamberg

Daniel Beimborn
Frankfurt School of Finance & Management

Under Review in The DATA BASE for Advances in Information Systems

Analyzing Development Patterns of Shared Understanding among IT and Business in an IT Project Life Cycle

Abstract

Shared understanding is crucially important to effective business/IT collaboration. To date, research has principally taken situational snapshots focusing on the level of business/IT shared understanding at specific points in time. To further understand how shared understanding evolves over time, we conducted four case studies in different IT projects. We performed a longitudinal cross-case analysis to identify patterns in the development of shared understanding over time and sought explanations for these patterns. We determined common challenges, like team member involvement or technical details at various phases in IT projects and provide recommendations on the timing and design of critical actions to overcome these challenges and facilitate shared understanding. By that, we found five development patterns that can be applied to describe the evolution of shared understanding in IT projects.

Keywords: Business/IT shared understanding; IT project management; Longitudinal cross-case analysis

Introduction

Shared understanding between business and IT professionals (B/IT-SU) has frequently been raised as one of the most critical ingredients for a harmonized and effective collaboration between business and IT units (e.g. Reich and Benbasat, 2000; Vlaar et al., 2008; Wagner et al., 2014). Research has shown that a high level of shared understanding enables strategic alignment (e.g. Preston and Karahanna, 2009) and facilitates requirements engineering in software development (e.g. Charaf et al., 2013) or IT implementation in infrastructure projects (Davis et al., 2009). Especially research focusing on information system development or on the implementation of large enterprise systems acknowledges the fundamental impact of B/IT-SU and information exchange in general between IT people and business/user groups (Chua et al., 2012; van den Hooff and de Winter, 2011; Vermerris et al., 2014). Overall, previous empirical research has confirmed the importance of shared understanding for business/IT collaboration at every level of the firm.

However, these results are mainly based on situational snapshots in companies, on data collected at one specific point in time. Even though research postulates that shared understanding is a volatile variable, very little research provides empirical evidence for this assumption (e.g. He et al., 2007; Levesque et al., 2001; Wagner and Weitzel, 2012). Most previous studies in IS research analyze the development of shared understanding retrospectively (e.g. Vermerris et al., 2014), conduct experiments (e.g. Bittner and Leimeister, 2014; Chiravuri et al., 2011) or use students as subjects (He et al., 2007; Levesque et al., 2001). Considering the low number of studies, the findings have been remarkably contradictory. For example, Vermerris et al. (2014) found indications that the early implementation of shared understanding is critical for the success of the project –

the sooner the better. On the other hand, He et al. (2007) found that it is normal for shared understanding to start at a very low level and increase over time and that an initial low level of shared understanding has no impact on the success of the collaboration.

To overcome these research limitations and to shed further light on the development of shared understanding in IT projects and its influencing factors, we establish our research question as follows:

What is the temporal effect of various antecedents of business/IT shared understanding?

To address this research question, we conducted a series of case studies, collecting longitudinal panel data and conducting interviews. We structure the antecedents of B/IT-SU identified in the respective cases based on the dimensions of social capital and determine common patterns in the development of B/IT-SU over time in a cross-case analysis.

The remainder of the paper is structured as follows. The next section describes the theoretical foundation of our work, defines and conceptualizes B/IT-SU and social capital, and provides an overview of previous related research. Then we describe how we collected longitudinal data on B/IT-SU in four IT projects. In the findings section, we introduce five notable patterns of how B/IT-SU developed over time derived from the cases, synthesize these findings in a cross-case analysis, and link them to causal managerial antecedents. After a discussion of the lessons learned, we conclude our paper with a short summary of the contributions and limitations of our study, and present recommendations for future research.

Theoretical Background

Business/IT shared understanding

Business/IT Shared Understanding (B/IT-SU) plays an important role in various strands of IS research. Some examples include alignment research, in which shared understanding represents a key factor in enabling social alignment between business and IT (e.g. Reich and Benbasat, 2000; Tan and Gallupe, 2006), systems development research, in which shared understanding has been described as a critical factor in the process of requirements engineering (e.g. Charaf et al., 2013) or system implementation (e.g. Chua et al., 2012; Davis et al., 2009). Defined as "the ability of IT and business […], at a deep level, to understand and be able to participate in the other's key processes" (Reich and Benbasat, 2000, p. 86), shared understanding enables knowledge transfer and improves service quality provided by IT (e.g. Ko et al., 2005; Robert et al., 2008; van den Hooff and de Winter, 2011).

Most research has conceptualized the shared understanding between business and IT professionals as either one-dimensional or two-dimensional. The one-dimensional conceptualization most commonly focuses either on the shared understanding of the work environment (Nelson and Cooprider, 1996) or objectives in the partnership (Chang et al., 2014; Reich and Benbasat, 2000). In the work environment, the focus is on a shared understanding of each other's processes (e.g. Ray et al., 2005; Stoel and Muhanna, 2012), roles and responsibilities in the work environment (e.g. Cannon-Bowers et al., 1993; Dhaliwal et al., 2011; Levesque et al., 2001) or the current role of IT in the organization (Preston and Karahanna, 2009). In contrast, the shared understanding of objectives has been discussed in terms of understanding system requirements (e.g. Charaf et al., 2013) or, more broadly, collaborative strategies and visions (e.g. Cohen and Toleman, 2006). Some research combines these two perspectives of shared understanding by distinguishing between a current and future perspective (e.g. Johnson and Lederer, 2007; Reich and Benbasat, 2000; Tiwana et al., 2003). We apply this idea and distinguish between shared understanding of *collaborative objectives* (Chang et al., 2014; Johnson and Lederer, 2010; Reich and Benbasat, 2000) and shared understanding of the *work environment*. Thus, by following the lead of Reich and Benbasat (2000)) we define shared understanding between business and IT professionals for the purpose of this study as the level of understanding of each other's work environments as well as of collaborative objectives within the partnership.

Focusing on the formation of shared understanding, previous research theoretically suggests that it will be achieved in a communicative act of learning and information sharing. The process of information sharing additionally relies on the comprehension of the information, articulation of a validity claim, and the acceptance of the validity claim (Habermas, 1985). The suitability of media to transfer the information depends on the novelty and potentials for negotiations of the piece of information (Dennis et al., 2008). Also, in highly specialized teams, research suggests that team performance increases when team members are aware of the knowledge distribution among team colleagues and are able to retrieve and consolidate necessary information from internal and external memories (Wegner, 1987). In the absence of formal hierarchies or procedural communication standards, the quality of member selection for the information sharing process depends on this awareness of expertise distribution (i.e., who knows what and who needs to know what).

In contrast to purely theoretical research thoughts and concepts or ex post analysis (e.g. retrospective interviews) on the formation of shared understanding (e.g. Grand et al., 2016; Vermerris et al., 2014), empirical research that is based on longitudinal data partly demonstrates very different findings. Levesque et al. (2001) found a decreasing level of shared understanding over time and explains this by an increase of team specialization, while He et al. (2007) identified an increasing level of shared understanding over time as well as a positive effect on team performance. On the other hand, van der Haar et al. (2015) found that an increasing as well as decreasing level of shared understanding can have a positive effect on team performance, while a stable level will have a negative effect. All these results have been derived from lab experiments involving student subjects. This makes it difficult to transfer the findings to the 'real life' of organizational IT projects. In real IT projects, the requirements and task specificities are most commonly developed based on knowledge of the business domain combined with knowledge of the IT domain within this particular firm (Preston and Karahanna, 2009).

MECHANISMS TO ENABLE B/IT-SU

Since the creation of shared understanding integrates social processes (interaction, communication) with intellectual processes (creation of own knowledge and understanding), previous research in this field has applied conceptualizations of social capital to structure the antecedents for the development of business/IT shared understanding (Preston and Karahanna, 2009; van den Hooff and de Winter, 2011; Wagner et al., 2014). "Social capital is the goodwill available to individuals or groups. Its source lies in the structure and content of the actor's social relations" (Adler and Kwon, 2002, p. 23). Thus, social capital theory has been frequently applied to analyze the social interactions in a group, like in an IT project team (e.g. Chua et al., 2012; van den Hooff and de Winter, 2011; Wagner et al., 2014). Based on this theory, research attempted to explain how team interactions contribute to performance in IT-related teams (van den Hooff and de Winter, 2011), how clan control can be implemented in complex IT projects (Chua et al., 2012), and how digitally enabled teams can be socially integrated (Robert et al., 2008). The benefits of a high level of social capital are broad. Social capital not only enables alignment among teams and organizational units (Karahanna and Preston, 2013), it also improves the quality of decision making (Robert et al., 2008), enables harmonized, long-lasting collaborations in uncertain environments (Ravindran et al., 2015) and explains knowledge transfer (Ko et al., 2005) and knowledge sharing (van den Hooff and de Winter, 2011). The latter is particularly important for our work because knowledge sharing results in an increase of shared understanding of joint objectives and the other party's work environment (Cooke et al., 2003; Wagner et al., 2014; H.-D. Yang et al., 2008). Therefore, we apply the social capital theory to structure the determinants of shared understanding found in our cases.

For the purpose of our study, we refer to Nahapiet and Ghoshal (1998) and define social capital as the "sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit" (Nahapiet and Ghoshal, 1998, p. 243). Accordingly, we conceptualize social capital by a structural, cognitive and relational perspective that ties individuals together (Chua et al., 2012; Preston and Karahanna, 2009; Wagner et al., 2014).

Structural capital, which describes the "overall pattern of connections between actors" (Nahapiet and Ghoshal, 1998, p. 244), has been analyzed in terms of the frequency or intensity of interactions (e.g. Chua et al., 2012; Wagner et al., 2014) and can be managed by appropriate mechanisms that enable formal and informal communication (Schlosser et al., 2015). Several studies on organizational (social) networks have confirmed the critical impact of structural capital on success (Sasidharan et al., 2012; Singh et al., 2011). However, various studies also found that structural capital has no direct effect on performance but is mediated by cognitive and relational capital (Karahanna and Preston, 2013; Tsai and Ghoshal, 1998; van den Hooff and de Winter, 2011).

Cognitive capital refers to shared interpretation and representation among individuals in a group (Nahapiet and Ghoshal, 1998). The concepts of cognitive capital and shared understanding partly overlap. Cognitive capital has been conceptualized as a direct antecedent for B/IT-SU of each other's work environment (Ko et al., 2005; Tiwana et al., 2003). van den Hooff and de Winter (2011) conceptualize cognitive capital as similar values or interpretations and find that, in the business and IT work environment, the amount of sharing knowledge significantly impacts B/IT-SU of each other's work environments.

Finally, relational capital focuses on relations between individuals, including trust and respect (Wagner et al., 2014). In our research, we apply the conceptualization of Robert et al. (2008), who described relational capital in terms of the level of trust, team norms, team identification and obligations. Previous research has frequently discussed relational capital as one of the most critical drivers for a long lasting and high performing relationship (e.g. Cohen and Toleman, 2006; Rai et al., 2009; Ravindran et al., 2015). Other scholars identify relational capital, which is influenced by cognitive and structural capital, as the ultimate enabler for team performance (Tsai and Ghoshal, 1998; van den Hooff and de Winter, 2011).

Even though, social capital has been conceptualized by applying various different dimensions, research also agrees that the dimensions of social capital cannot be seen as isolated variables; instead, they are tightly coupled and constantly influence each other (Nahapiet and Ghoshal, 1998) over time and in context (Chua et al., 2012; Maurer and Ebers, 2006; L. Yang et al., 2012). van Deth (2003) state that recent (mostly quantitative) approaches to analyze social capital reach their limits, when exploring the processes of social capital formation which highly depends on the constantly changing context, which changes over time (Avgerou, 2013; Devine and Roberts, 2003). As a consequence, research analyzing the effects of a temporal diffusion of social capital is rare. Most of those studies analyze online communities by focusing on network structures (i.e. structural capital) (Durst et al., 2013; Ravindran et al., 2015; Singh et al., 2011). A few others dig deeper into the multi-dimensionality of social capital by conducting case studies (van den Hooff and de Winter, 2011; Wagner and Weitzel, 2012; L. Yang et al., 2012). In doing that, they were able to provide various reasons (not only correlations) for the positive impact of social capital on team performance (Chua et al., 2012) and to provide insights into the dynamics among the dimensions of social capital (Maurer and Ebers, 2006). In consolidating previous longitudinal findings on social capital, research found, first, that the content of social capital changes along with the life cycle of a team in respect to the context of the team (L. Yang et al., 2012), second, that the mutual dependencies and reciprocities between the dimensions of social capital vary over time (Maurer and Ebers, 2006), and third, that only an adequate alignment between the dimensions of social capital enables team performance (Wagner and Weitzel, 2012).

Research Methodology

In our research, we attempt to explain the longitudinal effects of various antecedents on the development of B/IT-SU. To answer our research question, we chose an explanatory cross-case study. Purely quantitative measurement approaches in our research context are troublesome, due to the complex interactions between various variables and contextual interdependencies between mechanisms categorized by social capital dimensions in a longitudinal analysis. For that reason we applied an explanatory case study approach as recommended by Venkatesh et al. (2013), Dubé and Paré (2003) and Yin (2014). The major objective of a case study approach in this work is to examine the mechanisms and events that have a temporal impact on B/IT-SU. Explanatory cases are suitable for doing causal studies, by using theories to explain these causal links (Dubé and Paré, 2003). Thus, a critical aspect, which confines explanatory case study research from other case study research is the conscious choice of one or more theories of interest that provide essential input in the design of the study (Yin, 2014). Also the research approach explicitly allows times series analysis to explain longitudinal effects (Dubé and Paré, 2003). This work applies the conceptualization of social capital as a foundation for the examination of temporal effects among the social capital dimensions. The cases for the analysis have been selected and sampled based on their conditions that allows to explain the findings by using a social capital framework.

In the following the details on the analyzed cases as well as the data collection approach will be presented. The presentation of the cases does include information about the development of B/IT-SU, as well as the effects of events and mechanisms occurred in each case, which has been attached in appendix 1. The explanatory analysis of those case observations as well as a determination of patterns across the cases will then take place in the subsequent 'Findings' section.

Context of the Case Studies

The intent of this study is to gain insights into the determinants that influence the development of shared understanding during a project life cycle. In our study, we focus on traditional, waterfall-related rather than agile approaches, since these are still the more common approaches, especially in larger IT projects. Table 1 specifies the steps of a traditional project life cycle (PMBOK 2013) along which we collected our data (step 1, cf. above). We assume that the effect of certain drivers might change from phase to phase.

Table 1. Project phases (adapted from (PMBOK 2013))

Phase 1 **Initialization**	**Phase 2** **Planning**	**Phase 3** **Execution**	**Phase 4** **Closure**
The general idea for a project is examined and specified. Components of this phase are an initial draft of project objectives, rough-cut planning regarding resources and time schedule and a feasibility analysis. If the results of the feasibility analysis are positive the objectives and rough-cut planning will be formalized in a project charter.	The drafts of the initialization phase are specified in detail. This phase starts with a kick-off meeting or a workshop in which all team members discuss their expectations and understanding of the project objectives. The team jointly develops a work breakdown structure in which work packages, deadlines, and resources are formalized in detail.	Work packages are realized. The project manager is responsible for coordination between the work packages and for monitoring performance.	Termination of the project. The core element in this phase is a final report by the project manager, including relevant indices and project success or performance rates.

For our study, we were able to collect data in multiple IT projects in a single firm, enabling us to conduct an embedded case study with multiple sub-cases within the same environment or larger case (Yin 2014), which increases the level of comparability since many contextual factors are set equal. In the following a brief description of the context of each case will be presented. A more detailed description of the four cases, which explains how B/IT-SU developed over time in each case can be found in Appendix 1. The results of each case as presented in the appendix will be consolidated in a cross-case analysis and presented in the subsequent 'Findings' section.

Table 2 highlights the details of each project. Each project represents one case to be analyzed in the following.

Table 2. Details of analyzed projects				
Case	**Project Scope**	**Team Members**	**Project Focus**	**Brief description**
A	85 person days (p/d)	6	Software implementation	Implementation of a VideoIdent process for a client from the banking industry
B	89 p/d	4	Software development	Development and implementation of new functionalities in the company's intranet
C	170 p/d	6	IT infrastructure	Upgrading cash systems of staff canteens, including process and interface documentation
D	146 p/d	4	Interface implementation	Implementation of an interface for a client's fraud prevention system, which detects irregularities in the payment behavior of the end costumer

It is important to mention that all projects are business-driven projects, in which a business unit is the sponsor of the project and part of the project team at the same time. In such business-driven projects, B/IT-SU becomes especially relevant since the collaboration between business and IT on a daily basis is very intense. Further, all projects have been reported as successfully completed, even though some projects do not fully match the business expectations or took longer than expected.

Description of Case A: Implementation of a VideoIdent process

In Case A, the project team implemented a VideoIdent process for a client in the banking industry. Customers who want to open a bank account can prove their identification by showing their ID card and face into their laptop/smartphone camera. The task of the project team was to implement the backend of the process, including developing data interfaces, implementing the video software and realizing further VideoIdent functionalities. According to the project manager, the main challenges of this project were the novelty of the IT solution and the fact that the client was a new customer for the firm.

Description of Case B: Applications development

Case B was a small software project in which two IT members (software developer and IT project leader) and two business representatives jointly developed new features for their own company's intranet. The general objective was to develop a project portfolio management cockpit which aggregates and presents up-to-date project KPIs, like completion of milestones, expenses, remaining budgets or time schedules across all ongoing projects within the company. The project was initiated by the board of management and then delegated to a BU from the project organization. During the progress of the project, the BU and the board of management had weekly meetings in which they discussed the project status. Thus, the BU acted as an information broker between the management board and the IT members who developed the system.

Description of Case C: Upgrading a cash system

Case C is an internal IT infrastructure project in which the project team had to modernize the cash systems of the firm's four staff canteens. The tasks in the project included the exchange of hardware systems, documentation of new processes and interfaces, and the training of staff on the new systems.

Description of Case D: Implementing a fraud prevention pool

In Case D, the team had to implement new interfaces to a running system for an external client from the telecommunication industry. The client asked for interfaces to their Fraud Prevention Pool (FPP) to facilitate customer assessments like evaluating credit and payment history.

DATA COLLECTION

We collected data in four different IT projects in a large German IT service firm providing software development and support of CRM systems services to other firms in its corporate group and to external clients. These four analyzed projects are rather small software development and IT infrastructure projects compared to other projects of this IT subsidiary.

In each case, we collected data at predefined points in time during the project development (Figure 1). Further, we were allowed to review all project-related documentations and reports to get a detailed understanding of the context of the project and situation in the teams.

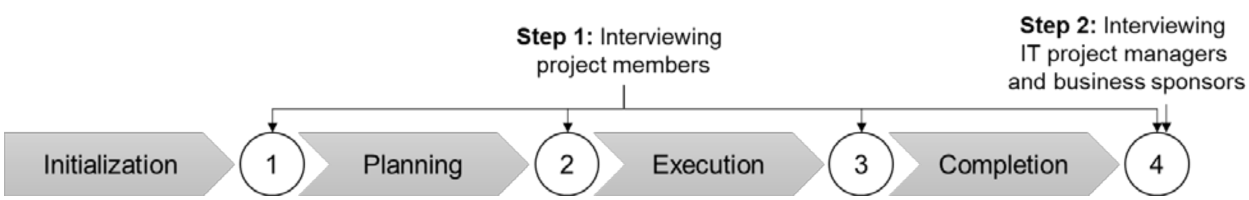

Figure 1. Data collection process

Step 1 – Evaluating the level of business/IT shared understanding

After every project phase, we measured the current state of the perceived level of B/IT-SU in the team using online structured interviews with closed evaluation questions, in form of polls[1]. These questions were adopted from previous studies and were designed to *indirectly* evaluate the *perceptual distance* between assessing one's own and others' understanding (Figure 2). Thus, we asked both groups (IT and business) to share their own understanding of the object (e.g. functional requirements). Next, we asked for their perception of the partners' understanding, e.g., we asked IT employees how they thought their business partners understand the functional requirements. By comparing own understanding to the perception of the understanding of partners, we are able to determine the perceptual distance between the understanding. The higher the distance, the lower the level of shared understanding perceived by the respondent.

[1] Please note that we do not intend to conduct a quantitative analysis based on the structured interviews results. We rather use the structured interviews to corroborate the findings in our cross-case analysis.

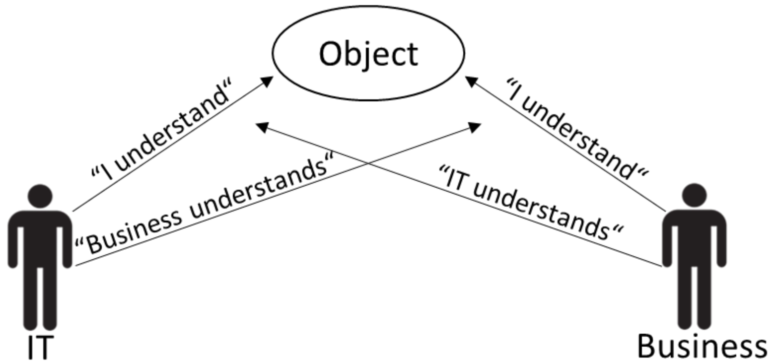

Figure 2. Concept of measurement instrument

The evaluation questions, which can be found in the Appendix, capture the understanding of *project objectives*, such as requirements specifications (Chang et al. 2014; Jiang et al. 2009), timeline and cost objectives, as well as the understanding of the *joint work environment* (Nelson and Cooprider 1996), such as challenges in the daily work of IT/business (Cohen and Toleman 2006), formal working tools (Cannon-Bowers and Salas 2001) or functional/technical procedures and practices (Stoel and Muhanna 2012). As result of step 1, we got longitudinal evaluations of the development of shared understanding among business and IT over time, which are multi-dimensional (shared understanding about objectives vs. work environment) and from multiple perspectives (IT vs. business parts of the overall team).

Step 2 – Determining B/IT-SU antecedents based on social capital mechanisms

The resulting longitudinal evaluations enable an aggregated view and a visualization of the development of shared understanding over time. To interpret and understand the development of B/IT-SU and its driving forces over the lifetime of the project, we discussed the results from step 1 with the respective IT project managers and business sponsors in an open-interview format, which took between 30 to 80 minutes. The interviews were transcribed and coded using MAXQDA. Table 3 highlights the coding framework. An extract for our coding protocol can be found in Appendix 3, Table 6.

Table 3. Coding framework

Project ID	Interview respondent	B/IT-SU dimension	Statement	Antecedent	Impact on B/IT-SU	Project phase
1 2 3 4	IT Business	Objectives Work environment	"Statement about the course of B/IT-SU"	Description of antecedent of B/IT-SU linked to an underlying social capital mechanism	Positive Negative	Initialization Planning Execution Closure

We analyzed and categorized the statements to derive factors that impact the level of B/IT-SU and discussed these factors in a group of three researchers. As a categorization scheme we applied the dimensions of social capital, which helped us identify and generalize the respective antecedent, which has the major impact according to this statement[2]. We added a brief description which links the statement to the dimensions of social capital. This description provides the linkages between the objective data and the interpretation of the result with a social capital lens. In the identification of antecedents, we only considered those which fulfilled at least one of the following criteria: An antecedent had to have been…

1) identified by both respondents (business sponsor and project manager) as important determinant,
2) mentioned more than three times in one interview, and/or
3) identified specifically as one of the most critical determinants in the development of B/IT-SU.

FINDINGS

In the following, we compare the different cases and identify similarities regarding the mechanisms facilitating and inhibiting the development of B/IT-SU. We first present a summarizing framework of antecedents found in the case studies categorizes by the dimensions of social capital. Then, we focus on the different phases of the project life cycle and identify the individual antecedents impacting the development of B/IT-SU in the respective phase.

ANTECEDENTS THAT IMPACT THE DEVELOPMENT OF B/IT-SU

In the case studies analyzed (see appendix 1 for detailed descriptions and analyses), we found different antecedents influencing the development of shared understanding. As described above, we sorted the antecedents into different categories structured by mechanisms relating to the different social capital dimensions (see Table 4). We corroborated the case findings by concepts from previous project management literature which addressed antecedents in IT projects, like joint planning (e.g. Cohen and Toleman 2006; Nelson and Cooprider 1996), feedback provision (e.g. Jani 2011; Vermerris et al. 2014; Vlaar et al. 2008) or reports and documentations (e.g. Mueller 2015; Rosenkranz et al. 2014). Whenever possible we consolidated multiple drivers into a joint category.

[2] As outline in the theoretical background section, the dimensions of social capital are tightly linked and influence each other. Our categorization attempts to identify the primary or explicit effect of each BITSU antecedent and to categorize it along the single social capital dimensions (by keeping in mind that those dimensions are interwoven).

Table 4. Antecedents of B/IT-SU		
Anteced-ent	**Mecha-nism[3]**	**Description of effect on B/IT-SU**
Joint planning	Structural mechanism	Joint planning implies (at least) a *collaboratively* developed description of work packages and roles and responsibilities (Cases C, D) involving all or the majority of the project members, and particularly both the IT and the business side. Ideally, joint planning starts with the joint execution of a feasibility analysis and rough-cut planning (Cases A, C).
Reports & Documen-tations	Structural mechanism	Reports & Documentations provide effective information platforms which serves as a communication channel between business and IT members. Status reports need to transparently indicate the status of the project as well as changing conditions affecting the project. In addition, the receivers of the status reports should carefully read them and discuss questions that arise (Case C). Too many technical terms may hinder the development of B/IT-SU (Cases C, D). Better visualizations and initial prototypes facilitate the development of B/IT-SU (Cases A, D). Documentations need to meet the following requirements: First, general objectives and work packages need to be incorporated in a business concept which highlights the system requirements and their purpose (Case B). Second, documentation should describe the setting and processes in which the project takes place (Case D). Third, documented guidelines, like role descriptions and documentation processes, help structure and formalize information for the project team (Cases A, B).
Feedback	Relational mechanism	Proving feedback on one's own understanding reveals potential misunderstandings of the technical complexity (Case A) or functional requirements (Case B).
Previous experience	Cognitive mechanism	We found two different types of (lack of) experience in our cases: experience regarding the targeted functional business domain (Case D) and experience in the technical implementation of the requirements (Cases A, C). A lack of experience can be a source of (false) expectations.

PATTERNS OF B/IT-SU DEVELOPMENT FOUND IN THE RESPECTIVE PROJECT PHASE

Based on the antecedents for the development of B/IT-SU as presented in the previous section, we now analyze commonalities and differences in the development of B/IT-SU triggered by the antecedents across the cases. We look for similar patterns regarding the development of B/IT-SU mentioned in the interviews with IT project managers and business sponsors and determine the reasons for that development based on the interview information. Figure 3 provides an overview

[3] This categorization highlights the primarily targeted social capital dimension. The mechanisms act as enablers of the respective social capital dimension, which interacts with other social capital dimensions. For an example, joint planning represents a structural binding of all team members. Certainly, the act of joint planning as structural binding will trigger cognitive capital as a consequence due to acts of information exchange, as well as relational capital, due to social interactions.

of the development of the B/IT-SU in all cases. We marked the single patterns of B/IT-SU development we found as EC for Early Collaboration, LK for Lack of Knowledge, FC for Feedback Culture and IC for Information Channels.

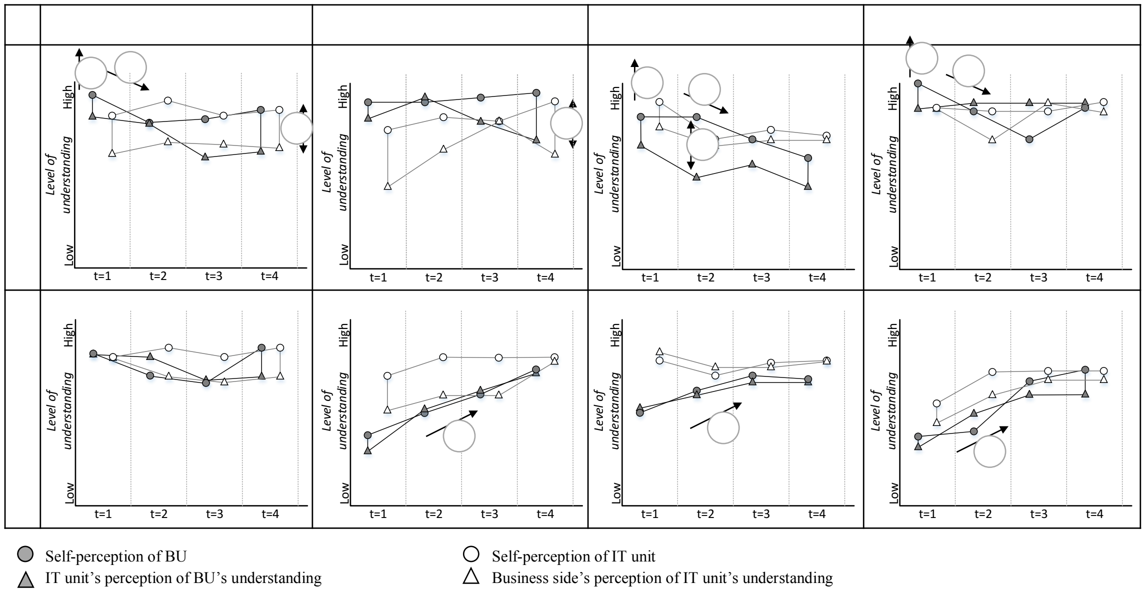

Figure 3. Overview of case findings[4]

(EC Early Collaboration; LK Lack of Knowledge; IC Information Channel; FC Feedback Culture)

Development pattern EC (Early Collaboration): Joint planning between business as well IT representatives enables high B/IT-SU of the objectives in the first phase.

In the pattern EC (Early Collaboration), we can see that (especially BU's) understanding of the project objectives starts at a very high level and decreases in the following phases (Cases A, C, D). In all three cases, the team members developed the project charter together. In Cases A and D, the project team conducted the whole feasibility analysis, rough-cut planning and work structure break-down together. In contrast, in Case C the IT project manager developed the project charter on his own but presented and discussed the charter in detail with the team before the planning phase started. Hence, the antecedents of joint planning in phase 1 can explain a very high B/IT-SU of project objectives. Joint planning, which we categorize as a structural mechanism, serves as a communication platform at an early project stage, on which business and IT representatives can jointly discuss the project objectives (Cohen and Toleman 2006).

What is different in Case B? As we can see, business perceives IT's understanding of the project objectives as low in phase 1. In Case B, the project was initiated by the management board and the BU, in cooperation with the management board, specified the project charter. IT members were not involved in the first phase and never met with the management board. We can assume

[4] A description and background information for the eight graphs in this figure can be found in appendix 1. Also, please note that this is not a quantitative analysis approach. In our analysis we are interested in the ups and downs in the development of BITSU which can be *captured* by fixed quantitative data. Nonetheless, we are not looking for a validated, statistical impact of different mechanisms on the development of BITSU.

that the level of IT's understanding for the project objectives were perceived as low at the beginning because "not all objectives have been clearly defined in a formal project charter" (business sponsor). Some requirements were formulated, while others were only discussed between the board and the BU. In addition, the IT project manager also acknowledged that the IT unit was not involved in the initialization or the planning phase ("We were just listeners", cf. above).

Development pattern LK (Lack of Knowledge): (Technical) details, lack of experience and (false) expectations reveal lack of B/IT-SU.

A lack of cognitive capital, often driven by a lack of knowledge or experience, can explain a sharp decrease of project objectives between phase 1 and phase 2. The level of complexity (Case D) or underlying cost structures (Case C) might be underestimated in phase 1. In phase 2, these false assumptions will be revealed. The business sponsor in Case D stated, "we went into this project way too starry-eyed. We thought all requirements were written in the contract with our customer". In the next phases, the business sponsor realized the complexity of the requirements. In contrast, IT's understanding of the project objectives remains very stable. The business sponsor argued that the IT unit has a lot of experience in dealing with this particular customer and knows the customers, processes, and objectives very well. Case A has a very similar background. The team raised the novelty of the targeted solution as main challenge in this project. They argued that they thought they understood the objectives in the project, but "underestimated the technical complexity of the IT solution" (business sponsor). The IT project manager, however, stated that his IT unit is very experienced in IT projects like this. In Case C, the challenge was not the technical complexity or novelty of the project but the issues that had not been discussed at the beginning of the project. The business sponsor mentioned that she felt well informed after the first meeting, but also realized that they had not discussed the cost-related issues. She realized in the planning phase that this question is critical in an IT project like this but that she could not understand the cost statements in the planning phase.

Thus, we can see that joint planning is not sufficient to keep a high level of B/IT-SU. Moreover, under certain circumstances joint planning has the potential to create a "false" or superficial shared understanding, which will be revealed as such in later phases. This risk is higher if the project team lacks experience or if the project task is novel in terms of structure or approach. It has proven important to discuss the complexity as well as cost-related issues in detail to maintain a high level of B/IT-SU of the project objectives. This findings supports previous research, which suggests that in-depth shared understanding of technical details is critical for the project success in projects characterized by novel structural approaches (Tiwana 2012).

Development pattern FC (Feedback Culture): Perceptual differences arise from low relational mechanism, like a weak feedback culture

In Cases A to C, we observe several gaps between self-perception of understanding and perception of the partner's understanding. We found that superficial discussions and little (consideration of) feedback caused these perceptional differences. A healthy feedback culture can be described as a team norm or as relational mechanism (Robert et al. 2008). Especially in Cases B and C we found two distinct examples of lack of feedback provision (Case B) and lack of feedback consideration (Case C). While in Case B both the business and IT unit stated that IT members had not been involved in the project planning for providing feedback ("We were just listeners"), the business unit in Case C seemed to ignore feedback which did not match her (cost) expectations (*"I guess* *she understood the situation [based on the cost statement], but she did not want to accept it").* Thus, the lack of consideration or provision of feedback caused a disruption in how the units assessed the current situation and led to a large perceptional gap between the units.

What was different in Case D? In Case D the business sponsor argued that the BU sometimes had problems understanding the concrete project objectives due to the high technical complexity. The business sponsor herself did not ask any detailed questions at the beginning, because she thought, "*it would look unprofessional*". However, after a while (in t=3) she realized that this belief was nonsense and the IT unit was very happy to answer all technical questions ("*they were very patient and sympathetic*", business sponsor). Thus, giving and receiving feedback on eye-level proved an important mechanism to achieve a high level of B/IT-SU.

Development pattern IC (Information Channel): Formal communication and information channels, like reports & documentations, facilitate the B/IT-SU of the work environment.

Cases B, C and D show that it is especially BU's understanding for the work environment that increased over time. The most substantial increases were found in Cases B and D.

In Case B, the interviewees mentioned problems due to a missing business concept, which led to a lack of transparency. Especially the BU did not understand "which technical specifications had to be implemented" and "the challenges and problems in the backend development" (IT project manager). The interviewees stated that this changed when they introduced frequent reports and an OIL (open issue list) during the planning and execution phase. Since all status reports were now documented in the OIL, BU could now develop an understanding for the technical challenges.

Very similarly in Case D, the interviewees mentioned initial problems due to a lack of transparency. However, in this case, the BU members knew little about the client or the IT solution and the level of understanding of the work environment started at a very low level. The business sponsor also mentioned the lack of information and insights which the BU could have used to learn more about the clients situation as an additional challenge in the development of B/IT-SU. However, frequent status reports increased the level of BU's understanding of the work environment. As the business sponsor pointed out, in addition to reporting frequency, reporting quality is key as well. A status report can be more effective if it favors business over technical terminology and visualizes information rather than providing lengthy descriptions.

In Case A we observed a high level of understanding at the very beginning, thus there was little potential for observing a notable impact of frequent reports and documentation. Still, the business sponsor mentioned that frequent (visualized) reports helped everyone stay informed. However, our respondents also mentioned that the information exchange has been very technical and difficult to understand for the business members, which causes the development described in pattern FC above.

Development pattern TK (Tacit Knowledge): Increasing shared understanding of the work environment does not automatically imply an increase of the understanding of project objectives.

A last pattern was found in the comparison of BU's understanding of the project objectives and of the work environment (therefore it could not be explicitly illustrated in Figure 3. Especially in Cases B, C and D, IT's perception on BU's understanding of the project objectives decreased steadily over time, while their perception of business side's understanding of the work environment increased. A potential explanation lies in the fundamental difference of the two types of knowledge. Research into knowledge and understanding (see for example Cannon-Bowers and Salas 2001) differentiate between implicit and explicit knowledge (Polanyi 1958). While explicit knowledge refers to "knowledge that is transmittable in formal, systematic language […], 'tacit' knowledge has a personal quality, which makes it hard to formalize and communicate" (Nonaka 1994, p. 16). Similar differentiations can be found in the conceptualization of B/IT-SU. While objectives are most commonly formalized in some way (e.g. within SLAs, in a project charter or in a formal contract), concrete tasks, challenges and problems in a work environment are more tacit and need to be experienced.

Typically, project objectives are or can be formalized in the project charter or in the planning phase, representing *explicit* knowledge. By contrast, the everyday work environment is fuzzier, requiring implicit and *tacit* knowledge to fully understand. We argue that knowledge or expectations codified in a project charter can be made obsolete much easier than tacit knowledge based on experience. In the interviews, we commonly observed a decrease of understanding of the project objectives in case of a lack of experiences and (false) expectations regarding technical complexity or cost statements. The respondents commonly reported that they did not expect this level of complexity when formalizing the project charter. In the development of B/IT-SU of the work environment, we found that in Cases B, C, and D the BUs were not very experienced in IT projects like this. They argued that at the beginning of the project they could not understand the concrete tasks within the work packages or reasons for specific reporting lines – even if attempts were made to codify or document this knowledge during the project. The respondents commonly argued that their understanding increased through frequent discussions with the IT unit. These findings support our assumptions that a deep understanding of the work environment requires much more tacit knowledge gained through experience and not easily codified in project documents. In contrast, project objectives can to some degree be formalized in a project charter, even though technical project details are difficult to formalize in the project charter.

This pattern is in line with findings by other scholars, such as van den Hooff and de Winter (2011), who could not find a significant direct impact of cognitive capital, which the authors defined as "a common ability that helps in understanding, interpreting and valuing other people's knowledge" (p. 3), on the degree of knowledge sharing regarding the respective work environment. However, they found that cognitive capital positively influences relational capital, which in turn influences knowledge sharing. In our study, we did not find any indications of this positive interlinked effect, possibly because the period of our data collection was too short to observe these effects. We can, however, confirm that cognitive capital does not immediately affect the level of B/IT-SU of project objectives. The following figures 4-7 briefly summarizes the findings of the cross-case analysis:

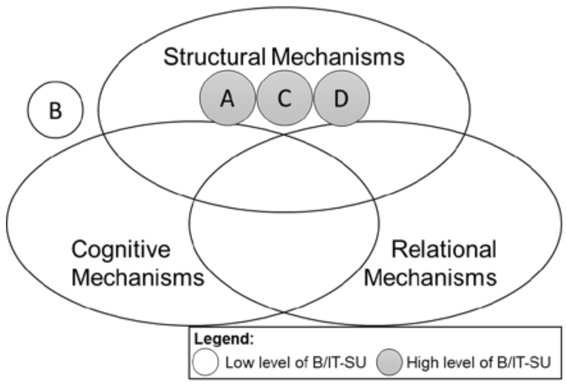

Figure 4. Situation at t=1 Initalization

Case A, C and D implemented structural mechanisms in the initialization phase by joint planning. By contrast, the IT unit in Case B has not been involved in the rough-cut planning, for which reason, shared understanding starts at a relatively low level.

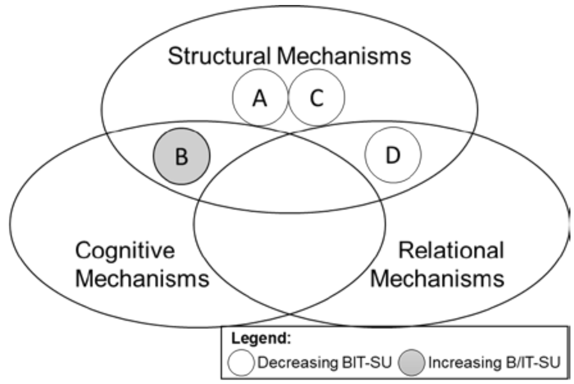

Figure 5. Development from t=1 (Initialization) to t=2 (Planning)

From t=1 to t=2, the level of B/IT-SU regarding project objectives decreased in Case A, C and D because the project complexity had been underestimated. Since in Case B the expectations were quite clear due to previous experience (cognitive mechanism), the perceived level of B/IT-SU remained stable. In addition, the team started to implement structural mechanisms (pattern IC), which had an additional positive effect on B/IT-SU.

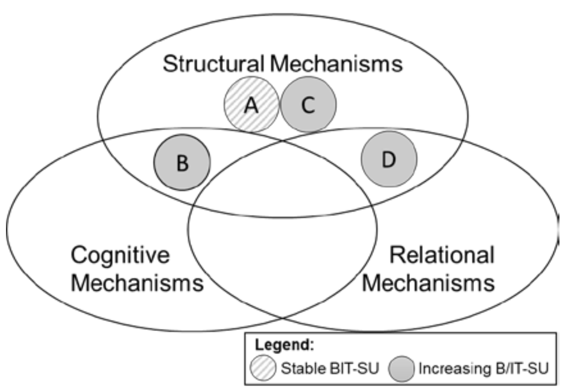

Figure 6. Development from t=2 (Planning) to t=3 (Execution)

From t=2 to t=3, B/IT-SU of project objectives remained rather stable while B/IT-SU of work environment increased in Cases B, C and D, due to frequent reports. In Case D, the team started discussing the procedure more frequently (pattern FC), which stabilized B/IT-SU. In Case A, these mechanisms showed no effect. Information distributed between business and IT was very technical, for which reason the gap between self-understanding and perception of others understanding regarding the project objectives started increasing on both sides.

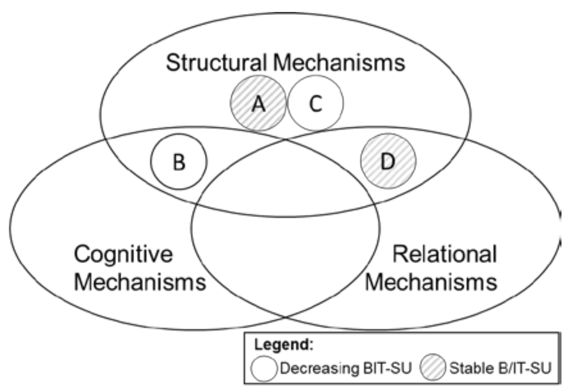

Figure 7. Development from t=3 (Execution) to t=4 (Completion)

A lacking feedback culture (pattern FC) became a problem for Case B in the last phase when the team realized that not the feedback provision was the problem but the feedback acceptance. Also, Case C suffered from pattern FC which has shown its symptoms in t=2. Cases A and D remained stable since the responsibilities and work packages has been clearly defined. Also, in Case D frequent feedbacks impeded additional drops of B/IT-SU.

CONCLUSION

CONTRIBUTION TO LITERATURE

In this cross-case study, we analyzed different events and mechanisms that impact the development of business/IT shared understanding (B/IT-SU) in IT projects. We categorized these antecedents according to the structural, cognitive and relational mechanisms. We collected longitudinal data in four IT projects to determine the development of B/IT-SU over the project lifetime and to find explanations for changes in the development of B/IT-SU. We identified common development patterns that explain the commonalities and differences in the development of B/IT-SU across the cases. Thus, the major contribution of our study lies in analyzing the temporal effects of different project factors and their impact on the development of B/IT-SU. We further derived necessary conditions, interplays between different antecedents and their impact on the following project phases. In summary, our study contributes to literature as follows:

Structural mechanisms for enabling B/IT-SU need to be implemented across the whole project life cycle. In our cross-case analysis, we observed that joint planning facilitates a high B/IT-SU at the beginning of the project but does not necessarily establish a high level of B/IT-SU across all stages of the project. Only in combination with frequent reports and documentations in the later phases can the level of B/IT-SU stay on a high level. A drop in B/IT-SU after the first phase seems to be quite common, when there is a lack of knowledge and experience (cognitive mechanism) in the team. In teams with these attributes the technical details have been frequently underestimated and the expectations seemed to be too high. Nonetheless, these insufficiencies can be absorbed by frequent structural mechanisms, like reports & documentations that provide a present information platform for business and IT. However, these structural mechanisms are a necessary but not sufficient condition to achieve a high level of B/IT-SU. If the information which is transferred by structural mechanisms is not processed and absorbed by the recipients of the information, a gap between perceptions will occur, leading to insufficient shared understanding. The consideration of the provided information is a critical component of relational mechanisms in which most of our cases exhibit insufficiencies. Also, this mechanism has been mentioned as one of the final and most important mechanisms to build shared understanding and to successfully complete the project. The development patterns are summarized in Figure 8.

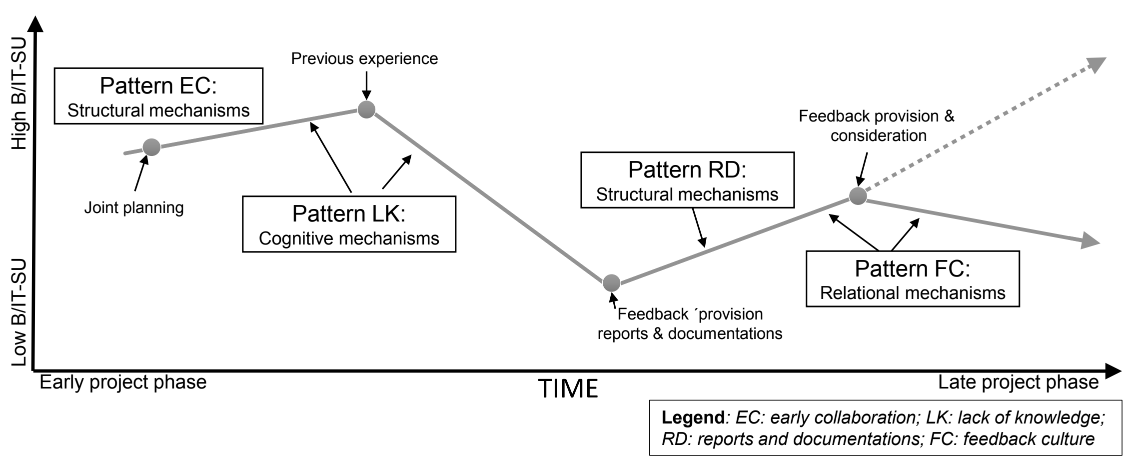

Figure 8. Common development patterns of B/IT-SU and its reasons

We also shed light on the discussion of whether shared understanding increases, due to structural mechanisms (He et al. 2007), or decreases due to specialization (Levesque et al. 2001). Our study reveals that structural mechanisms have the potential to contribute to a shared understanding between business and IT when maintained across the whole project. Based on our qualitative interview results, we found that a drop in shared understanding is commonly associated with a threat to the project rather than an explanation for specialization.

Based on this longitudinal study, we now have a deeper understanding of how to design management actions to facilitate these concrete antecedents. For instance, we found indications that a lack of experience can limit the development of B/IT-SU in the planning phase, while this limitation can be overcome over time by a culture of giving and receiving feedback in an eye-to-eye partnership.

Managerial implications

In the following, we highlight the most relevant managerial conclusions derived from the case analysis:

1. Joint planning starting at an early stage in the project leads to high shared understanding regarding project objectives. Thus, managers should enable cooperative planning from the beginning of the project, like joint feasibility analysis or break-down of the work packages. This joint planning will also help to cushion the drop of shared understanding when it comes to (technical) details.
2. A lack of knowledge and experience will intensify this drop from the initialization phase to the planning and execution phases. Based on different experiences, team members might make (false) assumptions that will become apparent later on, when the details are foregrounded. Thus, if there is a lack of experience in the team, the manager will need to actively get sufficient information from more experienced sources to cushion and finally increase the level of B/IT-SU during the project execution.
3. Frequent feedback about shared understanding helps to recover from a low level of shared understanding. However, it is not only important to provide feedback, but in turn to consider and accept feedback from partners for further discussions. Managers should focus on implementing a constructive and bidirectional feedback culture from the initialization to the closure of the project.
4. Shared understanding of the work environment, which represents a much more tacit domain of understanding than project objectives, can be improved by a high transparency of project-related processes. Frequent reports and documentations contribute to the creation of this transparency. In contrast, explicit knowledge about project objectives, in our cases, can be increased by formulating them clearly at the beginning of the project.

Limitations and further research

Some limitations have to be considered when interpreting the findings. One major issue is that we cannot guarantee that we have not overlooked other critical drivers. First, our findings are mainly determined by the interviews with the IT project manager and business sponsor of each project. We cannot exclude the possibility that the project leaders misinterpreted or forgot other aspects that would have been insightful for us. For future research, we recommend broadening the data collection approach by collecting objective data as well, such as reports, and more interviews per case. Second, our study does not include a quantitative measure of project performance, making it difficult to estimate the quantitative effects of changes in B/IT-SU on project success. According to the project leaders and business sponsors, our informants for the level of project success, the importance of B/IT-SU was high, but we do not have statistical evidence for that and need to rely on other studies that have already shown the importance of B/IT-SU. Future research could include richer measures of project success, like adherence to schedule, quality of functionalities or team member satisfaction that can be answered by every team member. Third, our findings are based on only four case studies from one company. Even though the four projects are very different regarding their objectives, organizational structure and stakeholders, the findings of a comparable case study in another firm and industry might differ. Further research could focus on different projects in different industries. Fourth, especially for the cross-case analysis, we had to subsume the detailed case findings into fewer meta-drivers. Although we followed the coding process carefully, there still might be other possibilities to combine and describe the different case specific findings in a cross-case analysis. More data from more different cases might minimize this limitation. Fifth, due to our case study approach, we could not ensure high variance regarding level of shared understanding in the cases. Indeed, in all four cases we found a rather high level of shared understanding. Future research should compare the effects of B/IT-SU antecedents in teams with a high vs. low level of shared understanding.

Despite these limitations, our study provides valuable in-depth insights into the organizational development of shared understanding in an IT project life cycle and contributes to literature by unveiling the effects of drivers on B/IT-SU. Based on these findings, we uncovered five patterns, which can be applied by research as well as in practice to categorize and further understand the effects of different social capital-related mechanisms.

APPENDIX

APPENDIX 1: ANALYSIS RESULTS OF EACH CASE

In the following a brief description of the results in each case will be presented. The results are consolidated in the findings section in the main body of this paper.

Analysis results of Case A

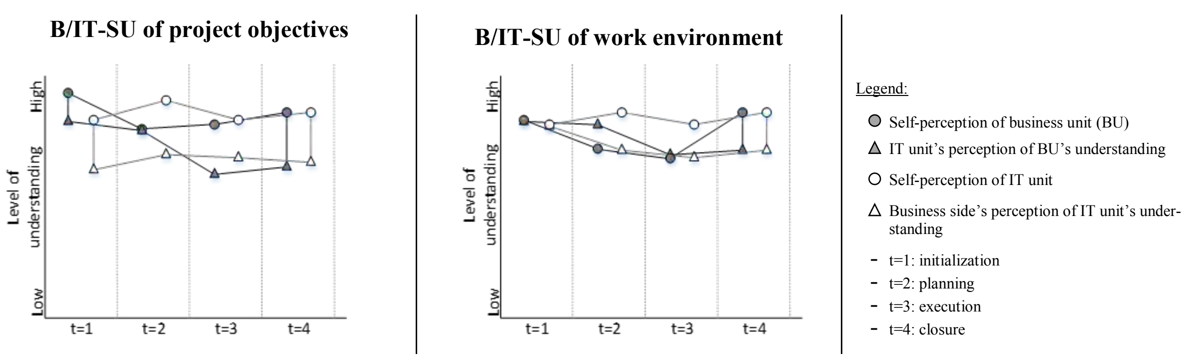

Figure 9. Level of B/IT-SU in Case A

In Figure 9, we can see the development of B/IT-SU of project objectives (left) and of the work environment (right) over time. Especially regarding business unit's (BU) perception of their own understanding we found a slight dip in t=2, followed by a decline of IT's perception of it in the subsequent period. In the next phases, BU's understanding recovered slightly. At the end of the project, business and IT members' understanding met at a high level, with some remaining discrepancy between self-perception and perception by the other unit.

The interviews with the IT project manager and business sponsor uncovered reasons for this development of B/IT-SU: The initially very high level of (perceived) understanding could be explained by **joint planning** in the initialization phase. Business and IT members jointly discussed and developed the requirements and conducted the feasibility analysis in the initialization phase: "All members were equally involved in the development of the work breakdown structure and project contract" (business sponsor).

The subsequent decrease of BU's understanding in the subsequent phase (as also perceived by the IT unit in the following step) can be explained by the collaboration's focus shifting from functional to technical details in the planning and execution phase. Due to the novelty of the project (i.e. lack of **experience**), the business members underestimated the technical complexity of the project in phase 1. When the team started planning the details, business members noticed that they did not fully comprehend the full scope of the project objectives. The IT project manager mentioned that, from then on, business members focused on more non-technical issues like monitoring the completion of work packages and milestones. Business members did not involve themselves in discussions about the technical content of the work packages. Both sides (IT and business) mentioned that the discussions centered on the functional requirements, while IT was very aware of the technical requirements as well. More detailed discussions and **feedback** about the individuals' understanding might have solved or as least minimized BU's underestimation of technical complexity.

However, understanding rose again towards the end of the project. A very important aspect highlighted by the business sponsor was constant **reporting** on project status by visualizing and modeling user stories and business processes. Based on these visualized models, discussions between IT and business were more focused on the status of the project. Besides the modeled user stories and business processes, the business sponsor mentioned that a project management handbook (representing **formalized guidelines)** describing the project roles and responsibilities in detail helped facilitate understanding of the collaborative work environment.

In summary, our interviews with the business sponsor and IT project manager revealed several indications for a harmonic business/IT partnership in the project. Both partners **perceived each other as equal partners** during the project and responsibilities were allocated clearly enough in the team. While IT members were responsible for the technical details, business members monitored the progress of the project and defined the functional requirements of the system. Across all phases, the business sponsor mentioned that a very detailed **reporting** of the underlying processes, content of work packages, and current state of the project were essential in keeping everyone well informed about the project.

Analysis results of Case B

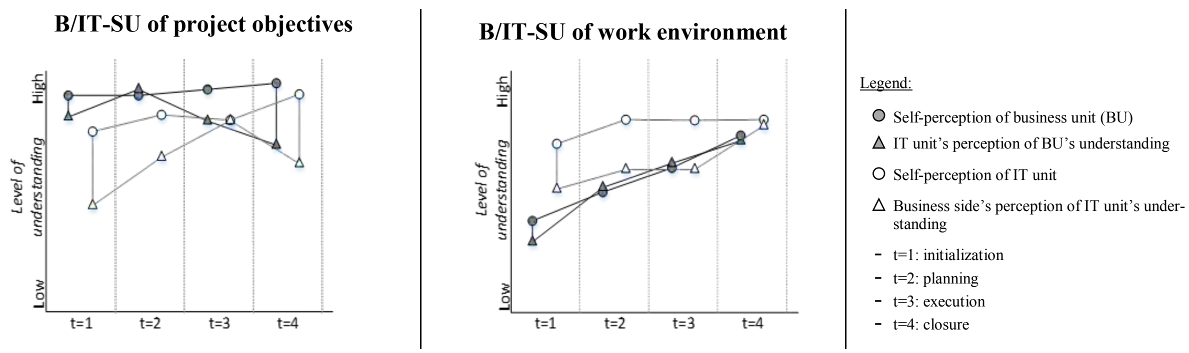

Figure 10. Level of B/IT-SU in Case B

Figure 10 illustrates the level of shared understanding between business and IT professionals in Case B at the four pre-defined points in time. There are some notable peculiarities: first, regarding the B/IT-SU of project objectives we find high perceptual distances at the beginning and at the end of the project; while IT and business were very confident about their own understanding of the project objectives, they perceived their partners' understanding as relatively low. Second, at the beginning of the project, the business side ranked IT's understanding of the project objectives as very low. This perception rises until the project execution phase (t=3) and then drops sharply again at the end of the project (t=4). Third, the only consistent notable rise in B/IT-SU can be found in BU's understanding of the work environment.

To understand the first particularity of the divergent perceptions of each other's understanding, it is important to understand the starting point of the project and the situation during project planning. The underlying project objective was to develop a management cockpit that visualizes the performance of existing projects in the company. However, there was no official project charter and no formalized description of the requirements. In the kick-off meeting, the BU presented a visualized draft of the cockpit and the IT project manager left the meeting with the impression that "everything is clear now, and we know what to do". In contrast, the business sponsor perceived the IT colleagues as being more skeptical. He mentioned that IT members were sitting in the meeting, but did not involve themselves deeply into the development of the requirements. The IT project manager even agreed on this perception, stating: "We were just listeners". The business sponsor would have hoped that the IT unit would provide more **feedback** to verify the shared understanding.

After the kick-off, the IT unit started developing the cockpit. Due to the lack of formalized requirements, the business sponsor suspected that IT unit "had to make assumptions every 15 minutes during the development about the intent of the single requirements" (business sponsor). In addition, the requirements changed several times, which increased the complexity during the development. As early as the planning phase, but especially in the execution phase, the IT project manager stated that he did not understand the functional usefulness of several of the requirements. However, the IT unit believed they understood the requested composition of the system features and did not question the content of these requirements. These miscommunications finally resulted in the revelation of divergent perceptions of the understanding of project objectives. The business sponsor mentioned that IT did not implement several critical features but instead developed unnecessary features. For their part, IT stated that the BU constantly changed the requirements during the execution and did not seem to understand the requirements themselves. Both the IT project manager and the business sponsor mentioned the lack of a detailed **business concept** specifying the requirements and system objectives as the fundamental problem in this project.

Regarding the development of shared understanding about each other's work environment, the development approach proved to be a source of misunderstandings. Even though the IT project manager mentioned that they applied Scrum, the business sponsor stated that critical components of the Scrum approach had not been defined (e.g., assigning the roles of Scrum master or product owner). Further, the business sponsor expected more and shorter sprints, enabling more intense communication between parties. Actually, the IT project manager explained that they did not work in sprints at all but delivered only the final version to the BU for testing. Both interviewees argued that these confusions about the **development approach** "led to several conflicts between business and IT" (business sponsor) at the beginning of the project.

Nonetheless, the team managed to achieve a high level of shared understanding in the last phase of the project. The business sponsor and project manager mentioned that the lack of transparency at the beginning of the project could be managed by an "open issue list" (OIL), which allows team members to marked project tasks as open or completed. This list could be used as a platform for detailed discussions. We found several indications that management actions formalizing the projects task packages, such as an OIL, provide an ideal communication base to further structure and develop the applied development approach. Since the OIL is a kind of reporting tool, which identifies and summarizes open and completed tasks for all team members, we use the more generic term of **reports** as a factor that explain the increase of B/IT-SU of the work environment.

Analysis results of Case C

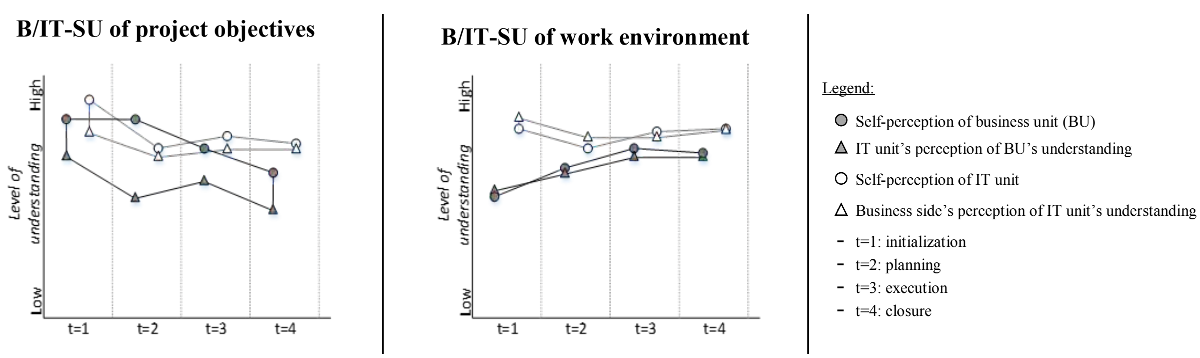

Figure 11. Level of B/IT-SU in Case C

As illustrated in Figure 11, all team members were quite confident about the level of understanding regarding the project objectives at the beginning of the project. While the level of BU's understanding of the project objectives remained stable during planning (t=2), IT's understanding of the objectives dropped in this early phase. The results for B/IT-SU of the work environment are quite different. While BU's understanding increased over time and remained stable on a high level from t=3 to t=4, IT's understanding was moderately high over the whole project duration. Additionally, we found nearly no perceptional distance between IT's and BU's perceptional understanding.

But why did the B/IT-SU of project objectives drop, while the B/IT-SU of the work environment increased over time? One factor may be that the initial circumstances in which the project was embedded were challenging. The IT project manager stated that usually the corporate controller would be the business sponsor of projects like this. However, in this case the responsibilities were transferred to another BU, which had no experience with this kind of projects. This transfer of responsibilities might explain the BU's lack of enthusiasm for the project. In the interviews with the ('new') business sponsor, she mentioned that she did not have time for this project and could not fulfill the tasks assigned to her. The IT project manager mentioned that she even questioned the necessity of the project and asked for reasons for this modernization.

Starting with the project initialization phase, we observe a good level of B/IT-SU of the project objectives. The project charter developed by the IT project manager had been discussed with the BU. Hence, the project started with a **jointly formulated project charter**. Already at this stage, the business sponsor mentioned that the objectives regarding costs statements were not sufficiently transparent. However, the business members had the (false) impression that the general objectives were clear for both sides.

In the following phase of project planning, the business sponsor requested more **transparency** regarding the cost statements. At this stage, it became clear that her priority remained the budget constraints (*"we had to find a cost-efficient solution"*), while the IT project manager focused on the quality of the systems (*"The project manager's only goal is to have an innovative system",* business sponsor). At the end of this phase, the business sponsor had the impression that the objectives had been discussed sufficiently and she felt well informed. The IT unit, in contrast, seemed to be disorientated by this new prioritization of project objectives, which is reflected by the results of the MU measurement and the interview with the IT project manager ("*I sent her the cost statements which highlighted in great detail the resources necessary to achieve the objectives in the project. I guess she understood the situation, but she did not want to accept it.*")

In the next phase, the project additionally suffered from continuous changes: For example, one of the four staff canteens decided to leave the project right before the implementation of the new system. The reasons remained unclear. Furthermore, after the project planning phase, the accounting unit decided to change the order of the hardware to more cost-efficient hardware. The IT project manager reported that these changes caused many adjustments of the project objectives. While the project manager stated that he (the project manager) constantly delivered status reports to the BU, the business sponsor mentioned her impression that he (the project manager) was constantly distracted by these changes from the initially established project objectives. She would have wished for more continuity regarding the project objectives. We cannot determine whether the business sponsor and business members did not understand (or even did not care for) these changes or if the reports had been indeed insufficiently transparent regarding these changes. However, both interviewees attributed the drop of BU's understanding of project objectives to a lack of transparency (or lack of BU's understanding) of the **status reports**.

Even though BU's understanding of project objectives decreased over time, the understanding for the work environment constantly increased from t=1 to t=3. Both interviewees argued that the **joint formalization** of work packages, reporting lines and responsibilities helped a lot to increase the understanding of the work environment. The IT project manager mentioned that most of the formalization techniques reflect common project management techniques that have been applied in previous IT projects. Since the IT unit is familiar with these techniques to structure their project, IT's understanding for the work environment was constantly on a high level, while BU's understanding increased over time.

Analysis results of Case D

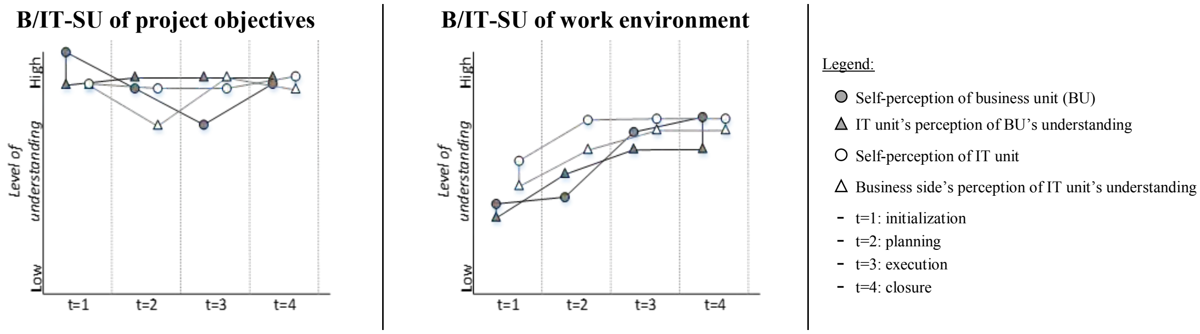

Figure 12. Level of B/IT-SU in Case D

Overall, we found a quite stable and high level of B/IT-SU of the project objectives (Figure 12, left). Interestingly, while IT perceived a high level of shared understanding of the business members, they themselves are not that confident (at least in t=2). The self-perception decreases slightly from t=1 to t=3 but then increases again to a high level in t=4. In addition, they believed in t=2 that IT's understanding for project objectives dropped as well. This development can be explained by the **lack of experience** of the BU. The business sponsor stated that they had been "*very naive at the beginning of the project. We saw the contracts with our client and believed that we just needed some minor adjustments in the system*". In phase 2, the BU noticed that they had underestimated the complexity of the project and that they had overlooked several (more technical) objectives. However, **intense discussions and examinations of the target system** helped the BU to get involved in the process and to get a high level of understanding of the project objectives over time.

Focusing on the development of B/IT-SU of the work environment, we can find a remarkable positive development and also very congruent perceptions among business and IT members during the whole project. The level of B/IT-SU starts at a very low level and constantly rises over time; the very low level at the beginning of the project is a consequence of the novelty of the involved BU. The business sponsor stated that her team had significant difficulties at the beginning of the project because most members in the BU – including herself – had just recently started their job at the company and did not have sufficient **experience** with the client's industry. The business sponsor further argued that they had problems due to a lack of **documentation of the processes and functions** to get familiar with the working routines and procedures at the start of the project. She stated that this lack of understanding for and the difficulties of learning about the work environment made it difficult for her to provide necessary information to the IT unit.

With the start of the planning phase (t=2) the team intensively **discussed the work packages,** which helped the BU to get a better understanding for the appropriate procedures and tasks in the project. The IT unit also benefited from these discussions, which gave them detailed insights into the targeted business domain. Nevertheless, the BU was not sufficiently satisfied after the meeting. The business sponsor mentioned that she and her team colleagues from the BU did not understand the content of the work packages because they were "*very technical, so I did not understand what exactly had to be done in the work packages*". In addition, she stated that she had problems because the discussions in the meeting were not well structured. Work packages and tasks in the project have been discussed randomly and the IT project manager switched rapidly between the different work packages. Thus, we summarize that effective discussions need to be sufficiently structured and members should apply the "same language" to describe the work packages.

In the subsequent phases of the project, the level of IT's understanding of the work environment remained stable. "*All necessary information has been transferred*" in the planning phase (IT project manager). On the other hand, the understanding of the BU increased sharply and reaches the level of understanding of the IT unit. The business sponsor attributes this sharp increase to the constant interaction between IT developers and the BU using **status reports**. The developers frequently reported the developments of the programming to the BU. The business sponsor mentioned that she could not understand the reports of the IT unit at the beginning, because of the technical language. However, after the unit reported more visualized and prototype-based results, the business sponsor stated that she had kind of an "aha moment" in which she understood all the previous discussions and reports.

APPENDIX 2: STRUCTURED INTERVIEW QUESTIONS

Table 5. Questions in structured interviews

	Self-perception	*Perception of business/IT unit on IT/business unit*
Project Objectives	How do you perceive your own understanding of … - functional requirements of the IT solution. - technical requirements of the IT solution. - objectives regarding the schedule. - objectives regarding costs and expenses.	How do you perceive the understanding of your colleagues in the business/IT unit regarding the … - functional requirements of the IT solution. - technical requirements of the IT solution. - objectives regarding the schedules. - objectives regarding costs and expenses.
Work Environment	How do you perceive your own understanding of … - functional/technical procedures and approaches - available resources (time, budget, HR) - formal working tools (documentation, forms, workflow structure) - specific challenges in realization - organizational structure and reporting lines - roles and responsibilities in the project	How do you perceive the understanding of your colleagues in the business/IT unit regarding the … - functional/technical procedures and approaches - available resources (time, budget, HR) - formal working tools (documentation, forms, workflow structure) - specific challenges in realization - organizational structure and reporting lines - roles and responsibilities in the project

(using a five-point Likert scale from 1 – "very low" to 5 – "very high")

APPENDIX 3: EXTRACT FROM CODING PROTOCOL

Table 6. Exemplary extract of the coding approach

ID	Dimension	Interview response	Statement	Antecedent	Impact	Project phase
A	Objectives	IT	"However, after we documented the feedback of our business partners as well as a bug report, the communication has been improved and everybody knew what to do."	Formalization of feedbacks and reports helps the team to get on the same page (cognitive mechanism)	Positive	Execution Closure
			"I wrote down the major topics which we [business and IT] had planned in a document. That helped a lot in the latter discussions."	Formalization of requirements and plans provides a foundation for discussions (cognitive mechanism)	Positive	Planning Execution
		Business	"The objectives have been documented in the project plan based on the work packages, so that I knew when and what milestone should be achieved by whom as well as the current degree of completion."	Documentation and reporting the objectives and milestone completion build a common ground between business and IT (cognitive mechanism)	Positive	Planning Execution Closure
			"The formulization of the work packages has been an integrated part of the development approach, for which reason I was up to date at all times during the project"	The formulization and status report of the work packages keeps everyone informed (cognitive mechanism).	Positive	Planning Execution Closure

REFERENCES

Adler, P. S., and Kwon, S.-W. (2002). "Social capital: prospects for a new concept." *Academy of Management Review, 27*(1), 17-40.

Avgerou, C. (2013). "Social Mechanisms for Causal Explanation in Social Theory Based IS Research." *Journal of the Association for Information Systems, 14*(8), 399-419.

Bittner, E., and Leimeister, J. M. (2014). "Creating shared understanding in heterogeneous work groups: why it matters and how to achieve it." *Journal of Management Information Systems, 31*(1), 111-143.

Cannon-Bowers, J. A., and Salas, E. (2001). "Reflection on shared cognition." *Journal of Organizational Behavior, 22*, 195–202.

Cannon-Bowers, J. A., Salas, E., and Concerse, S. (1993). Shared mental models in expert team decision making. In C. NJ (Ed.), Individual and Group Decision Making, (pp. 221-246). Hillsdale, NJ: Lawrence Erlbaum Associates.

Chang, J. Y. T., Jiang, J. J., Klein, G., and Wang, E. T. G. (2014). "Do too many goals impede a program? A case study of enterprise system implementation with multiple interdependent projects." *Information & Management, 51*(4), 465-478.

Charaf, M. C., Rosenkranz, C., and Holten, R. (2013). "The emergence of shared understanding: applying functional pragmatics to study the requirements development process." *Information Systems Journal, 23*(2), 115–135.

Chiravuri, A., Nazareth, D., and Ramamurthy, K. (2011). "Cognitive Conflict and Consensus Generation in Virtual Teams During Knowledge Capture: Comparative Effectiveness of Techniques." *Journal of Management Information Systems, 28*(1), 311–350.

Chua, C. E. H., Lim, W.-K., Soh, C., and Sia, S. K. (2012). "Enacting Clan Control in Complex IT Projects: A Social Capital Perspective." *MIS Quarterly, 36*(2), 577–600.

Cohen, J. F., and Toleman, M. (2006). "The IS–business relationship and its implications for performance: An empirical study of South African and Australian organisations." *International Journal of Information Management, 26*(6), 457–468.

Cooke, N. J., Kiekel, P. A., Salas, E., Stout, R., Bowers, C., and Cannon-Bowers, J. A. (2003). "Measuring Team Knowledge: A Window to the Cognitive Underpinnings of Team Performance." *Group Dynamics: Theory, Research, and Practice, 7*(3), 179-199.

Davis, J. M., Kettinger, W. J., and Kunev, D. G. (2009). "When users are IT experts too: the effects of joint IT competence and partnership on satisfaction with enterprise-level systems implementation." *European Journal of Information Systems, 18*(1), 26–37.

Dennis, A. R., Fuller, R. M., and Valacich, J. S. (2008). "Media, Tasks, and Communication Processes: A Theory of Media Synchronicity." *MIS Quarterly, 32*(3), 575-600.

Devine, F., and Roberts, J. M. (2003). "Alternative approaches to researching social capital: A comment on van Deth's measuring social capital." *International Journal of Social Research Methodology, 6*(1), 93-100.

Dhaliwal, J., Onita, C. G., Poston, R., and Zhang, X. P. (2011). "Alignment within the software development unit: Assessing structural and relational dimensions between developers and testers." *The Journal of Strategic Information Systems, 20*(4), 323–342.

Dubé, L., and Paré, G. (2003). "Rigor in Information Systems Positivist Case Research: Current Practices, Trends, and Recommendations." *MIS Quarterly, 27*(4), 597-635.

Durst, C., Viol, J., and Wickramasinghe, N. (2013). "Online Social Networks, Social Capital and Health-related Behaviors: A State-of-the-art Analysis." *Communications of the Association for Information Systems, 23*(5), 134-158.

Grand, J. A., Braun, M. T., Kuljanin, G., Kozlowski, S. W. J., and Chao, G. T. (2016). "The Dynamics of Team Cognition: A Process-Oriented Theory of Knowledge Emergence in Teams." *Journal of Applied Psychology, 101*(10), 1353-1385.

Habermas, J. (Ed.) (1985). *Theory of communicative Action*. Boston, Massachusetts: Beacon Press.

He, J., Butler, B. S., and King, W. R. (2007). "Team Cognition: Development and Evolution in Software Project Teams." *Journal of Management Information Systems, 24*(2), 261-292.

Jiang, J. J., Klein, G., Wu, S. P. J., and Liang, T.P. (2009). "The relation of requirements uncertainty and stakeholder perception gaps to project management performance." *Journal of Systems and Software, 82*(5), 801-808.

Johnson, A. M., and Lederer, A. L. (2007). "The Impact of Communication between CEOs and CIOs on their Shared Views of the Current and Future Role of IT." *Information Systems Management, 24*(1), 85–90.

Johnson, A. M., and Lederer, A. L. (2010). "CEO/CIO mutual understanding, strategic alignment, and the contribution of IS to the organization." *Information & Management, 47*(3), 138–149.

Karahanna, E., and Preston, D. S. (2013). "The Effect of Social Capital of the Relationship Between the CIO and Top Management Team on Firm Performance." *Journal of Management Information Systems, 30*(1), 15–56.

Ko, D.-G., Kirsch, L. J., and King, W. R. (2005). "Antecedents of Knowledge Transfer from Consultants to Clients in Enterprise System Implementation." *MIS Quarterly, 29*(1), 59–85.

Levesque, L. L., Wilson, J. M., and Wholey, D. R. (2001). "Cognitive divergence and shared mental models in software development project teams." *Journal of Organizational Behavior, 22*(1), 135-144.

Maurer, I., and Ebers, M. (2006). "Dynamics of Social Capital and Their Performance Implications: Lessons from Biotechnology Start-ups." *Administrative Science Quarterly, 51*(2), 262–292.

Mueller, J. (2015). "Formal and Informal Practices of Knowledge Sharing Between Project Teams and Enacted Cultural Characteristics." *Project Management Journal, 46*(7), 53-68.

Nahapiet, J., and Ghoshal, S. (1998). "Social Capital, Intellctual Capital, and the Organizational Advantage." *Academy of Management Review, 23*(2), 242–266.

Nelson, K. M., and Cooprider, J. G. (1996). "The Contribution of Shared Knowledge to IS Group Performance." *MIS Quarterly, 20*(4), 409–432.

Nonaka, I. (1994). "A Dynamic Theory of Organizational Knowledge Creation." *Organization Science, 5*(1), 14–37.

PMBOK, P. M. I. (2013). *A Guide To The Project Management Body Of Knowledge (PMBOK Guides)* (Fifth ed.). Newtown Square, Pa: Project Management Institute.

Polanyi, M. (1958). *Personal Knowledge. Towards a post-critical philosophy*. Chicago IL: The University of Chicago Press.

Preston, D. S., and Karahanna, E. (2009). "Antecedents of IS Strategic Alignment: A Nomological Network." *Information Systems Research, 20*(2), 159–179.

Rai, A., Maruping, L. M., and Venkatesh, V. (2009). "Offshore Information Systems Projekt Success: The Role of Social Embeddedness and Cultural Characteristics." *MIS Quarterly, 33*(3), 617–641.

Ravindran, K., Susarla, A., Mani, D., and Gurbaxani, V. (2015). "Social Capital and Contract Duration in Buyer-Supplier Networks for Information Technology Outsourcing." *Information Systems Research, 26*(2), 379-397.

Ray, G., Muhanna, W. A., and Barney, J. B. (2005). "Information Technology and the Performance of the Customer Service Process: A Resource-based Analysis." *MIS Quarterly, 29*(4), 625–652.

Reich, B. H., and Benbasat, I. (2000). "Factors that influence the Social Dimension of Alignment between Business and Information Technology Objectives." *MIS Quarterly, 24*(1), 81–113.

Robert, L. P., Dennis, A. R., and Ahuja, M. K. (2008). "Social Capital and Knowledge Integration in Digitally Enabled Teams." *Information Systems Research, 19*(3), 314–334.

Rosenkranz, C., Vranesic, H., and Holten, R. (2014). "Boundary Interactions and Motors of Change in Requirements Elicitation." *Journal of the Association for Information Systems, 15*(6), 306-345.

Sasidharan, S., Santhanam, R., Brass, D. J., and Sambamurthy, V. (2012). "The Effects of Social Network Structure on Enterprise Systems Success: A Longitudinal Multilevel Analysis." *Information Systems Research, 23*(3), 658-678.

Schlosser, F., Beimborn, D., Weitzel, T., and Wagner, H.-T. (2015). "Achieving social alignment between business and IT – an empirical evaluation of the efficacy of IT governance mechanisms." *Journal of Information Technology, 30*, 119-135.

Singh, P. V., Tan, Y., and Mookerjee, V. (2011). "Network Effects: The Influence of Structural Capital on Open Source Project Success." *MIS Quarterly, 35*(4), 813-829.

Stoel, M. D., and Muhanna, W. A. (2012). "The dimensions and directionality of trust and their roles in the development of shared business-IS understanding." *Information & Management, 49*(5), 248-256.

Tan, F. B., and Gallupe, R. B. (2006). "Aligning Business and Information Systems Thinking: A Cognitive Approach." *IEEE Transactions on Engineering Management, 53*(2), 223–237.

Tiwana, A. (2012). "Novelty-Knowledge Alignment: A Theory of Design Convergence in Systems Development." *Journal of Management Information Systems, 29*(1), 15–52.

Tiwana, A., Bharadwaj, A., and Sambamurthy, V. (2003). "The Antecedents of Information Systems Development Capability in Firms: A Knowledge Integration Perspective." In: *International Conference on Information Systems*, Seattle, Washington, USA.

Tsai, W., and Ghoshal, S. (1998). "Social Capital And Value Creation: The Role of Intrafirm Networks." *Academy of Management Journal, 41*(4), 464–476.
van den Hooff, B., and de Winter, M. (2011). "Us and them: a social capital perspective on the relationship between the business and IT departments." *European Journal of Information Systems, 20*(3), 255–266.
van der Haar, S., Li, J., Segers, M., Jehn, K. A., and Van den Bossche, P. (2015). "Evolving team cognition: The impact of team situation models on team effectiveness." *European Journal of Work and Organizational Psychology, 24*(4), 596-610.
van Deth, J. W. (2003). "Measuring social capital: Orthodoxies and continuing controversies." *International Journal of Social Research Methodology, 6*(1), 79-92.
Venkatesh, V., Brown, S., and Bala, H. (2013). "Bridging the Qualitative-Quantitative Divide: Guidelines for Conducting Mixed Methods Research in Information Systems " *MIS Quarterly, 37*(1), 21-54.
Vermerris, A., Mocker, M., and Heck, E. v. (2014). "No time to waste: the role of timing and complementarity of alignment practices in creating business value in IT projects." *European Journal of Information Systems, 23*(6), 629-654.
Vlaar, P. W. L., van Fenema, P. C., and Tiwari, V. (2008). "Cocreating Understanding and Value in distributed Work: How Members of Onsite and Offshore Vendor Teams give, make, demand, and break sense." *MIS Quarterly, 32*(2), 227–255.
Wagner, H.-T., Beimborn, D., and Weitzel, T. (2014). "How Social Capital among IT and Business Units Drives Operational Alignment and IT Business Value." *Journal of Management Information Systems, 31*(1), 241-272.
Wagner, H.-T., and Weitzel, T. (2012). "How to achieve operational Business-IT Alignment: Insights from a Global Aerospace Firm." *MIS Quarterly Executive, 11*(1), 25–36.
Wegner, D. M. (1987). Transactive Memory: A Contemporary Analysis of the Group Mind. In B. Mullen & G. R. Goethals (Eds.), *Theories of group behavior* (pp. 185-208). New York, NY: Spinger.
Yang, H.-D., Kang, H.-R., and Mason, R. M. (2008). "An exploratory study on meta skills in software development teams: antecedent cooperation skills and personality for shared mental models." *European Journal of Information Systems, 17*(1), 47–61.
Yang, L., Fu, X., and Pan, S. L. (2012). "Leveraging Social Capital and Absorptive Capacity for Knowledge Integration: A Case Study of a Cross-Organization IT Project." In: *European Conference on Information Systems*, Barcelona, Spain.
Yin, R. K. (2014). *Case Study Research: Design and Methods* (5 ed.): SAGE Publications.

Appendix
Paper VII

Paper VIII

The Impact of Agile Practices on Team Interaction Quality - Insights into a Longitudinal Case Study

Christian Jentsch

University of Bamberg

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PAPER IX

WHEN A LACK OF SHARED UNDERSTANDING IS BENEFICIAL – A LONGITUDINAL ANALYSIS OF THE EVOLUTION AND RELEVANCE OF BUSINESS/IT SHARED UNDERSTANDING TO TEAM SUCCESS IN IT-DRIVEN PROJECTS

Christian Jentsch

University of Bamberg

Daniel Beimborn

Frankfurt School of Finance & Management

Geneviève Bassellier

Desautels Faculty of Management, McGill University

When a lack of shared understanding is beneficial – A longitudinal analysis of the evolution and relevance of business/IT shared understanding to team success in IT-driven projects

Abstract

This longitudinal study analyzes the impact of shared understanding on team success in IT projects. We collected survey data from members in 14 IT project teams at three times across the project life cycle, providing us 278 data points in total. Our results suggest, that a team mental model (which is shared understanding about the task and team) is a significant enabler for team success, but at the same time decreases when the project evolves. Shared domain knowledge (which is the shared understanding of each other's work domain) has a significant (positive as well as negative) impact on the development of team mental models and team success. Also, shared domain knowledge can get irrelevant for the success of the team, when a strong team learning behavior is established.

Keywords: Team mental model, shared domain knowledge, IT projects, longitudinal study

Introduction

Powerful IT systems are crucial to stay competitive in a changing market environment (Chakravarty et al. 2013). However, optimal IT support for the business organization is often hindered by misunderstandings of the business environment (Bassellier and Benbasat 2004; Tiwana 2012), a lack of knowledge of potentials and opportunities of IT (Davis et al. 2009; Johnson and Lederer 2010; Preston and Karahanna 2009) or even an inadequate way of language usage among business and IT (Rosenkranz et al. 2013). These walls can be teared down by the development of a shared understanding between business and IT professionals, which has been proven in several studies (Bassellier and Benbasat 2004; Ray et al. 2005; Vlaar et al. 2008).

Research argues that business/IT shared understanding (B/IT-SU) is a variable which is constantly changing in a volatile environment (e.g. Benlian and Haffke 2016; Rosenkranz et al. 2013). However only a few studies have provided empirical evidence for the evolution of shared understanding and the impact of its drivers over time (apart from some qualitative studies like Charaf et al. 2013; Chua et al. 2012; Wagner and Weitzel 2012). In addition, research that is based on longitudinal, quantitative data partly demonstrates very different findings regarding the ideal timing for implementation as well as temporal development of shared understanding in teams. Some research indicates that the early implementation of shared understanding is critical for the success of the project – the sooner the better (Vermerris et al. 2014). Others argue that it is pretty common for shared understanding to start at a low level and *increases* over time. An initial low level of shared understanding has no effect on the success of the collaboration (He et al. 2007). The exact opposite statement is based on research findings which show that shared understanding commonly *decreases* in IT projects as a result of specialization (Levesque et al. 2001). For a team it is important to have a clear picture of the collaborative work at the very beginning of the project, which will decrease when each member start focusing on the individual's tasks (van der Haar et al. 2015).

A possible explanation for the contradicting findings might be found in the nature of the concept of shared understanding. Especially the meaning of "shared" within the concept of shared understanding seem to imply very different facets that might provide an answer for the contradicting research findings. While some research conceptualizes "shared" as similar understanding, e.g. regarding business and IT processes (Ray et al. 2005), project objectives (Vermerris et al. 2014) or a problem (Chakraborty et al. 2010), other research describes "shared" as combined or congruent understanding (Okhuysen and Eisenhardt 2002; Vlaar et al. 2008; Wagner et al. 2014) that represents the knowledge and expertise that is consolidated in a team. Based on this differentiation, we assume that it is impossible to provide a generic answer whether B/IT-SU increases or decreases along an IT project lifecycle, but different facets of B/IT-SU become important at other stages during the IT project. For that reason, our underlying research question can be established as following:

RQ: How does B/ITS-SU evolve and benefit to team success in IT projects?

In our research we construct a two-stage research framework. First, we analyze the longitudinal interaction of two perspectives of B/IT-SU, namely shared domain knowledge and team mental models. Next, we analyze the temporal effects at three different times during the projects of shared domain knowledge and team mental models on team success. The data for our study is based on longitudinal survey data over 13 months in 14 IT project teams, surveying all team members at three different points in time. Our final calculations are based on 106 individuals and 278 responses.

The remainder of the paper is structured as followed: We will first provide a brief introduction of the concepts of shared domain knowledge and team mental models as used in our study. Based on the theoretical foundation, we present our research model and introduce the underlying hypotheses. Next, we present our research method and provide insights into the underlying cases. After a presentation of the results, we discuss our findings and their contribution to theory as well as implications for practitioners. We conclude the paper with a brief summary of our contribution as well as limitations of our research and provide ideas for further research.

THEORETICAL FOUNDATION: SHARED UNDERSTANDING IN BUSINESS/IT COLLABORATIONS

Shared understanding plays an important role in various strands of the IS field. Most commonly research focuses on IT-related collaborations composed of professionals from the IT and business unit. Some examples are alignment research, in which shared understanding represents a key factor in enabling social alignment between business and IT (e.g. Karahanna and Preston 2013; Reich and Benbasat 2000; Tan and Gallupe 2006), systems development research, in which shared understanding has been described as a critical factor in the process of requirements engineering (e.g. Charaf et al. 2013; He et al. 2007; Tiwana 2012), or system implementation (e.g. Abraham et al. 2015; Davis et al. 2009; Ko et al. 2005). To describe shared understanding, previous research often refers to the concept of cognitive capital, which is one of the three dimensions of social capital (e.g. Chua et al. 2012; Robert et al. 2008; Wagner et al. 2014). Social capital can be applied to describe the quality of informal and formal connections, like trust communication patterns or shared interpretation, between business and IT representatives (Wagner et al. 2014). Based on the concept of cognitive capital, we define shared understanding as "resources providing shared representations, interpretations, and systems of meaning among parties" (Nahapiet and Ghoshal 1998, p. 244).

However, the conceptualization of these resources widely diverges in previous research. Especially in research on social alignment and IT operations, shared understanding is often described as "the ability of IT and business […], at a deep level, to understand and be able to participate in the other´s key processes" (Reich and Benbasat 2000, p. 86). Based on this definition, shared understanding has been conceptualized as the understanding for each other's work environments (Nelson and Cooprider 1996), daily business and IT processes (Ray et al. 2005) or strategies (Chan et al. 2006). On the other hand, research on information systems development, IS implementation and other types of IT projects usually describes shared understanding as "the extent to which members share a common understanding (shared meaning and expectations) about their teamwork and/or task" (Robert et al. 2008, p. 320). Shared understanding regarding the distribution of knowledge (Levesque et al. 2001), applied development technologies (He et al. 2007) and/or adequate problem-solving processes (Windeler et al. 2015) play crucial role in these conceptualizations.

From related research in applied psychology we learned that shared understanding is a very broad concept (e.g. Mohammed et al. 2010), which has also been discussed as a meta-construct for concepts like shared mental models (Chakraborty et al. 2010), shared situation awareness (Berner et al. 2016), strategic consensus (Tallon 2013) or transactive memory systems (Kotlarsky et al. 2009). In our research, we attempt to answer the question whether shared understanding of each other's work environments helps to build a shared understanding of task-related and team-related aspect of a project team, which in turn has been found to enable project success. In other words: Does shared domain knowledge influence team mental models, which in turn enables project success? In the following, we provide a brief description and definition of our two core variables shared domain knowledge and team mental models. After that, we describe the linkage between these concepts, as well as major antecedents and outcome of these variables by deriving our research hypotheses.

Shared domain knowledge (SDK)

The awareness of the own, the partner's, and the joint domain has been discussed as a major variable for success especially in distributed teams (Espinosa et al. 2007; Tiwana 2004; Vlaar et al. 2008) and alignment between business and IT units (Bassellier and Benbasat 2004; Reich and Benbasat 2000). The argument is that individuals in a team that are aware of their own as well as their partner's situation are able to direct their actions correspondingly (Smith and Hancock 1995).

Our concept of shared domain knowledge (SDK) relates to the concept of shared situation awareness, which is up-to-the-minute comprehension of what is happening in the joined task environment (Endsley 1995). The concept has been applied frequently in psychology studies, focusing on aviation and other real-time tasks. Endsley (1995) define situation awareness as "the *perception* of the elements in the environment within a volume of time and space, the *comprehension* of their meaning and the *projection* of their status in the near future" (p. 36). The environmental data perceived by an individual will be compared to the existing mental models. The result of this comparison is an adjusted understanding of the current situation. Focusing on situation awareness in teams Endsley and Robertson (2000) argue that the team success depends on a high level of individual as well as shared situation awareness for the environmental elements that connects the tasks of the team members. For our study, we transfer the definition of Endsley (1995) to IS research by describing shared situation awareness between business and IT professionals as the level of shared *perception* of each other's work environments and key processes, the *comprehension* for their meaning to the collaboration and the *projection* of their status to the process in the joined project. Based on that refinement, we adjust the labeling of the concept into shared domain knowledge. In previous IS studies, we learned that shared domain knowledge enables effective collaboration (Tiwana 2012) and harmonized partnership (Bassellier and Benbasat 2004) among business and IT units. When members from the business and IT units understand each other's work environment (Nelson and Cooprider 1996) or key processes (Reich and Benbasat 2000) they are able to increase business process performance (Ray et al. 2005), facilitate IT flexibility (Wagner et al. 2014) and collaborate efficiently in IT projects (Tiwana 2012).

TEAM MENTAL MODELS (TMM)

The concept of Team Mental Models (TMM) has been frequently applied to analyze the performance in software development (e.g. Espinosa et al. 2007; Levesque et al. 2001; Yang et al. 2008) and/or globally distributed teams (e.g. Chiravuri et al. 2011; Robert et al. 2008; Windeler et al. 2015). Mental Models can be described as "mechanism whereby humans generate descriptions of system purpose and form, explanations of system functioning and observed system states, and predictions of future system states" (Rouse and Morris 1984, p. 7). Based on Mathieu et al. (2000) most previous research differs between task-based and team-based mental models. While task-related mental models analyze the understanding of the underlying task (like goals or work packages), team-related mental models focus on the understanding regarding the teammates, like preferences and competencies of colleagues (Cannon-Bowers and Salas 2001).

In contrast to SDK, we could not find any study that applies TMM in research on business/IT alignment or other IT operations apart from IT projects. Indeed, the concept of TMM is handy in collaborations, in which the tasks are quite clear and the roles and responsibilities can be widely formalized. Tasks in IT project teams have been often conceptualized as elicitation of software requirements (Chakraborty et al. 2010), IT development procedures (He et al. 2007) or technology implementation (Davis et al. 2009). The team-related aspects of mental models on the other hand most commonly refer to the understanding of expertise distribution or who-knows-what (He et al. 2007; Levesque et al. 2001; Yang et al. 2008). Especially in globally distributed software development, task-related and team-related mental models have been found to be significantly supportive for team coordination, since the synchronization and coordination of task processing requires to be well organized in virtual teams (Espinosa et al. 2007). But also in collocated teams, the shared understanding of the task-related aspects and distribution of knowledge increases team effectiveness (Yang et al. 2008), decision quality (Robert et al. 2008), as well as the satisfaction in the team (Guchait et al. 2016).

For the purpose of our study, we define team mental models as the reciprocal understanding of task-related and team-related aspects in the collaboration among business and IT members.

The meaning of "shared" in a team and for an individual

For the design of our study it is essential to understand the different meanings of *shared* in the concept of shared understanding as well as the distinction and similarities between the notion of shared understanding and agreement. Sharedness has been discussed frequently in research of applied psychology. Cannon-Bowers and Salas (2001) present a widely acknowledged differentiation between the meanings of sharedness, namely overlapping, similar/identical, compatible/complementary, and distributed. The differences can be especially found in the degree of specialization between group members. While overlapping means partly (not fully) redundant understanding, distributed understanding describes a fully specialized team in which every member has his/her own modular task. The authors describe distributed understanding in the example of military combat teams, in which every member is highly specialized. In related IS research, previous studies usually describe shared understanding as either similar/identical or compatible/complementary.

Similarity can refer to "similar belief about the value of feedback for team development" (Cannon-Bowers and Salas 2001, p. 198) or other team coordination processes that enables team efficiency (Yang et al. 2008) and reduces team conflicts (Chiravuri et al. 2011). Research that refers to that notion of sharedness argues that similar cognitive resources provide a joined reference framework (Bittner and Leimeister 2013). The conceptualization of sharedness as similarity has been widely adopted in the research on team mental models (Mohammed et al. 2010). The degree of similarity is analyzed by the level of interrater agreement (IRA) and intra-class correlation (ICC). The higher the agreement in a team, the higher the similarity of cognitive resources. For our study, we adopt this understanding of shared as similar regarding the conceptualization of team mental models. We picked the notion team mental model over shared mental model to make clear that the mental model is shared or similar on a team-level.

Compatible understanding on the other hand most commonly has been adopted in research on shared domain knowledge (Kotlarsky et al. 2009; Wagner et al. 2014). Vlaar et al. (2008) introduced the notion of "congruent and actionable understanding". They present a framework of socio-cognitive processes to develop an understanding that enables the team members to take action. This concept related to the notion of compatible/complementary understanding, which describes shared understanding as the level of knowledge that leads "team members to draw similar expectations for performance" (Cannon-Bowers and Salas 2001, p. 198). Based on previous related IS research, we argue that business members do not need to have a similar/identical knowledge of processes and technical tools in the IT unit and the other way around. However, they need to make sense of the partner's domain to achieve an actionable understanding. That does not imply that every team member will think alike (Tallon 2013). Diversity of perspectives is still a critical aspect in IT projects (Lee and Xia 2010). Weick (2005) argues that a great variety of compatible understanding leads to situations that can be only achieved in a team of more than one person. Thus, previous research analyzed the compatibility rather than similarity of understanding, by focusing on the perceived level of shared domain knowledge on an individual level (Karahanna and Preston 2013). An individual that has shared domain knowledge with the team members is rather able to identify possibilities for combining knowledge from different team members. Even though, we assume that shared means compatible in the concept of shared domain knowledge, we designed the measurement instrument to interpret both: shared as similar and shared as compatible domain knowledge (see section research methodology).

THEORETICAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

In the following, we will describe the interplays between the central concepts in our study based on previous research and derive the hypotheses which link the concepts. The research framework is shown in Figure 1. In our research framework, we differ between three levels of analysis: the time-dependent project phase level of each individual (Level 1), the individual level (Level 2) and the team level (level-3).

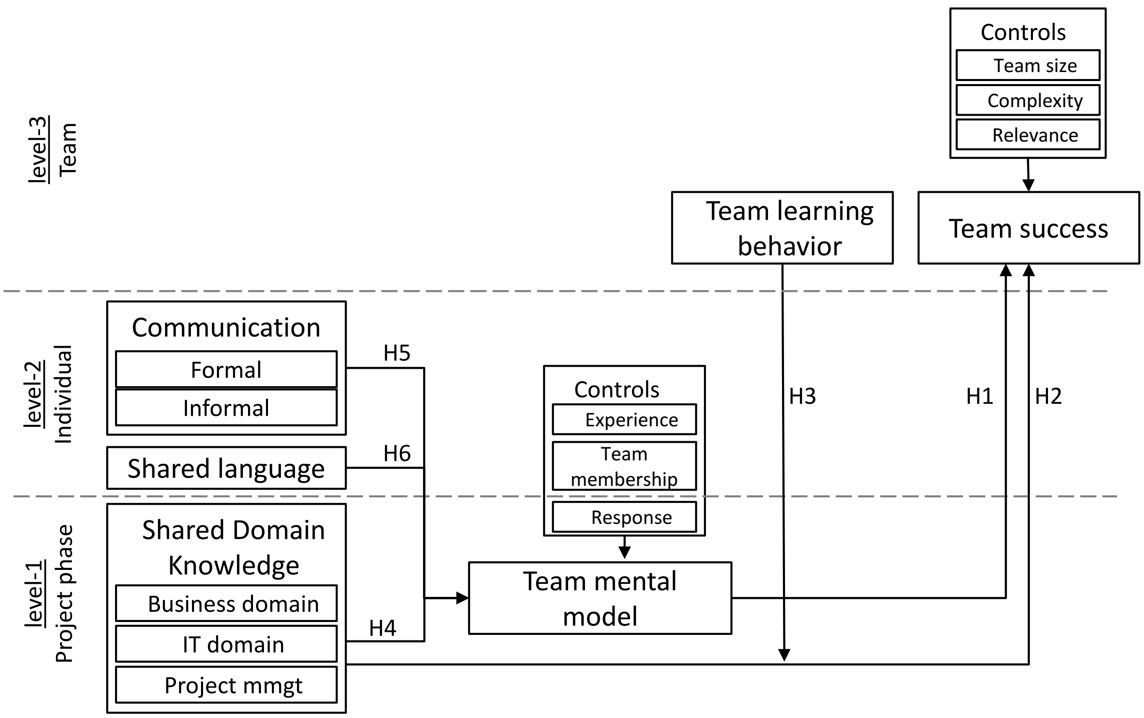

Figure 1. Research framework

SHARED UNDERSTANDING AS ENABLER FOR TEAM SUCCESS IN IT PROJECTS

Previous research found that high performing business/IT collaborations can be characterized by efficient team coordination, which is driven by shared understanding of tasks and team members (e.g. Espinosa et al. 2007), objectives and strategies (e.g. Reich and Benbasat 2000) as well as business and IT domain (e.g. Tiwana 2012). Even though longitudinal studies are rare, we found indications that the understanding for the task and distribution of knowledge (namely TMM) temporally increases likewise to the level of team success. By analyzing the interactions in student work groups of a software development class, He et al. (2007) found that the level of TMM and level of performance start at a very low level and increase likewise over time. Their findings also indicate that a low team mental model at the beginning of a project is very normal and has no (negative) impact on team success. (Student) teams, that succeed to implement a high level of team mental models, are able to integrate their knowledge in a virtual as well as in a face-to-face environment without any losses (Robert et al. 2008). Besides increased team success and knowledge integration, research found that teams who assimilate their values and beliefs will achieve a sustainable clan control which coordinates and maximizes the team success (Chua et al. 2012). For the purpose of this study, we describe team success as the quality of the final outcome of a team task. Aspects like functionalities, technical specificities as well as stakeholder satisfaction are critical indicators to describe the amount of team success in an IT project (Lee and Xia 2010; Thomas and Fernández 2008)

Also, most studies suggest a strong positive relationship between TMM and team success, van der Haar et al. (2015) determined the contradicting finding that an increasing as well as a decreasing level of TMM can have a positive impact on team success. This finding might be explained by Marks et al. (2000), who found that TMM predict team success more strongly in novel developments than in a routine environment. Thus, for teams which are confronted with novel tasks – like in most IT projects – a high level of TMM has been assumed to positively impact team success. In our research, we focus on IT projects, which have a higher proportion of novel rather than routine tasks. Thus, we expect a positive influence of team mental models at the beginning (t=1), during (t=2) and at the end (t=3) of the project on team success at the end of the project (t=3).

H1a: Team mental models at t=1, t=2 and t=3 positively influence team success at t=3.

In contrast to previous assumptions, Levesque et al. (2001) found in a longitudinal student experiment that mental models diverge over time. The authors assume that an increasing level of specialization comes hand in hand with a decreasing level of team mental models. By contrast, other research argues that increasing specialization and diversity has a positive influence on the team outcome (Lee and Xia 2010; Tallon 2013; Yang et al. 2008). However, these studies most commonly refer to diversification of domain knowledge and not on TMM. An answer might be found again in the novelty of the task to be conducted in the team. Waller et al. (2004) found a positive influence of task novelty on the development of TMM, while the execution of routine tasks has a negative impact on TMM. Since we focus on novel tasks, we assume an increasing level of TMM over time.

H1b: Team mental models in IT projects increase over time.

Focusing on shared understanding of each other's domains (shared domain knowledge) we found several studies that confirm a positive influence of business and IT domain understanding on performance in daily operations (Ray et al. 2005), strategic collaborations (Preston and Karahanna 2009) as well as in IT projects (Tiwana 2012). Research indicates that project teams that fail to implement SDK at a very early stage will not be able to fully recover and maximize the team success (Vermerris et al. 2014). The implementation of cross-domain knowledge between IT and business units enables trust and results in an increased level of operational business/IT alignment (Wagner and Weitzel 2012).

In our conceptualization, we differ between three dimensions of shared domain knowledge – namely SDK of the business environment (SDK-B), SDK of the IT environment (SDK-IT) and SDK of project management (SDK-PM). Regarding the first, research found that business domain understanding is necessary to elicit the requirements to address the 'real' business requirements (Vermerris et al. 2014). Shared understanding of market and product characteristics as well as daily routines and challenges of the business units has an enormous effect on the alignment of the business/IT units (Bassellier and Benbasat 2004; Schlosser et al. 2015) and the success of the partnership (Nelson and Cooprider 1996; Ray et al. 2005). Regarding the second, SDK-IT has also been proven as a driver for team success (Nelson and Cooprider 1996; Ray et al. 2005; Tiwana 2012) and business/IT alignment (Vermerris et al. 2014; Wagner et al. 2014; Wagner and Weitzel 2012). Davis et al. (2009) found that when an IT user group (e.g. business unit) is competent in IT development and implementation procedures, they are more likely to be satisfied with the implemented IT systems. Finally, since we focus in our research on shared understanding in IT projects, we introduce the third dimension of SDK of project management. In previous research this dimension has been often subsumed in SDK-IT (Davis et al. 2009; Tiwana 2012; Wagner et al. 2014). However, previous researchers explicitly differs between the technical knowledge of IT infrastructure and application and the procedural knowledge of development projects and IT management (Bassellier et al. 2003). In our research, we focus explicitly on IT projects, and argue that SDK-B covers the environment of the business partner, SDK-IT covers the environment of the IT partner and SDK-PM covers the procedural environment, in which the team collaborates. Summing up, we establish the following three hypotheses:

H2: Shared domain knowledge of (a) business, (b) IT, (c) project management positively influence team success.

From previous studies, we learned that the process of knowledge sharing does not start just because the team members are sitting in one room (Schlosser et al. 2015). Research argues, that the mechanism of domain knowledge sharing needs to be intentionally triggered and managed by, for example, cross-trainings (Cooke et al. 2003), mutual involvement in goal setting (Hsu et al. 2011) or information transparency (Wagner and Weitzel 2012). Team learning behavior covers mechanisms that enable a productive feedback, information sharing and supportive team culture (Guchait et al. 2016). In a large case study, Chua et al. (2012) analyzed the development of building cognitive ties in a project group, to implement clan control and increase team success. Other research confirms the significant impact of team building mechanism on team formation and team outcome (Hsu et al. 2011). Klein et al. (2009) found that especially "role-clarification and goal-setting components improved performance" in their sample (p. 2015). For our study, we argue that shared domain knowledge has a direct effect on performance (see hypotheses above). This effect will be positively increased, when team learning mechanism are introduced. Thus, our next hypothesis is:

H3: Team learning behavior positively moderates the effect of shared domain knowledge on team success.

DEVELOPING A TEAM MENTAL MODEL IN IT PROJECTS

Especially in IS projects the development of TMM highly relies on an effective exchange of domain knowledge (Espinosa et al. 2007; Rosenkranz et al. 2014; Yang et al. 2008). Lacking SDK can quickly lead to misunderstanding of the team tasks and requirements (Vlaar et al. 2008). In turn, processes of sensemaking, sensegiving and senseproviding enable the development of different types of project-related understanding (i.e. TMM). Other research, raise the importance of shared domain knowledge and analyze cross-trainings, liaison units or colocation as mechanism to implement a high level of SDK (e.g., Cooke et al. 2003, Schlosser 2012). Yang et al. (2008) applied the, so called, T-shaped skills, which cover the expertise of an individuals' work domain (vertical line of the T) and the understanding of the partners work domain (horizontal line of the T). In their research framework, the authors identified T-shaped skills as the major antecedents for the development of TMM. Indeed, almost all research we found agrees on the importance of shared domain knowledge on the formation of strategic partnerships (Preston and Karahanna 2009), as a critical enabler for an intention to develop IT-business partnership (Bassellier and Benbasat 2004) and a driver for performance of IT-enabled business processes (Ray et al. 2005).

However, other research in this field focusses more on project-related knowledge areas than the exchange of domain-specific knowledge (e.g. He et al. 2007; Levesque et al. 2001; Robert et al. 2008; Swaab et al. 2002). These research studies have in common, that they analyze interactions of ad hoc teams, like student work groups with very little or no relevant domain knowledge. In an organizational setting the objectives and tasks are developed based on domain-specific criteria on the business as well as on the IT side. Only if team members understand the relevant business processes, potentials of IT and the possibilities of implementation, they are able to organize adequate tasks to achieve the objectives. Research in this field analyze the level of knowledge of business and IT processes, strategies, costumers and/or tools commonly applied in the respective organization (Nelson and Cooprider 1996; Reich and Benbasat 2000; Tiwana 2012) as well as common IS project approaches and methodologies (Bassellier et al. 2003; Reich and Benbasat 2000; Wagner et al. 2014). As previously described we differ between the business and IT work domain as well as project management work domain, which represents the joined work space of business and IT team members. Our next hypothesis is:

H4: Shared domain knowledge of (a) business, (b) IT and (c) project management positively influences the development of team mental models.

However, the exchange of domain knowledge requires adequate communication channels and a sufficient level of communication frequency (Vlaar et al. 2008). By focusing on the construct of structural linkage between team members, previous research found significant interactions between the amount of communication in teams on the development of shared understanding. Previous studies confirmed communication intensity as an important driver of shared understanding in a team (e.g., Chua et al. 2012, van den Hooff and de Winter 2011). Additional statistical evidence support the assumption that communication drives team mental models (e.g. Karahanna and Preston 2013, Wagner et al. 2014). Communication channels have often been conceptualized into formal and informal communication channels (e.g. Preston and Karahanna 2009; Schlosser et al. 2015). In our study, we adopt this conceptualization and suggest the following hypotheses:

H5a: Formal communication channels, like official meetings, positively influence the development of team mental models.

H5b: Informal communication, like corridor talks, positively influence the development of team mental models.

However, the pure existence of regular communication channels does not necessarily imply that team members start interacting on a detailed level (Schlosser et al. 2015; Wagner and Weitzel 2012). There is still a high risk that misunderstandings occur due to false usage of language. For example, inaccurate usage of metaphors can become the source for misunderstandings in project teams (Hekkala et al. 2018). Thus, previous research underlines the importance of a shared language in business/IT teams (Bassellier and Benbasat 2004; Karahanna and Preston 2013; Rosenkranz et al. 2014). In a field study Charaf et al. (2013) highlighted the complexity and various layers of semantic alignment in the communication of an information systems development project. The authors emphasize the necessity of a shared (linguistic) language to close the 'communication gaps' which cause project failure due to misunderstood business needs. We argue that communication is a necessary but not sufficient condition to facilitate the development of TMM. To interact with other team members and overcome communication gaps, it is also important to speak the same (linguistic) language and use a similar linguistic style. Thus, our last hypothesis is:

H6: Shared language positively influences the development of team mental models.

RESEARCH METHODOLOGY

DATA GATHERING AND COLLECTION APPROACH

Our study focuses on business/IT shared understanding over a project life cycle. For that reason, we collected longitudinal data in different IT projects. We collected survey data in 14 IT project teams from September 2016 to October 2017 at three times during the respective project; first, after a respective project-kick off, second, after around the half-time of the project and third, at the end of the project.

For the selection of industry partner firms, we concentrated on companies that are located in the broader region of the researchers, which is Germany. We chose this geographical focus to facilitate information exchange mechanism between researchers and industry partners like regular site visits of the researchers. In total, we found six companies that agreed to participate in our longitudinal study. The smallest company in our sample is a software provider for medical practices and hospitals (approx. 800 employees) and the largest company is an international supplier in the automotive industry (approx. 220.000 employees). In one company, we collected data in two different IT projects (Case C and Case D), which brings us to a total sample of seven projects.

Table 1 provides a brief overview of the projects used in this study. Based on the large project scope, two projects (Case C and E) have been executed by more than one team. We decided to adopt this splitting for our analysis because in both projects we received very different feedback from the team members. Since we focus on team interactions, we treated each team separately, which results in 14 teams we analyzed in our sample.

Table 1. Details of the analyzed cases					
Case	**Industry**	**Project type**	**Description**	**Team size**	**Duration**
A	Automotive	Software Customization/ Implementation	Updating and extending the contract management system	15	10.2016 – 08.2017
B	Production	Software Customization/ Implementation	Implementation of customized tools for enterprisewide e-collaboration	8	10.2016 – 10.2017
C	Production	ERP-driven process standardization;	Processes standardization in 3 subsidiaries based on the enterprisewide ERP system. (Analysis phase)	92 (7 teams)	09.2016 – 10.2017
D	Production	Website development	Website development including interfaces and contextual programming	15	02.2017 – 08.2017
E	Insurance	Process reengineering & Digitalization	All customer related processes will be redesigned to increase the speed and quality of customer contacts.	24 (2 teams)	02.2017 – open end
F	Production	Software Costumization, Implementation	Implementation of a learning management system	8	02.2017- 09.2017
G	(Software) Production	Software development	Development of an information system, which guides the user through the process to complete a medical PX.	8	09.2016 – 01.2017

We started our research with interviewing project and unit managers. In all cases, we were able to present our research approach at the kick-off meeting of each project. After the kick-off, we sent out the first (out of three) surveys to all team members. In all three surveys, we measured the level of individuals' domain knowledge as well as the perceived partners' domain knowledge in the business/IT unit. Based on these two constructs, we calculated the level of shared domain knowledge. More details regarding this procedure will be described below. Also, we measured the individuals mental model at all three times. In the first survey, we additionally collected demographic data. For the second data collection phase, we attempt to pick a point in time at the half time of the scheduled project duration. The appropriate time had been discussed with the project manager. In this survey, we added measures for team learning behavior. The last survey was sent out after the official project completion. In this survey, we added measures for team success, shared language and communication intensity. Table 2 provides an overview of the constructs and the points in time at which they were measured.

Table 1. Overview of data collection process

Construct		Mental models	SDK: Business domain	SDK: IT domain	SDK: IT project management.	Shared language	Communication intensity	Team success	Demographics	Team learning behavior
Measured at	t=1	X	X	X	X				X	
	t=2	X	X	X	X					X
	t=3	X	X	X	X	X	X	X		

In total, we received answers from 161 out of 170 individuals, which proves the positive effect of our regional focus. 81 individuals filled out all three surveys. 30 individuals filled out two of three surveys and 50 individuals only filled out one survey. That results in 353 responses. Thus, our response rate is 69,22% based on 510 potential responses (170 individuals' times three responses). Since we are interested in the longitudinal effects in our research framework, we deleted the individuals that completed only one survey. 111 individuals remained in our data set. Due to missing values we had to excluded 5 further individuals. Thus, our final calculations are based on 106 individuals and 278 responses.

MEASUREMENTS

We adopted and adapted existing measures from previous research whenever possible. We applied a 5-point Likert Scale from 1 = disagree to 5 = agree or 1 = very low to 5 = very high. The items of the survey are listed in the Appendix. Since the study took place in Germany, all items were applied in German language.

Team success has been measured by four items, focusing on the functional as well as technical quality of the outcome and the fit of the outcome to the user/customer needs. These first three items have been adapted from Lee and Xia (2010). We adjusted the original items so that they fit to all of our diverse case settings. In addition, we added a measure for organizational satisfaction to our construct of team success as suggested by Thomas and Fernández (2008).

Our measure of team learning behavior (TLB) was designed to explicitly address the task-related and team-related Mental Models as well the continuity of information provision. First, we applied two items, designed by Hsu et al. (2011), that measure the quality of responsibility distribution (TLB1) and member involvement (TLB2) in the teams. Second, we focus on the continuity of information provision by measuring the currency (TLB3) and completeness (TLB4) of information distributed in the teams (Wixom and Todd 2005).

Next, we applied two items to measure shared language (Ko et al. 2005; Preston and Karahanna 2009; van den Hooff and de Winter 2011). In the operationalization, we differ between respondents from the IT unit and respondents from the business unit. Thus, the specific domain of the question was adjusted to the role of the respondent.

The formative measure of communication intensity covers the amount of official team meetings (including online meetings) and informal interactions, like corridor talks. The measure for informal interaction has been added to all team member surveys. However, to measure the amount of official team meetings, we received relevant information for some teams from the project manager. We have been informed for example from five teams, that they have regular daily or weekly meetings. At our regular site visits, we have been kept updated by the project managers.

Next, we measured team mental models by differing between understanding of task characteristics (two items) and team characteristics (two items). The items have been designed based on the work of Cannon-Bowers and Salas (2001) measuring individual mental models. Justification for the aggregation to the team-level is provided by the indices r_{WG} and ICC (Klein and Kozlowski 2000). Details about these indices are provided in the next section.

Last, shared domain knowledge has been designed regarding the individual's domain knowledge of the business environment (DK-B), domain knowledge of the IT environment (DK-IT) and domain knowledge of project management (DK-PM). We did not ask the respondents directly about their perception of *shared* domain knowledge but asked them to rate their own understanding ("Do you understand …") as well as their perception of their partners understanding ("Do you think your team partners from the business/IT unit understand …"). The level of shared domain knowledge (SDK) has been calculated by using the distance between the two perceptions. A high level of SDK represents a small distance, which in turn implies that the respondents perceive their domain knowledge as *similar*. In contrast, a low level of SDK indicates, that the respondents perceive their domain knowledge as *distributed*. For measuring SDK-B, we asked for the understanding of market and product aspects as well as routines and challenges in the business units that are effected by the IT project (partly adapted from Bassellier and Benbasat 2004). SDK-IT focuses on the understanding for daily challenges in the IT unit as well as the understanding for concrete tools to manage IT systems. In the design of the items we were inspired by Bassellier et al. (2003); Nelson and Cooprider (1996); and Tiwana (2012). SDK-PM focuses on the understanding of procedures as well as potentials for improvement of IT project management approaches (Wagner et al. 2014).

Analysis

In the following we will present the findings of our data collection. We first focus on results of the reliability and validity of our measures. This step is crucial to assess the quality of our data using exploratory and confirmatory factor analysis and also to check the structure of our data. Since we analyze the perception of individuals, which belong to different teams, we assume a hierarchically nested structure in our data. In applying indicators for assessing inter-rater agreement and intra-class correlation we are able to test the nested structure of our data.

After this preliminary analysis, we present the analysis approach in which we applied hierarchical linear modeling 2 (HLM2) as well as hierarchical multivariate linear modeling (HMLM). The latter approach has been applied to analyze the longitudinal (i.e. time series) effect of SDK on

TMM. All constructs have been measured at three times during the project. Since we measured team success only at the end of each project, the construct of team success is not applicable in the same model. Instead, we built a second model by using HLM2, in which we analyze the temporal (i.e. time points) effect of shared understanding on team success. The results of the two models are presented in the subsequent sections.

PRELIMINARY ANALYSIS

As a first step, we did an exploratory factor analysis (EFA) to calculate the factor loadings of our measures. We excluded the items for measuring communication intensity, since we partly imputed the data based on provided information from the project managers. We conducted two sequential EFA. In the first EFA, we focused on the items that were measured at all three times, which is team mental models and shared domain knowledge. The resulting constructs have been averaged and included in the second EFA, in which we analyzed all constructs measured only once in the project.

The factor loadings of most items exceed the threshold of 0.7. Only six items of the data in the second EFA are below 0.7 but still above 0.6. Moreover, these six items show no or only little cross loadings to other constructs. Comparable previous research has accepted even lower factors loadings (below 0.6 but above 0.5) (Samaha et al. 2011; Sasidharan et al. 2012).

Next, we focused on the confirmatory factor analysis calculating Cronbach's alpha. All constructs show values above 0.7. The results of the EFA and CFA suggest that items measuring IT domain and project management knowledge (DK-IT and DK-PM) belong to one construct. However, since we assume a formative construct, we tested for multicollinearity by calculating the variance inflation factor between the items measuring DK-IT and DK-PM (results are attached in the appendix). The values vary between 2.35 and 3.1. Previous research agrees that values below 3.3 indicate that there is no collinearity (Cenfetell and Bassellier 2009; Kock and Lynn 2012). Thus, we kept DK-IT and DK-PM as two separated constructs.

Next, we analyzed the inter-rater agreement (IRA), to determine the level of agreement *within* each team. In our multilevel analysis, the third level of analysis is the team level in which we attempt to analyze the effect of team learning behavior on success. Also, we are interested whether or not the mental models and perception of success is shared within the team. Inter-rater agreement also provides justification for theoretical discussion and interpretation of the constructs on a team level. Since we measured all items at the individual level, we applied calculations for inter-rater agreement, which provides a justification to aggregate this indicator to the next level and treat it as a team variable (Klein and Kozlowski 2000). In our analysis we applied the index r_{wg} developed by James et al. (1984) as a justification for data aggregation between different levels of analysis. An index above 0.7 on average across all teams indicates a sufficiently high level of agreement in the team and allows to lift the variable to the next level (Klein and Kozlowski 2000). The r_{WG} in our set varies between 0.802 and 0.936. The results are documented in the Appendix Table 9.

Last, we focused on the variance that can be explained *between* teams by applying the analysis of intra-class correlation. First, we calculated the ICC(1) to estimate the proportion of variability that can be explained by team membership. Second, we focused on ICC(2) to analyze the reliability of the team means. By that, we are able to determine if teams distinguishable, based on the mean team member scores (Bliese 2000). Previous research has shown a common ICC(1) between 0.1

and 0.5, while the optimal level of ICC(2) depends on the research focus (Shieh 2016). The larger the average group team size, the larger the ICC(2), when ICC(1) is fixed (Klein and Kozlowski 2000). Research on project teams most commonly accepts an ICC(2) above 0.5 without limitations (Liao and Chuang 2004; Maruping and Magni 2015) and still considers values over 0.4 as moderately acceptable for aggregation (e.g. He et al. 2007; Kudaravalli et al. 2017; van der Haar et al. 2015). All our results are significant with the lowest ICC(1) of 0.152 for team learning behavior. The ICC(2) varies between 0.456 for team mental models at t=1 and 0.823 for team success. The results are shown in the appendix Table 9.

Hierarchical (Multivariate) Linear Modeling

Hierarchical linear modeling has recently been applied in IS research more and more often (Rai et al. 2009). It is the most preferable approach when the analysis is based on nested data, reflecting a hierarchical structure (Raudenbush and Bryk 2006; Sasidharan et al. 2012). Examples for nested data structures are students nested in workgroups (He et al. 2007), offshore projects nested in project managers (Rai et al. 2009), or repeated survey responses nested in study participants (Samaha et al. 2011). For our data analysis, we chose hierarchical linear modeling for two reasons. First, in our research question, we aim to analyze the interplay of different levels in a project team – namely the time-variant response level, the time-invariant individual level and the team level. Previous research argues that ignoring the structure of hierarchical nested data would assume "that there is no between-unit variance on the dependent variable" (Rai et al. 2009, p. 629), which leads to artificial small standard errors. Second, we attempt to minimize the risks that are attached to single-point-in-time measures. We argue that shared domain knowledge and team mental models are constantly changing constructs for which reason the results of single point in time measures might vary based on the time of data collection. By applying hierarchical multivariate linear modeling, we are able to analyze shared domain knowledge and team mental models based on longitudinal data across a whole project life cycle. The structure of repeated measures can be understood as multilevel data since the responses over time of an individual are nested within this respective individual (Ko and Dennis 2011).

For our analysis, we split the model into two parts. First, we analyze the impact of shared language (level-2), communication intensity (level-2) and shared domain knowledge (level-1) on team mental models (level-1) across the project lifecycle. The level-1 constructs have been measured at three points in time during the project, for which reason we apply a longitudinal analysis using HMLM. Second, we analyze the temporal impact of shared domain knowledge and team mental model at t=1, t=2 and t=3 respectively on team success measured at t=3 as well as the moderation effect of team learning behavior measured at t=2 using HLM2.

Shared Domain Knowledge and Team Mental Models

In our first model, we apply Hierarchical Multivariate Linear Modeling using the software tool HLM7, which allows us to analyze the longitudinal effects of the level-1 coefficients by marking each data collection time of each individual. The outcome of this model will provide evidence whether SDK influences TMM over time (here: over the project life cycle). Table 3 presents the results of this model. We controlled for time on level-1, and team membership and experience measured by years of experience in the respective company on level-2. The model has been calculated by 278 responses on level-1 (i.e. responses over three data collection times) and 106 data points on level-2 (i.e. individuals). The mathematical formula for this random coefficient model is attached in the appendix.

Table 2. HMLM results for team mental models			
Controls			
Team membership	-.003	-.017	-.019
Experience	.125**	.095*	.092**
Time	-.135***	-.129***	-.118**
Level-2 coefficients			
Formal communication		.183**	.176**
Informal communication		.118*	.124*
Shared language		.156**	.157**
Level-1 coefficients			
SDK business			-.126+
SDK IT			-.152*
SDK PM			.143*
Model statistics			
Pseudo-R^2 for t=1	.142	.178	.240
Pseudo-R^2 for t=2	.139	.226	.189
Pseudo-R^2 for t=3	.192	.365	.392

+p<.10; *p<.05; **p<.01; ***p<.001

The results suggest significant effects of all variables, except the control variable for team membership. While all level-2 coefficients have a positive effect on the development of team mental models, SDK-B and SDK-IT have a negative impact on TMM. The results also show that time has a significant negative impact on the development of TMM, which indicates that TMM marginally decreases over time. Indeed, we found evidence in previous research supporting this finding which argues that team mental models diverge over time, due to specialization and role distribution (Levesque et al. 2001). There is no need that every team member is completely informed regarding the project specificities if either the objectives are very well defined or the roles and responsibilities are clearly distributed among team members (Grand 2016). Related research indicates that team mental models might be significantly more important at the beginning of the project, while the importance decreases towards the end (Marks et al. 2000). At the beginning it is important to get everyone on the same page, to enable in-depth communication. A decreasing team mental model can indicate an increasing specialization, which also leads to high performance (van der Haar et al. 2015). To prove that assumption, we include team success in the next step to analyze the temporal effect of team cognition (i.e. team mental models and shared domain knowlege) on team success in our next model.

Impact of Shared Domain Knowledge and Team Mental Models on Team Success

In this model, we analyze the impact of SDK and TMM respectively in t=1, t=2 and t=3 on team success in t=3. Also, we analyze the moderation effects of team learning behavior on the impact of shared domain knowledge on team success. In our analysis we apply HLM2, which enables us to consider individual as well as team aspects. The number of responses we can include in this model drops from 278 to 216 responses from 72 individuals because we now do only include individuals who responded at all three data collection times. The results for the direct and moderation effect models at t=1, 2, 3 are presented in Table 3.

Table 3. HLM2 results for team success at t=3 as outcome							
	Model 0	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Controls							
Team size	.105+	.105+	.098+	.105+	.105+	.105+	.105+
Complexity	-.683***	-.681***	-.682***	-.681***	-.677***	-.677***	-.675***
Relevance	.650*	.648*	.645**	.647*	.643*	.643*	.641*
Coefficients at t=1: Main effects							
SDK-B		.049					
SDK-IT		.319*					
SDK-PM		-.143					
TMM		-.047					
Coeffcient at t=1: Interactions							
SDK-B x TLB			-.413+				
SDK-IT x TLB			-.535***				
SDK-PM x TLB			.331**				
Coefficients at t=2: Main effects							
SDK-B				-.049			
SDK-IT				.258*			
SDK-PM				-.205+			
TMM				.289+			
Coefficients at t=2: Interactions							
SDK-B x TLB					-.625*		
SDK-IT x TLB					-.503**		
SDK-PM x TLB					.063		
Coefficients at t=3: Main effects							
SDK-B						-.439**	
SDK-IT						.035	
SDK-PM						.037	
TMM						.594***	
Coefficients at t=3: Interactions							
SDK-B x TLB							.589+
SDK-IT x TLB							-.402*
SDK-PM x TLB							.465*
Pseudo-R^2	.318	.343	.414	.363	.425	.435	.460

+p<.10; *p<.05; **p<.01; ***p<.001

In the direct and moderation effect model, we found significant impacts of the control variables team size ($p=.094$), complexity ($p<.001$) and relevance ($p=.014$) on team success measured at t=3. Also, we found SDK-IT being significant at t=1 ($p=.041$) and t=2 ($p=.018$), TMM being significant at t=2 ($p=.068$) and t=3 ($p<.001$), SDK-PM being slightly significant only at t=2 ($p=.052$) and SDK-B being significant only at t=3 ($p=.002$). While the effect of SDK-IT is positive in t=1 and t=2, we found a negative effect of SDK-B at t=3 and SDK-PM at t=2. Also, the coefficient of TMM almost doubles from t=2 to t=3.

Focusing on the moderation effect model we found a significant moderation effect of TBL at every time point on almost every coefficient. Only for SDK-PM at t=2 we did not find any significant impact. Interestingly TLB seems to have a negative moderation effect on SDK-IT but a positive effect on SDK-PM across the project development. In contrast, we found a negative moderation effect on SDK-B at t=1 and t=2 but a positive effect at t=3.

To further analyze the apparently contradicting effects of team learning behavior on the dimensions of SDK, we conducted post-hoc graphical analyses of two representative results, in which we found a significant effect in the direct effect model as well as in the moderation effect model. For that reason, we picked the moderation effects of TLB on the relationship of SDK-IT at t=1 on team success (see Figure 2) and, SDK-B at t=3 on team success (see Figure 3). We split all teams into three groups: Teams that rated the level of team learning behavior as high (n=3; above 75th percentile), medium (n=7; around 50th percentile) and low (n=3, below 25th percentile). In both cases, the results show a substitution effect of TLB, which means that the direct effect of SDK decreases with an increase of TLB. At the same time the highest level of success can be only achieved in a combination of high TLB and low SDK-B at t=3 and high SDK-IT at t=1. The effect of SDK however becomes marginal when TLB is high.

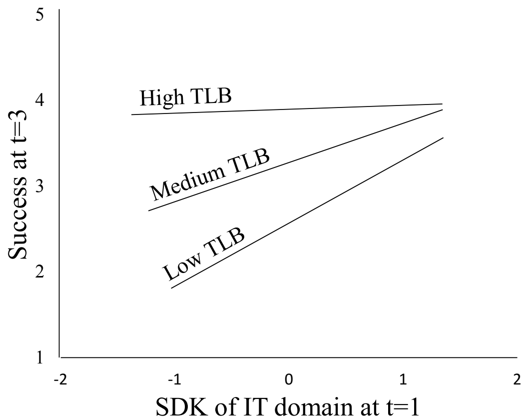

Figure 2. Moderation effect of TLB on SDK of IT domain at t=1

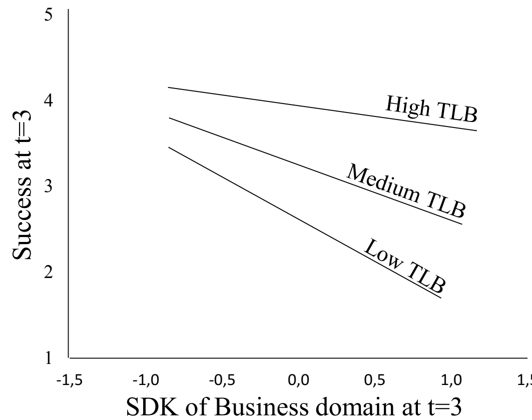

Figure 3. Moderation effect of TLB on SDK of business domain at t=3

Discussion

The formation and development of team mental models

Our first central question was: How do team mental models evolve in IT projects? The results confirm and partly contradict previous research findings: we are able to confirm previous research studies regarding the significant positive impact of formal and informal communication (Preston and Karahanna 2009; Reich and Benbasat 2000; Vlaar et al. 2008) as well as the positive role of shared language (Ko et al. 2005; Rosenkranz et al. 2014; van den Hooff and de Winter 2011) for knowledge transfer as an enabler for team mental models. Also, we can confirm that SDK-PM has a positive impact on the development of TMM. Since SDK-PM refers to the components of how to structure the collaborative project, a significant positive impact is quite comprehensible.

Furthermore, our results suggest a decreasing level of team mental models over time. Thus, we confirm the findings of Levesque et al. (2001) and show a negative impact of time on team mental models. At the same time, we found a critically high impact of team mental models on team success, suggesting that a decreasing level of TMM has a negative impact on team success (van der Haar et al. 2015). We reason that decrease by increasing specialization. When a team is able to implement a similar and accurate TMM at the very beginning of the project, every team member knows exactly every task and distribution of expertise in the team. We assume that this situation leads to the result that team members start working intensively on their own tasks and relinquish or minimize (time-consuming) communication.

The argument of specialization can also be utilized to explain the negative impact of SDK-B and SDK-IT on the development of TMM. Let us assume that there is a team in which all members perfectly understand the work domain of their colleagues on the one hand and a fully misaligned team on the other hand. The need for knowledge exchange in the second team is much higher than in the first team. Knowledge exchange is enabled by intense communication and shared language, which also potentially uncovers profound misunderstanding. Teams – like the first team in our example – that assume to have a perfect level of SDK might risk to minimize the amount of communication. However, when the project evolves, the teams have to work on a very detailed level, which will test the profoundness of shared domain knowledge. We assume that teams which thought to have a high level of SDK at the beginning of the project will invest less time to build a team mental model of task aspects and distribution of expertise in this particular project.

Shared domain knowledge and IT team success

For a more detailed interpretation of the impact of the shared domain knowledge, we determined the level of interrater agreement (IRA) in the teams. By using this index, we can determine if team members commonly agree on the level of SDK or if the level of SDK is a very subjective and individually different rating. We found that there is a high agreement and even an increase of the level of SDK-B across all three times (0.81 for t=1, 0.88 for t=2, 0.90 for t=3) and a constantly high agreement regarding the level of SDK-PM (0.75 for t=1, 0.76 for t=2, 0.75 for t=3). However, we only found a low to moderate level of agreement regarding SDA-IT (0.51 for t=1, 0.51 for t=2, 0.56 for t=3). The IRA indicates that SDK-B and SDK-PM are team attributes, while SDK-IT is more an individual than a team attribute. That leads us to different explanation for the results. In referring to the different meanings of shared as similar or distributed understanding, the data shows that teams, which have a high *similar* understanding of the business domain, perform worse than teams having a high level of *distributed* understanding of the business domain. Focusing on shared knowledge of the IT domain the opposite is the case.

First, the positive impact of SDK-IT in t=1 and t=2 on team success can be explained by previous research, which argues that IT knowledge enables user satisfaction (Davis et al. 2009). Tiwana (2012) found that business's technical knowledge becomes essentially important in IT projects with novel procedures. Indeed, most of the project managers told us, that they attempt to apply novel agile-related procedures. Most of our respondents also mentioned that they are not very experienced in these project methodologies. Thus, our results seem to support the findings of Tiwana (2012) stating that SDK-IT is critical in IT projects with novel development approaches and methods. A similar knowledge in this domain, helps the team to focus on the most critical aspects to realize the project.

Second, we found a strong negative impact of SDK-B at t=3 on team success. IRA indicates that the agreement for the level of SDK-B constantly increases over time. At the end of the project, when the impact of SDK-B on team success becomes significant, the team strongly agrees on the level of SDK-B. At the same time SDK-B has a negative impact on team success. This finding might be interpreted by two alternative explanations. First, the teams who fully understood the business environment rated the project outcome lower than teams who have weaker shared knowledge of the business environment, because the first category of team realizes all the potentials functionalities that that are not achieved in the project. The more the team knows, the more potentials they see, the less satisfied they are. Second, the finding might be found in the discussions on diversity in IT teams. Especially in agile project management, very diverse knowledge has proven to extend the horizon for potential functionalities and increases team success (Lee and Xia 2010). A perfectly aligned team regarding the business domain knowledge might work efficiently, but also might be very reluctant to accept new ideas (Sabherwal et al. 2001). Thus, potentially our findings might indicate that too much alignment creates isolation / silo orientation at other sides.

In contrast, recognizing and accepting the different competencies in the team increases the success of the team.

Thus, the findings on shared domain knowledge are quite interesting, since they provide two important insights. First, shared domain knowledge regarding the IT domain should be similar, while shared domain knowledge regarding the business domain needs to be distributed (or even better: compatible), but not similar. Second, the role of shared domain knowledge can be very different within one IT project. At the beginning of the project, shared (i.e. similar) IT knowledge is important to get on the same page regarding optimal project procedure and information sharing, while shared (i.e. compatible) domain knowledge regarding the business domain gets important towards the end of the project, when the project is being executed and completed.

TEAM LEARNING BEHAVIOR AS A SUBSTITUTE FOR SHARED DOMAIN KNOWLEDGE

The last interesting aspect, we found in our data is the moderating effect of team learning behavior on the influence of SDK-IT at t=1 and SDK-B at t=3 on team success. As the findings suggest a high level of team learning behavior can almost completely substitute this direct effect. That means, the level of SDK-IT and SDK-B is (almost) irrelevant for team success, when there is a high level of team learning behavior. As assumed in the introduction, strong IT teams do not necessarily have a shared domain knowledge of the business domain, but rather cover a great variety of expertise, while keeping an eye on a high level of team learning behavior.

Table 5 provides a brief summary of our core findings and positions them to previous research:

Table 5. Implications for theory		
Research strand	**Existing research**	**Our contribution**
Team mental models	Studies provide competing findings for decreasing as well as increasing levels of team mental models and the effects on team success. Evidence is mainly drawn from student work groups. (e.g. He et al. 2007; Levesque et al. 2001; Robert et al. 2008).	In a business context team mental models decrease over time due to specialization. Nonetheless, team mental models have a significant positive impact on team success.
Operational alignment	Shared business knowledge has a strong positive effect on team success (e.g. Ray et al. 2005; Vermerris et al. 2014; Wagner et al. 2014).	We provide empirical evidence for the negative impact of an "over-alignment" regarding shared business knowledge on team success. In other word, a high level of perceived diversity of knowledge increases team success.
	A (too) late implementation of shared understanding limits team success in IT project teams (Vermerris et al. 2014).	We provide a more differentiated discussion on shared understanding and could show (1) a positive impact of TMM across the second half of the project life cycle, (2) a positive impact of shared IT knowledge at the beginning of the project and a negative impact of shared business knowledge at the end of the project.
Team coordination	Appropriate team learning behavior has a high impact on team success (e.g. Chua et al. 2012; Hsu et al. 2011; Klein et al. 2009).	We can not only support previous findings, but also provide evidence that strong team learning behavior may even substitute the effects of shared business/IT knowledge.

CONCLUSION

The study has limitations which point to opportunities for further research. First, our measures only analyze the perceptual shared understanding of the team members, but not the actual level of shared understanding. Thus, our findings, especially regarding the negative effect of shared business knowledge on team success, would be very different when analyzing the 'real' shared understanding. Future research could expand the measure by also including constructs measuring the accuracy of shared understanding, by, for example, applying knowledge tests or similarity ratings (Mohammed et al. 2000). Second, we measured team success only on an individual level at the end of each project. The team members might be biased regarding the actual contribution of the project for the end users/clients. Since in most projects the team members from the business unit are (only) representatives for or a small number of the group of end users, the actual success will be proven after the implementation of the IS solution. Bugs and weaknesses of the IT solution might be uncovered later in the actual use of the project outcome. Further research might therefore apply other measures for team success on an end user level after the actual go-live of the IT solution. Third, our data set comprises only 14 IT teams, which is a rather small number to conduct statistical analysis. By using multilevel analysis and focusing on the response-level and individual-level, we limited this limitation. However, future research should attempt to increase the data base to improve statistical power.

Under consideration of these limitation, our work offers four different contributions. First, team mental models, which have a highly significant impact on team success, decrease over time. Second, a shared knowledge of project management helps the team to form team mental models, while a high level of shared business and IT domain knowledge has the potential to limit the development of TMM. Third, especially in novel IT projects regarding the project approach, shared domain knowledge of the IT environment can help to enable team success. Fourth, an over-alignment in the project team regarding the business domain can limit team success. The team needs to be aware of the differences in business knowledge (if existing) among team members when maximizing team success. Thus, summing up our study show that different perspectives of shared understanding between business and IT members can have very different (positive as well as negative) effects on team success across the duration of an IT project. A too general recommendation regarding the relevance of shared understanding can be troublesome, since the relevance of the different perspectives changes over time and can be substituted by adequate management mechanism.

LITERATURE

Abraham, R., Aier, S., and Winter, R. 2015. "Crossing the Line: Overcoming Knowledge Boundaries in Enterprise Transformation," *Business & Information Systems Engineering* (57:7), pp. 3-13.

Bassellier, G., and Benbasat, I. 2004. "Business Competence of Information Technology Professionals: Conceptual Development and Influence on IT-Business Partnerships," *MIS Quarterly* (28:4), pp. 673–694.

Bassellier, G., Benbasat, I., and Reich, B. H. 2003. "The Influence of Business Managers' IT Competence on Championing IT," *Information Systems Research* (14:4), pp. 317–336.

Benlian, A., and Haffke, I. 2016. "Does Mutuality Matter? Examining the Bilateral Nature and Effects of CEO–CIO Mutual Understanding," *The Journal of Strategic Information Systems* (25:2), pp. 104-126.

Berner, M., Augustine, J., and Maedche, A. 2016. "The Impact of Process Visibility on Process Performance," *Business & Information Systems Engineering* (58:1), pp. 31-42.

Bittner, E., and Leimeister, J. M. 2013. "Why Shared Understanding Matters - Engineering a Collaboration Process for Shared Understanding to Improve Collaboration Effectiveness in Heterogeneous Teams," *Hawaii International Conference on System Sciences*, Maui, Hawaii.

Bliese, P. D. 2000. "Within-Group Agreement, Non-Independence, and Reliability: Implications for Data Aggregation and Analyses," in *Multilevel Theory, Research, and Methods in Organizations: Foundations, Extensions, and New Directions,* K.J. Klein and S.W.J. Kozlowski (eds.). San Francisco, CA: Jossey-Bass., pp. 349-381.

Cannon-Bowers, J. A., and Salas, E. 2001. "Reflection on Shared Cognition," *Journal of Organizational Behavior* (22:2), pp. 195–202.

Cenfetell, R. T., and Bassellier, G. 2009. "Interpretation of Formative Measurement in Information Systems Research," *MIS Quarterly* (33:4), pp. 689-707.

Chakraborty, S., Sarker, S., and Sarker, S. 2010. "An Exploration into the Process of Requirements Elicitation: A Grounded Approach," *Journal of the Association for Information Systems* (11:4), pp. 212-249.

Chakravarty, A., Grewal, R., and Sambamurthy, V. 2013. "Information Technology Competencies, Organizational Agility, and Firm Performance: Enabling and Facilitating Roles," *Information Systems Research* (24:4), pp. 976-997.

Chan, Y. E., Sabherwal, R., and Thatcher, J. B. 2006. "Antecedents and Outcomes of Strategic IS Alignment: An Empirical Investigation," *IEEE Transactions on Engineering Management* (53:1), pp. 27–47.

Charaf, M. C., Rosenkranz, C., and Holten, R. 2013. "The Emergence of Shared Understanding: Applying Functional Pragmatics to Study the Requirements Development Process," *Information Systems Journal* (23:2), pp. 115–135.

Chiravuri, A., Nazareth, D., and Ramamurthy, K. 2011. "Cognitive Conflict and Consensus Generation in Virtual Teams During Knowledge Capture: Comparative Effectiveness of Techniques," *Journal of Management Information Systems* (28:1), pp. 311–350.

Chua, C. E. H., Lim, W.-K., Soh, C., and Sia, S. K. 2012. "Enacting Clan Control in Complex IT Projects: A Social Capital Perspective," *MIS Quarterly* (36:2), pp. 577–600.

Cooke, N. J., Kiekel, P. A., Salas, E., Stout, R., Bowers, C., and Cannon-Bowers, J. A. 2003. "Measuring Team Knowledge: A Window to the Cognitive Underpinnings of Team Performance," *Group Dynamics: Theory, Research, and Practice* (7:3), pp. 179-199.

Davis, J. M., Kettinger, W. J., and Kunev, D. G. 2009. "When Users Are IT Experts Too: The Effects of Joint IT Competence and Partnership on Satisfaction with Enterprise-Level Systems Implementation," *European Journal of Information Systems* (18:1), pp. 26–37.

Endsley, M. R. 1995. "Toward a Theory of Situation Awareness in Dynamic Systems," *Human Factors* (37:1), pp. 32-64.

Endsley, M. R., and Robertson, M. M. 2000. "Situation Awareness in Aircraft Maintenance Teams," *International Journal of Industrial Ergonomics* (26:2), pp. 301-325.

Espinosa, J., Slaughter, S., Kraut, R., and Herbsleb, J. 2007. "Team Knowledge and Coordination in Geographically Distributed Software Development," *Journal of Management Information Systems* (24:1), pp. 135–169.

Grand, J. A., Braun, M. T., Kuljanin, G., Kozlowski, S. W. J., and Chao, G. T. 2016. "The Dynamics of Team Cognition: A Process-Oriented Theory of Knowledge Emergence in Teams," *Journal of Applied Psychology* (101:10), pp. 1353-1385.

Guchait, P., Lei, P., and Tews, M. J. 2016. "Making Teamwork Work: Team Knowledge for Team Effectiveness," *The Journal of Psychology* (150:3), pp. 300-317.

He, J., Butler, B. S., and King, W. R. 2007. "Team Cognition: Development and Evolution in Software Project Teams," *Journal of Management Information Systems* (24:2), pp. 261-292.

Hekkala, R., Stein, M.-K., and Rossi, M. 2018. "Metaphors in Managerial and Employee Sensemaking in an Information Systems Project," *Information Systems Journal* (28:1), pp. 142-174.

Hsu, J. S. C., Chang, J. Y. T., Klein, G., and Jiang, J. J. 2011. "Exploring the Impact of Team Mental Models on Information Utilization and Project Performance in System Development," *International Journal of Project Management* (29:1), pp. 1-12.

James, L. R., Demaree, R. G., and Wolf, G. 1984. "Estimating within-Group Reliability with and without Response Bias," *Journal of Applied Psychology* (69), pp. 85-98.

Johnson, A. M., and Lederer, A. L. 2010. "CEO/CIO Mutual Understanding, Strategic Alignment, and the Contribution of IS to the Organization," *Information & Management* (47:3), pp. 138–149.

Karahanna, E., and Preston, D. S. 2013. "The Effect of Social Capital of the Relationship between the CIO and Top Management Team on Firm Performance," *Journal of Management Information Systems* (30:1), pp. 15–56.

Klein, C., Diazgranados, D., Salas, E., Le, H., Burke, C. S., Lyons, R., and Goodwin, G. F. 2009. "Does Team Building Work?," *Small Group Research* (40:2), pp. 181-222.

Klein, K. J., and Kozlowski, S. W. J. 2000. "From Micro to Meso: Critical Steps in Conceptualizing and Conducting Multilevel Research," *Organizational Research Methods* (3:3), pp. 211-236.

Ko, D.-G., and Dennis, A. R. 2011. "Profiting from Knowledge Management: The Impact of Time and Experience," *Information Systems Research* (22:1), pp. 134-152.

Ko, D.-G., Kirsch, L. J., and King, W. R. 2005. "Antecedents of Knowledge Transfer from Consultants to Clients in Enterprise System Implementation," *MIS Quarterly* (29:1), pp. 59–85.

Kock, N., and Lynn, G. S. 2012. "Lateral Collinearity and Misleading Results in Variance-Based Sem: An Illustration and Recommendations," *Journal of the Association for Information Systems* (13:7), pp. 546-580.

Kotlarsky, J., Van den Hooff, B., and Huysman, M. 2009. "Bridging Knowledge Boundaries in Cross-Functional Groups: The Role of a Transactive Memory System," in: *International Conference on Information Systems*. Phoenix, AZ, USA.

Kudaravalli, S., Faraj, S., and Johnson, S. L. 2017. "A Configural Approach to Coordinating Expertise in Software Development Teams " *MIS Quarterly* (41:1), pp. 43-64.

Lee, G., and Xia, W. 2010. "Toward Agile: An Integrated Analysis of Quantitative and Qualitative Field Data," *MIS Quarterly* (34:1), pp. 87-114.

Levesque, L. L., Wilson, J. M., and Wholey, D. R. 2001. "Cognitive Divergence and Shared Mental Models in Software Development Project Teams," *Journal of Organizational Behavior* (22:1), pp. 135-144.

Liao, H., and Chuang, A. 2004. "A Multilevel Investigation of Factors Influencing Employee Service Performance and Customer Outcomes," *Academy of Management Journal* (47:1), pp. 41-58.

Marks, M. A., Zaccaro, S. J., and Mathieu, J. E. 2000. "Performance Implications of Leader Briefings and Team-Interaction Training for Team Adaptation to Novel Environments," *Journal of Applied Psychology* (85:6), pp. 971-986.

Maruping, L. M., and Magni, M. 2015. "Motivating Employees to Explore Collaboration Technology in Team Contexts," *MIS Quarterly* (39:1), pp. 1-16.

Mohammed, S., Ferzandi, L., and Hamilton, K. 2010. "Metaphor No More: A 15-Year Review of the Team Mental Model Construct," *Journal of Management* (36:4), pp. 876-910.

Mohammed, S., Klimoski, R., and Rentsch, J. R. 2000. "The Measurement of Team Mental Models: We Have No Shared Schema," *Organizational Research Methods* (3:2), pp. 123–165.

Nahapiet, J., and Ghoshal, S. 1998. "Social Capital, Intellctual Capital, and the Organizational Advantage," *Academy of Management Review* (23:2), pp. 242–266.

Nelson, K. M., and Cooprider, J. G. 1996. "The Contribution of Shared Knowledge to IS Group Performance," *MIS Quarterly* (20:4), pp. 409–432.

Okhuysen, G. A., and Eisenhardt, K. M. 2002. "Integrating Knowledge in Groups: How Formal Interventions Enable Flexibility," *Organization Science* (13:4), pp. 370-386.

Preston, D. S., and Karahanna, E. 2009. "Antecedents of IS Strategic Alignment: A Nomological Network," *Information Systems Research* (20:2), pp. 159–179.

Rai, A., Maruping, L. M., and Venkatesh, V. 2009. "Offshore Information Systems Projekt Success: The Role of Social Embeddedness and Cultural Characteristics," *MIS Quarterly* (33:3), pp. 617–641.

Raudenbush, S. W., and Bryk, A. S. 2006. *Hierarchical Linear Models: Applications and Data Analysis Methods*, (2nd ed.). London: Sage Publications.

Ray, G., Muhanna, W. A., and Barney, J. B. 2005. "Information Technology and the Performance of the Customer Service Process: A Resource-Based Analysis," *MIS Quarterly* (29:4), pp. 625–652.

Reich, B. H., and Benbasat, I. 2000. "Factors That Influence the Social Dimension of Alignment between Business and Information Technology Objectives," *MIS Quarterly* (24:1), pp. 81–113.

Robert, L. P., Dennis, A. R., and Ahuja, M. K. 2008. "Social Capital and Knowledge Integration in Digitally Enabled Teams," *Information Systems Research* (19:3), pp. 314–334.

Rosenkranz, C., Charaf, M. C., and Holten, R. 2013. "Language Quality in Requirements Development: Tracing Communication in the Process of Information Systems Development," *Journal of Information Technology*).

Rosenkranz, C., Vranesic, H., and Holten, R. 2014. "Boundary Interactions and Motors of Change in Requirements Elicitation," *Journal of the Association for Information Systems* (15:6), pp. 306-345.

Rouse, W. B., and Morris, N. M. 1984. "On Looking into the Black Box: Prospects and Limits in the Search for Mental Models," *Psychological Bulletin* (100).

Sabherwal, R., Hirschheim, R., and Goles, T. 2001. "The Dynamics of Alignment: Insights from a Punctuated Equilibrium Model," *Organization Science* (12:2), pp. 179-197.

Samaha, S. A., Palmatier, R. W., and Dant, R. P. 2011. "Poisoning Relationships: Perceived Unfairness in Channels of Distribution," *Journal of Marketing* (75), pp. 99-117.

Sasidharan, S., Santhanam, R., Brass, D. J., and Sambamurthy, V. 2012. "The Effects of Social Network Structure on Enterprise Systems Success: A Longitudinal Multilevel Analysis," *Information Systems Research* (23:3), pp. 658-678.

Schlosser, F. 2012. "Mastering the Social IT/Business Alignment Challenge," *Americas Conference on Information Systems*:Paper 17).

Schlosser, F., Beimborn, D., Weitzel, T., and Wagner, H.-T. 2015. "Achieving Social Alignment between Business and IT – an Empirical Evaluation of the Efficacy of IT Governance Mechanisms," *Journal of Information Technology* (30:2), pp. 119-135.
Shieh, G. 2016. "Choosing the Best Index for the Average Score Intraclass Correlation Coefficient," *Behavior Research Methods* (48:3), pp. 994-1003.
Smith, K., and Hancock, P. A. 1995. "Situation Awareness Is Adaptive, Externally Directed Consciousness," *Human Factors* (37:1), pp. 137-148.
Swaab, R., Postmes, T., Neijens, P., Kiers, M., and Dumay, A. 2002. "Multiparty Negotiation Support: The Role of Visualization's Influence on the Development of Shared Mental Models," *Journal of Management Information Systems* (19:1), pp. 129–150.
Tallon, P. P. 2013. "Do You See What I See? The Search for Consensus among Executives' Perceptions of IT Business Value," *European Journal of Information Systems*).
Tan, F. B., and Gallupe, R. B. 2006. "Aligning Business and Information Systems Thinking: A Cognitive Approach," *IEEE Transactions on Engineering Management* (53:2), pp. 223–237.
Thomas, G., and Fernández, W. 2008. "Success in IT Projects: A Matter of Definition?," *International Journal of Project Management* (26), pp. 733-742.
Tiwana, A. 2004. "Beyond the Black Box: Knowledge Overlaps in Software Outsourcing," *IEEE Software* (21:05), pp. 51–58.
Tiwana, A. 2012. "Novelty-Knowledge Alignment: A Theory of Design Convergence in Systems Development," *Journal of Management Information Systems* (29:1), pp. 15–52.
van den Hooff, B., and de Winter, M. 2011. "Us and Them: A Social Capital Perspective on the Relationship between the Business and IT Departments," *European Journal of Information Systems* (20:3), pp. 255–266.
van der Haar, S., Li, J., Segers, M., Jehn, K. A., and Van den Bossche, P. 2015. "Evolving Team Cognition: The Impact of Team Situation Models on Team Effectiveness," *European Journal of Work and Organizational Psychology* (24:4), pp. 596-610.
Vermerris, A., Mocker, M., and Heck, E. v. 2014. "No Time to Waste: The Role of Timing and Complementarity of Alignment Practices in Creating Business Value in IT Projects," *European Journal of Information Systems* (23:6), pp. 629-654.
Vlaar, P. W. L., van Fenema, P. C., and Tiwari, V. 2008. "Cocreating Understanding and Value in Distributed Work: How Members of Onsite and Offshore Vendor Teams Give, Make, Demand, and Break Sense," *MIS Quarterly* (32:2), pp. 227–255.
Wagner, H.-T., Beimborn, D., and Weitzel, T. 2014. "How Social Capital among IT and Business Units Drives Operational Alignment and IT Business Value," *Journal of Management Information Systems* (31:1), pp. 241-272.
Wagner, H.-T., and Weitzel, T. 2012. "How to Achieve Operational Business-IT Alignment: Insights from a Global Aerospace Firm," *MIS Quarterly Executive* (11:1), pp. 25–36.
Walker, G., Kogut, B., and Shan, W. 1997. "Social Capital, Structural Holes and the Formation of an Industry Network," *Organization Science* (8), pp. 109-125.
Waller, M. J., Gupta, N., and Giambatista, R. C. 2004. "Effects of Adaptive Behaviors and Shared Mental Models on Control Crew Performance," *Management Science* (50:11), pp. 1534-1544.
Weick, K. E. 2005. "Managing the Unexpected: Complexity as Distributed Sensemaking," in *Uncertainty and Surprise in Complex Systems: Questions on Working with the Unexpected,* R.R. McDaniel and D. Driebe (eds.). Heidelberg: Springer Berlin, pp. 51-66.
Windeler, J., Maruping, L. M., Robert, L. P., and Riemenschneider, C. K. 2015. "E-Profiles, Conflict, and Shared Understanding in Distributed Teams," *Journal of the Association for Information Systems* (16:7), pp. 608-645.
Wixom, B. H., and Todd, P. A. 2005. "A Theoretical Integration of User Satisfaction and Technology Acceptance," *Information Systems Research* (16:1), pp. 85-102.
Yang, H.-D., Kang, H.-R., and Mason, R. M. 2008. "An Exploratory Study on Meta Skills in Software Development Teams: Antecedent Cooperation Skills and Personality for Shared Mental Models," *European Journal of Information Systems* (17:1), pp. 47–61.

Appendix

Results of preliminiary analysis

Table 6. Construct correlations (1)					
#	Construct	Mean	SD	CA	AVE
1	Team success	3.422	1.029	.908	.664
2	Team learning behavior	3.361	0.995	.883	.615
3	Shared language	3.523	0.830	.804	.583
4	Mental models	3.715	0.547	.762	.528
5	DK business (self)	3.685	0.639	.779	.615
6	DK business (others)	3.692	0.747	.850	.680
7	DK IT (self)	3.017	1.013	.839	.467
8	DK IT (others)	3.802	1.015	.884	.668
9	DK PM (Self)	3.293	0.742	.859	.614
10	DK PM (Others)	3.732	0.765	.810	.725

Table 7. Construct correlations (2)										
#	Construct	1	2	3	4	5	6	7	8	9
1	Team success	1								
2	Team learning behavior	.573**	1							
3	Shared language	.239*	.126	1						
4	Mental models	.409**	.391**	.235*	1					
5	DK business (self)	-.098	-.065	-.187*	.109	1				
6	DK business (others)	.188	.249**	.607**	.198*	-.212*	1			
7	DK IT (self)	.334**	.232*	.413**	.216*	-.299**	.552**	1		
8	DK IT (others)	-.030	-.082	-.307**	-.041	.391**	-.250*	-.548**	1	
9	DK PM (Self)	.365**	.236*	.237*	.407**	-.133	.291**	.729**	-.411**	1
10	DK PM (Others)	.234*	.134	-.191	.115	.229*	-.039	-.281**	.768**	-.191

Table 7. Survey and factor loadings

Construct	Item ID	Item
Team success	The IT solution delivered by the project …	
	Suc1	… comprises all necessary functionalities.
	Suc 2	... meets technical requirements.
	Suc 3	... perfectly matches end-user needs.
	Suc 4	Overall our organization is very satisfied with the project outcome.
Team learning behavior	TLB1	There was extensive communication among group members regarding their respective roles within the group.
	TLB2	All team members were equally involved in the identification of major problems and implementing solutions..
	TLB3	Information distributed in the team was always up-to-date.
	TLB4	Information distributed in the team was always complete.
Shared language	SL1	Our colleagues from the IT are (I am) able to explain technical concepts in a non-technical language so that non-IT people can understand them (me).
	SL2	Our IT colleagues (I) use terms that we from the business unit (the business) can understand.
Communication intensity	CI1	In the last 4 weeks, how many team meetings (incl. online) took place?
	CI2	How often did you spoke with your colleagues regarding project content outside of formal meetings?
Domain knowledge of business domain	How do you rate your own understanding regarding … / How do you rate the understanding of your partners in the business/IT unit regarding …	
	DAB1	... the customers of your company?
	DAB 2	... the product landscape of the company?
	DAB 3	... the daily tasks and routines of the business unit that is addressed in the project <<name of project>>.?
	DAB 4	... the daily challenges of these business units?
Domain know-ledge of IT domain	DAIT1	... the daily challenges of the IT unit?
	DKIT 2	... tools to manage IT systems (like UML, Visual Studios, JDK or MySQL Workbench)?
Domain knowledge of project management	DKPM1	... procedures in IT projects, like in the project <<name of project>>.
	DKPM2	... possibilities for optimizing IT projects, like <<name of project>>?
Mental models	How would you rate your understanding regarding …	
	MM1	... the work packages in the project?
	MM2	... the structured approach and methods in the project?
	MM3	... the roles and responsibilities in the project, such as decision rights?
	MM4	... distribution of knowledge among the team members?

Table 8. Factor loadings for the second EFA

Constructs	Items	1	2	3	4	5	6	7	8
Team success	PSuc1	**.832**	.215	-.031	.129	-.083	.093	.052	.248
	PSuc2	**.832**	.285	-.042	.008	.003	.199	.119	.023
	PSuc3	**.881**	.164	.087	.047	.021	-.032	.184	.045
	PSuc4	**.753**	.414	.186	.230	-.224	.016	.057	.071
Team learning behavior	TLB1	.241	**.733**	-.203	.314	-.002	.004	.061	.091
	TLB2	.122	**.858**	.069	.054	-.006	.129	.207	.049
	TLB3	.325	**.850**	.004	.117	-.089	.066	-.155	.130
	TLB4	.330	**.861**	-.024	.138	-.010	.072	-.107	.000
Shared language	SL1	.129	.019	**.774**	-.114	-.068	.405	.056	-.149
	SL3	-.044	-.072	**.790**	.148	-.072	.149	.190	-.229
Mental models	MM1	.151	.064	.110	**.817**	.214	-.003	.005	-.069
	MM2	.137	.086	.050	**.846**	.051	.011	.241	-.068
	MM3	.068	.175	-.133	**.839**	-.043	.093	-.098	.121
	MM4	-.106	.392	.128	**.649**	-.006	.119	.063	.280
DK business (Self)	DKB1-S	.085	.148	-.105	.247	**.654**	-.230	-.224	.416
	DKB2-S	.205	-.120	.157	.299	**.647**	-.065	-.295	.381
	DKB3-S	-.167	-.042	-.112	.105	**.901**	-.066	-.046	.181
	DKB4-S	-.129	-.071	-.056	-.100	**.940**	-.043	-.027	.036
DK business (Others)	DKB1-O	.250	.114	.238	.123	.172	**.789**	-.053	-.028
	DKB2-O	.164	-.027	.547	.153	-.082	**.651**	-.025	.162
	DKB3-O	-.117	.136	.021	-.060	-.278	**.820**	.237	-.217
	DKB4-O	.027	.082	.117	.103	-.101	**.876**	.176	-.140
DK IT (Self)	DKIT1-S	-.025	.191	.150	-.058	-.168	.536	**.639**	-.265
	DKIT2-S	.191	-.169	.237	-.131	-.189	.498	**.611**	-.137
DK IT (Others)	DKIT1-O	-.005	-.076	-.133	-.008	.247	-.220	-.198	**.821**
	DKIT2-O	.032	.123	-.049	-.114	.282	-.175	-.151	**.843**
DK PM (Self)	DKPM1-S	.205	-.033	.166	.189	-.115	.108	**.869**	-.088
	DKPM2-S	.111	.050	-.050	.069	-.045	.020	**.903**	-.189
DK PM (Others)	DKPM1-O	.303	.191	-.090	.167	.016	-.077	-.075	**.831**
	DKPM2-O	.059	.060	-.083	.070	.064	.055	-.080	**.922**

Table 9. Multicollinearity of items measuring DKIT and DKPM				
	DKIT1-S	DKIT2-S	DKPM1-S	DKPM2-S
DKIT1-S		1.62	2.35	2.27
DKIT2-S	1.77		2.28	2.58
DKPM1-S	2.97	2.63		1.86
DKPM2-S	2.38	2.46	1.54	
	DKIT1-O	DKIT2-O	DKPM1-O	DKPM2-O
DKIT1-O		1.77	2.76	3.01
DKIT2-O	1.63		3.10	2.90
DKPM1-O	2.39	2.31		1.77
DKPM2-O	1.96	2.05	1.49	

Table 10. Results for interrater agreement and intra-class correlation					
Con-struct	Team success	Team learning behavior	Team mental model at t=1	Team mental model at t=2	Team mental model at t=3
r_{WG}	0.936	0.902	0.853	0.802	0.851
SD	0.034	0.059	0.073	0.245	0.149
ICC(1)	0.407	0.152	0.108	0.113	0.213
ICC(2)	0.823	0.585	0.456	0.496	0.650
p-value	<0.001	0.007	0.050	0.030	0.002

Multilevel models

Model 1: Longitudinal effect of SDK on TMM

Level-1:

$$TMM_{mi} = (IND1_{mi})*TMM_{1i}* + (IND2_{mi})*TMM_{2i}* + (IND3_{mi})*TMM_{3i}*$$

$$TMM_{ti}* = \pi_{0i} + \pi_{1i}*(TIME_{ti}) + \pi_{2i}*(SDKB_{ti}) + \pi_{3i}*(SDKPM_{ti}) + \pi_{4i}*(SDKIT_{ti}) + \varepsilon_{ti}$$

where TMM_{mi} related to the observed data at occasion m and TMM_{ti*} describes the complete data of Team Mental Model at time t of the individual i. $INDx_{mi}$ represents the indicator or marker x of the repeated measure. The value can be only 1 or 0. $\pi_{0i\text{-}2i}$ are the level 1 coefficients.

Level-2 Model

$$\pi_{0i} = \beta_{00} + \beta_{01}*(CI1_{2i}) + \beta_{02}*(CI2_{4i}) + \beta_{03}*(SL_i) + \beta_{04}*(EXPERI_{1i})$$

$$\pi_{1i} = \beta_{10}$$

$$\pi_{2i} = \beta_{20}$$

$$\pi_{3i} = \beta_{30}$$

$$\pi_{4i} = \beta_{40}$$

where $\beta_{00\text{-}20}$ describe the level 2 coefficient.

Model 2a (mixed): Direct Effect Model of SDK and TMM on Success

$$Success_{ij} = \gamma_{00} + \gamma_{01}*TeamSize_j + \gamma_{02}*Complexity_j + \gamma_{03}*Relevance_j$$
$$+ \gamma_{10}*SDKBt_{ij}$$
$$+ \gamma_{20}*SDKPMt_{ij}$$
$$+ \gamma_{30}*SDKITt_{ij}$$
$$+ \gamma_{40}*TMMt_{ij}$$
$$+ u_{0j} + r_{ij}$$

Model 2b (mixed): Moderation Effect Model of SDK on Success moderated by TLB

$$Success_{ij} = \gamma_{00} + \gamma_{01}*TeamSize_j + \gamma_{02}*Complexity_j + \gamma_{03}*Relevance_j$$
$$+ \gamma_{10}*SDKBt_{ij} + \gamma_{11}*TLB_j*SDKBt_{ij}$$
$$+ \gamma_{20}*SDKPMt_{ij} + \gamma_{21}*TLB_j*SDKPMt_{ij}$$
$$+ \gamma_{30}*SDKITt_{ij} + \gamma_{31}*TLB_j*SDKITt_{ij}$$
$$+ \gamma_{40}*TMMt_{ij}$$
$$+ u_{0j} + r_{ij}$$

Appendix
Paper IX

PUBLICATIONS

Holotiuk, F., Beimborn, D. and Jentsch, C. (2018) "The Determinants and Role of Agility in Digital Organizations", *European Conference on Information Systems*, Portsmouth, UK.

Reitz, A., Jentsch, C. and Beimborn, D. (2018) "How to decompress the Pressure – The moderating Effect of IT Flexibility on the negative Impact of Governmental Pressure on Business Agility", *Hawaii Conference on Information Systems*, Big Island, Hawaii.

Jentsch, C., Beimborn, D., Reitz, A. (2017) "Templates for joined work systems – How business process modularity and IT flexibility enable mutual understanding among business and IT" *International Conference on Information Systems*, Seoul, South Korea.

Jentsch, C. (2017) "The Impact of Agile Practices on Team Interaction Quality - Insights into a Longitudinal Case Study", Americas Conference on Information Systems, Boston, USA.

Jentsch, C., Reitz, A. and Beimborn, D. (2017) "The Impact of Process and IT Modularity for Mutual Understanding among Business and IT", *ACM SIGMIS CPR Conference*, Bengaluru, India.

Kalgovas, B., Jentsch, C. and Haffke, I. (2017) "Digital Utopia for the IT function: Ambidextrous, Agile and Socially Aligned through Bimodal IT and Mutual Understanding", *Winter Global Business Conference* 2017, Tignes, France.

Jentsch, C. and Beimborn D. (2016) Die Relevanz einer starken Partnerschaft. In: PriceWaterhouseCoopers AG. „Fit für die Zukunft - Wie sich bankfachliche Dienstleister erfolgreich für den Business Process Outsourcing Markt 2020 aufstellen"; https://www.pwc.de/de/finanzdienstleistungen/banken/assets/studie-bpo-2016.pdf, 08.03.2018

Jentsch, C. and Beimborn, D. (2016) "IT is all about the Game – An exploratory study on the impact of task characteristics on the dimensions of business/IT shared understanding", *European Conference on Information Systems*, Istanbul, Turkey.

Kalgovas, B., Jentsch, C. and Haffke, I. (2016) "A tense alignment: Deriving diversity and shared understanding in digital innovation", *Winter Global Business Conference 2016*, Tignes, France

Lüders, P., Jentsch, C., and Beimborn, D. (2015) "Measuring Outsourcing Relationship Quality: Towards a Social Network Analysis Approach", *Americas Conference on Information Systems*, Puerto Rico, USA.

Lajtkep, F., Beimborn, D., Jentsch, C., and Stimmer, J. (2015) "I choose you - Developing a rating system for software outsourcing arrangements of SMEs", *Americas Conference on Information Systems*, Puerto Rico, USA.

Jentsch, C., Schlosser, F., and Beimborn, D. (2015) "Applying a configurational approach for explaining the role of relationship quality for successful outsourcing arrangements". *Global Sourcing Workshop*, La Thuile, Italy.

Jentsch, C., Schlosser, F., and Beimborn, D. (2014b) "From Strategic to Operational Collaborations: The Divergent Nature of Business/IT Shared Understanding", *Americas Conference on Information Systems*, Savannah, USA.

Jentsch, C., Beimborn, D., Jungnickl, C., and Renner, G. (2014a) "How to Measure Shared Understanding among Business and IT", *Academy of Management Conference*, Philadelphia, USA, *Published in Best Paper Proceedings.*

Jentsch, C. and Beimborn, D. (2014a) “What Matters in Business/IT Shared Understanding? Development of a Unified Construct”, *European Conference on Information Systems*, Tel Aviv, Israel.

Jentsch, C. and Beimborn, D. (2014b) “Shared Understanding Among Business and IT - A Literature Review and Research Agenda”, *European Conference on Information Systems*, Tel Aviv, Israel.

Jentsch, C. and Beimborn, D. (2013) “Do Business and IT understand each other” *Proceedings of the Special Interest Group on Organizations and Society in Information Systems* (OASIS) (Pre-ICIS Workshop), Milan, Italy.

DEUTSCHE ZUSAMMENFASSUNG

Das gemeinsame Verständnis zwischen IT und Fachbereichen wurde in vergangenen Forschungsstudien immer wieder als eine der wichtigsten Voraussetzungen für eine harmonische und effektive Zusammenarbeit identifiziert. Ein hohes gemeinsames Verständnis unterstützt die Entwicklung von strategischen Business/IT Alignment, das Anforderungsmanagement in der Softwareentwicklung sowie die Systemimplementierung in Infrastrukturprojekten. Auch wenn die Relevanz eines gemeinsamen Verständnisses immer wieder hervorgehoben wird, so weichen die Beschreibungen des Konzeptes teilweise stark voneinander ab. Beispielweise beschreiben Forschungen im Bereich des strategischen Alignments das gemeinsame Verständnis als Einigkeit zwischen CIO und CEO über die Rolle der IT in der Organisation, während die Forschungen im Bereich der Teamkoordination gemeinsame Wertvorstellungen oder das Verständnis über die Vorlieben, Stärken und Schwächen der Teammitglieder in den Vordergrund rücken. Die unterschiedlichen Konzeptualisierungen haben einen direkten Einfluss auf die Forschungsergebnisse, aus denen teilweise sehr widersprüchliche Empfehlungen abgleitet werden. So herrscht beispielsweise Uneinigkeit, ob das gemeinsame Verständnis in strukturierten Arbeitsumfeldern an Relevanz verliert. Die Entwicklung eines gemeinsamen Verständnisses binde viele Ressourcen, während das gemeinsame Verständnis in strukturierten Arbeitsumfeldern gleichzeitig an Relevanz verliere. Andere Forschungen legen dar, dass nicht die Relevanz im Allgemeinen sinke, sondern dass sich lediglich die Relevanz einzelner Dimensionen verschiebe. Die kontextbezogene und aktuelle (zeitbezogene) Situation in der Kooperation bestimme also die Konzeptualisierung und somit die Relevanz einzelner Dimensionen eines gemeinsamen Verständnisses.

Um die Ausprägungen des gemeinsamen Verständnisses zu erforschen, unterscheidet diese Arbeit somit zwischen den Kontingenzfaktoren Kontext und Zeit. Es wird angenommen, dass sich die Ausprägungen und Einflüsse des gemeinsamen Verständnisses in Abhängigkeit zum Kontext, in der es entwickelt wird, sowie im Zeitverlauf verändert. Die resultierende Forschungsfrage lautet:

Wie beeinflussen der Kontext und die Zeit die Entwicklung des gemeinsamen Verständnisses und dessen Einfluss auf den Erfolg der Zusammenarbeit zwischen Fach- und IT-Bereichen?

Zur Beantwortung der Forschungsfrage ist diese Dissertation in drei Themenblöcke gegliedert. Der erste Teil der Arbeit analysiert und konsolidiert die bisherigen Diskussionen im zugrundeliegenden Forschungsumfeld. Dabei werden die Ergebnisse aus verschiedenen Forschungssträngen (Paper I) zu einem umfassenden Konzept zusammengefasst (Paper II) und Empfehlungen für die Operationalisierung entwickelt (Paper III). Der zweite Teil der Arbeit konzentriert sich auf die kontextbezogenen Konzeptualisierungen und Einfluss des gemeinsamen Verständnisses auf den Erfolg der Kooperation. Ein zu dem Zweck entwickeltes Rahmenwerk (Paper IV) wird in einer explorativen Fallstudienserie mit qualitativen Belegen untermauert (Paper V). In einer abschließenden empirischen Studie (Paper VI) wird der statistische Zusammenhang zwischen dem Kontingenzfaktor Komplexität und dem gemeinsamen Verständnis zwischen Fach- und IT-Bereichen analysiert. Der dritte Teil der Arbeit konzentriert sich auf den zweiten Kontingenzfaktoren im Forschungsmodell: die Zeit. Eine Folge von zwei longitudinalen Fallstudienserien (Paper VII und Paper VIII) bildet das Fundament für die anschließende empirische Studie (Paper IX), in der die Entwicklung sowie Auswirkungen des gemeinsamen Verständnisses im Lebenszyklus von IT-Projekten analysiert wird.

Die Ergebnisse der Dissertation zeigen, dass das gemeinsame Verständnis zwischen Fach- und IT-Bereichen ein multidimensionales Konstrukt darstellt, welches sich entsprechend des Kontextes im Zeitverlauf verändert. Die entwickelten Rahmenwerke können in Forschung und Praxis angewandt werden, um ein tieferes Verständnis der Auswirkungen des gemeinsamen Verständnisses innerhalb und zwischen verschiedenen Kooperationsformen und über die Zeit zu erreichen. Die drei wichtigsten Ergebnisse lassen sich wie folgt zusammenfassen:

Erstens hilft diese Dissertation die Vielzahl an Konzeptualisierungen zu strukturieren, indem ein umfassendes Konzept entwickelt wird, das die wichtigsten Dimensionen bisheriger Forschung umfasst. Das Konzept wird durch empirische Belege gefestigt, die zeigen, dass die Bedeutung von „gemeinsam" von der jeweiligen Dimension abhängt, über die ein gemeinsames Verständnis herrschen soll. Gemeinsames Verständnis von technischen und aufgabenspezifischen Aspekten muss als ähnlich oder teilweise überlappend verstanden werden, da diese Überlappungen den Kooperationspartner helfen, gemeinsame Lösungsverfahren zu entwickeln. Im Gegensatz dazu sollte das gemeinsame Verständnis zu fachlichen, geschäftsspezifischen Aspekten als verteiltes oder kompatibles Verständnis konzipiert werden, da die Herausforderung in der Regel darin besteht, das Fachwissen verschiedener Personen zu nutzen und neue Ideen und Ansätze zu entwickeln.

Zweitens trägt diese Dissertation zur Diskussion über die Relevanz des gemeinsamen Verständnisses in strukturierten Arbeitsumgebungen (d.h. modulare IT- und Geschäftsstrukturen) bei. Die Ergebnisse widersprechen früheren Untersuchungen, die argumentieren, dass die Notwendigkeit des Wissensaustauschs in strukturierten Umgebungen abnimmt. Ein gemeinsames Verständnis, welches durch eine strukturierte Umgebung gefördert wird, steigert den positiven Effekt einer strukturierten Umgebung auf den Kooperationserfolg zusätzlich. Jedoch zeigt sich auch, dass eine strukturierte Umgebung die Entwicklung des gemeinsamen Verständnisses nicht per se fördert, wie bisher angenommen. Vielmehr ist die Kombination aus fachlicher und technischer Arbeitsumgebungsstruktur von zentraler Bedeutung.

Drittens unterstreichen die Ergebnisse, dass eine universelle Empfehlung für das ideale Timing in der Implementierung des gemeinsamen Verständnisses nicht möglich ist. Unterschiedliche Perspektiven des gemeinsamen Verständnisses beeinflussen den Kooperationserfolg in unterschiedlichen Phasen der Kooperation. Ein überlappendes Verständnis der IT-Domäne zu Beginn einer Kooperation hilft dem Team, den Ablauf der Kooperation zu strukturieren, während ein überlappendes Verständnis von aufgabenbezogenen Aspekten im weiteren Verlauf hilfreich ist, um den Fokus der gemeinsamen Ziele nicht aus den Augen zu verlieren. Ein unterschiedliches bzw. ergänzendes fachliches Verständnis über alle Teammitglieder in den späteren Kooperationsphasen trägt zum Teamerfolg bei, indem es dem Team hilft das Fachwissen zu konsolidieren und etwas Neues zu schaffen. Somit ist eine zeitabhängige Kombination der verschiedenen Perspektiven des gemeinsamen Verständnisses wichtig, um den Kooperationserfolg zu maximieren.

Diese Dissertation unterstreicht die Notwendigkeit einer gezielteren Diskussion der Entstehung und Wirkung des gemeinsamen Verständnisses zwischen Fach- und IT-Bereichen, um scheinbar widersprüchliche Forschungsergebnisse zu vereinen und konkrete Empfehlungen für die Praxis zu entwickeln. Dabei erweitert die Dissertation Tiefe und Spezifizität zu früheren, eher universellen Empfehlungen, welche leicht missinterpretiert werden können, und öffnet damit neue Türen in der laufenden Forschung zum gemeinsamen Verständnis zwischen Fach- und IT-Bereichen.

ABSCHLUSSERKLÄRUNG

Hiermit erkläre ich gemäß *§ 10 Abs. 2 Punkt 2 der Promotionsordnung der Fakultät Wirtschaftsinformatik und Angewandte Informatik der Universität Bamberg*, dass ich die vorliegende Dissertation selbstständig verfasst, nicht die Hilfe einer Promotionsberatung in Anspruch genommen, keine anderen Hilfsmittel als die im Quellen- und Literaturverzeichnis genannten benutzt und alle aus Quellen und Literatur wörtlich oder sinngemäß entnommenen Stellen als solche kenntlich gemacht habe.

Gemäß *§ 10 Abs. 2 Punkt 4 der Promotionsordnung der Fakultät Wirtschaftsinformatik und Angewandte Informatik der Universität Bamberg* erkläre ich zudem, dass die Dissertation oder wesentliche Teile derselben nicht bereits einer anderen Prüfungsbehörde zur Erlangung des Doktorgrades vorlagen.

Gemäß *§ 10 Abs. 2 Punkt 5 der Promotionsordnung der Fakultät Wirtschaftsinformatik und Angewandte Informatik der Universität Bamberg* lege ich im Folgenden dar, in welcher Form Teile der vorliegenden Dissertation bereits publiziert sind:

Paper	Veröffentlicht in
Paper I	Jentsch, C., and Beimborn, D. 2014. "Shared Understanding among Business and IT - a Literature Review and Research Agenda," *European Conference on Information Systems*, Tel Aviv, Israel.
Paper II	Jentsch, C., and Beimborn, D. 2014. "What Matters in Business/IT Shared Understanding? Development of a Unified Construct," *European Conference on Information Systems*, Tel Aviv, Israel.
Paper III	Jentsch, C., Beimborn, D., Jungnickel. Christoph, and Renner, G.-S. 2014. "How to Measure Shared Understanding among Business and IT," *Best Paper Proceedings of the 2014 Academy of Management Meeting*, Philadelphia, PA.
Paper IV	Jentsch, C., Schlosser, F., and Beimborn, D. 2014. "From Strategic to Operational Collaborations: The Divergent Nature of Business/IT Shared Understanding," *Americas Conference on Information Systems*, Savannah, GA.
Paper V	Jentsch, C., and Beimborn, D. 2016. "IT Is All About the Game - an Exploratory Study on the Impact of Task Characteristics on the Dimensions of Business/IT Shared Understanding," *European Conference on Information Systems*, Istanbul, Turkey.
Paper VI	Teile des Papers basieren auf der Veröffentlichung: Jentsch, C., Beimborn, D., and Reitz, A. 2017. "Templates for Joined Work Systems – How Business Process Modularity and IT Flexibility Enable Mutual Understanding among Business and IT," *International Conference on Information Systems*, Seoul, South Korea.
Paper VIII	Jentsch, C. 2017. "The Impact of Agile Practices on Team Interaction Quality - Insights into a Longitudinal Case Study," *Americas Conference on Information Systems* Boston, MA, USA.

Im Folgenden lege ich zudem gemäß *§ 9 Absatz 4 Satz 6 der Promotionsordnung der Fakultät Wirtschaftsinformatik und Angewandte Informatik der Universität Bamberg* den jeweiligen Beitrag dar, den ich für die Artikel der vorliegenden Dissertation erbracht habe, die mit mehreren Autoren abgefasst wurden:

- Paper I, II, V und VII wurden gemeinsam mit Prof. Dr. Daniel Beimborn unter meiner Federführung geschrieben. Sämtliche Inhalte des Artikels wurden von mir erstellt und durch den Co-Autor geschärft und revidiert. Im Falle von Paper VII wurde die Datenerhebung von einer Masterandin unterstützt.
- Paper III wurde gemeinsam mit Prof. Dr. Daniel Beimborn und zwei Masteranden (Georg-Sebastian Renner und Christoph Jungnickl) unter meiner Federführung geschrieben. Sämtliche Inhalte des Artikels wurden von mir erstellt. Die Masteranden haben bei der Datenerhebung unterstützt. Die Inhalte des Papers wurden durch Prof. Daniel Beimborn geschärft und revidiert.
- Paper IV wurde gemeinsam mit Frank Schlosser und Prof. Dr. Daniel Beimborn unter meiner Federführung geschrieben. Sämtliche Inhalte des Artikels wurden von mir erstellt und durch die Co-Autoren geschärft und revidiert.
- Paper VI wurde gemeinsam mit Prof. Dr. Daniel Beimborn und mit Andreas Reitz (Frankfurt School of Finance & Management) unter meiner Federführung geschrieben. Das Studiendesign, die Datenerhebung sowie statistische Datenauswertung wurde in enger Abstimmung mit den Co-Autoren durchgeführt. Andreas Reitz war zudem primär für theoretische Einführung des Modularitätskonzeptes verantwortlich. Die Inhalte des Papers wie Forschungsmotivation, theoretische Fundierung, Forschungsmodell, Ergebnisdiskussion und Kontribution wurde von mir erstellt und durch die Co-Autoren revidiert.
- Paper IX wurde gemeinsam mit Prof. Dr. Daniel Beimborn und Prof. Dr. Geneviève Bassellier (McGill, Kanada) unter meiner Federführung geschrieben. Sämtliche Inhalte des Artikels wurden von mir erstellt und durch die Co-Autoren geschärft und revidiert.

Christian Jentsch, Bamberg, den 22.10.2018