CHAPTER I INTRODUCTION

1 VIRTUAL TEAM AND AWARENESS TECHNOLOGY

Globalization requires companies to intelligently distribute work across time and space. Therefore, organizations increasingly turn to virtual teams (Majchrzak et al. 2005). Research defines virtual teams as groups of geographically distributed individuals that rely on information technology for accomplishing their work (Powell et al. 2004). Modern organizations increasingly require the formation of structurally diverse teams, where employees work with team members from different business units, overseas branches or delegates of other companies (Cummings 2004). Structurally diverse arrangements allow for sharing knowledge and integrating different perspectives to expedite implementation of new ideas and spark innovation across locations (Majchrzak et al. 2004). Moreover, facing increased market pressure to cut costs, companies increasingly outsource business functions to external providers. For this purpose, work teams of outsourcer and provider have to coordinate the provision of services and the transfer of business specific knowledge across time and space (Dibbern et al. 2008).

In contrast to co-located teams, virtual teams hardly meet in person and therefore have to fully rely on information technology (Robert et al. 2009). Technology, however, severely limits the means of communication and thus tremendously changes the way people work together (Powell et al. 2004). Consequently, a plethora of studies have sought to investigate why collaboration in virtual teams is much more difficult than in co-located settings (Hinds and Bailey 2003; Powell et al. 2004). A fundamental problem of virtual collaboration is that team workers lack awareness about their team members' activities (Kraut et al. 2002). According to Dourish and Bellotti (1992, p. 107), awareness denotes the *"… understanding of the activities of others, which provides a context of [ones] own activity"*. In co-located teams, people learn

about each other's activities by simply observing their team members carrying out a task, speaking about their activities in scheduled meetings as well as during chance encounters in the office space. In virtual teams, however, people cannot observe their colleagues and rarely meet in person (Kraut et al. 2002). Consequently, the main source of awareness in virtual teams is the information conveyed by the collaboration tools used. For this reason, research in information systems (IS), human-computer interaction (HCI), and computer-supported cooperative work (CSCW) has striven to explore new means of supporting awareness (for reviews see Seebach et al. 2011; Steinmacher et al. 2013). The design of such tools has been aimed at transmitting additional awareness cues beyond the awareness that is already conveyed through conventional communication tools such as email and teleconferencing environments (Gutwin and Greenberg 2002; Tee et al. 2009). Meanwhile independent innovators have set off the hype around social media. While social media functions mainly focus on the transmission of general social cues of people, they can also leverage awareness of activities among collaborators. For this reason, commercial producers of collaboration tools have started to incorporate social media functions as tools for enhancing awareness in collaboration settings (e.g. Arrington 2010; Majchrzak et al. 2009). Nonetheless, although there are many examples of collaboration tool designs, which enhance awareness, these designs have been rather ad hoc and barely evaluated with respect to their impacts on interaction processes in teams (Dabbish and Kraut 2008).

In general, IS research has emphasized the benefits of theory-driven design and rigorous evaluation of IS artifacts (Gregor and Jones 2007; Hevner et al. 2004). This dissertation seeks to apply these principles to the design of awareness technology for virtual teams. Drawing on theory from IS and related disciplines, this dissertation aims to inform the design of innovative awareness technologies and further the knowledge on the assessment of these technologies within the context of virtual teams. While the dissertation is comprised of three different research studies, as a whole, these studies aim at contributing to the knowledge on (1) how awareness technology

can enhance collaboration in teams, (2) how such awareness technology should be designed to best improve teamwork, and (3) how different conditions impact on the usage and efficacy of awareness technology.

2 MOTIVATION AND RESEARCH QUESTIONS

After having outlined the general focus of this dissertation, this section will explain the motivation for each of the three presented research studies by explaining the specific research gaps that these studies seek to fill.

2.1 Study 1: Awareness Technology and Coordination

Study 1 deals with the design of awareness technology for improving coordination in teams. The improvement of coordination in teams has been a long-lasting issue in IS and other disciplines (Massey et al. 2003; Powell et al. 2004). Coordination in teams is challenging and also co-located teams often lack contextual information that supports coordination (McGrath 1991). However, since virtual team members cannot meet in person, awareness of other team members' activities is particularly reduced and virtual teams struggle even more to coordinate themselves (Kraut et al. 2002; Ocker et al. 1995). Although various designs of awareness tools have been presented by academic research or commercial product development teams, no evidence has been given whether these tools in fact improve coordination. From virtual team research, we know that awareness is important, however, we do not know how to generate awareness for virtual teams. Even though prior research has shown in short-term experimental settings that computer-mediated awareness may positively influence decision effectiveness in teams (Cooper and Haines 2008) and reduce interruptions in dyads (Dabbish and Kraut 2008), little is known about how awareness tools have to be designed to support coordination in teams that work over longer periods. As to what concerns commercial designs of awareness applications, the hype around social media has originated a plethora of new functions from which some can be applied to

improve awareness in virtual teams. It is not clear, though, whether such functions indeed have a benefit for coordination, which is of additional value to the benefit that conventional tools provide. The question is whether social media can provide additional information that goes beyond the awareness cues transmitted via the exchange of email and work documents. Moreover, prior research has stressed the role of the task context for the appropriation and effectiveness of collaboration technology (Desanctis and Poole 1994; Goodhue and Thompson 1995; Zigurs and Buckland 1998). In particular, teams working on complex task are understood to be in need for special technological support (Zigurs and Buckland 1998). Hitherto, the fit of awareness tools and team task has not been explored. While most researchers agree that awareness has a positive influence on teamwork and various aspects of awareness have been identified (Gutwin and Greenberg 2002; Schmidt 2002; Steinmacher et al. 2013), it is not clear which of these different types of awareness are needed when working on a complex task or respectively a less complex task and more importantly how this awareness can be provided via information technology.

> ***Research Question 1****: Can social media functions increase awareness in virtual teams and thereby improve team coordination; and if so is the impact moderated by the task and how do such features have to be designed?*

2.2 Study 2: Awareness Technology and Privacy

Study 2 is concerned with the improvement of privacy in awareness technology for enhancing knowledge sharing within and across teams. In today's information age, knowledge of employees is a major resource of modern organizations (Alavi and Leidner 2001; Kane and Alavi 2007; Nonaka 1994). Although individuals as well as teams may compete with each other, especially the exchange of knowledge across teams may lead to an exchange of expertise, the dispersion of innovative ideas, and the creation of new knowledge through the recombination of information from diverse sources (Hansen 1999; Nonaka 1994; Tsai 2002). Awareness of other's activi-

ties may enhance knowledge sharing by building a shared context and providing for opportunities for informal interactions (Kraut et al. 2002). Collaboration technology such as social media may provide extra channels for communicating awareness (Malhotra and Majchrzak 2012; Riemer et al. 2011). However, the communication of awareness also entails the revelation of information that may be considered private to individuals or teams (Chen et al. 2009; Krasnova et al. 2010; Lowry et al. 2011). Especially when actors stand in competition, they may be more reluctant to disclose information (Tsai 2001). While, literature on social media and awareness tools has stressed the conflict between privacy and awareness (Dourish and Bly 1992; Patil and Kobsa 2009; Romero and Markopoulos 2009; Tee et al. 2009; Wang and Kobsa 2009), prior research has not explored how much awareness is needed from outside the team and how the privacy of teams can be protected. In particular, it is not known how awareness features should be designed for delivering awareness to team members as well as members from other teams.

> ***Research Question 2****: Can privacy in social media functions enhance awareness and thereby improve knowledge sharing within and across teams; and if so, how does privacy have to be designed in awareness features?*

2.3 Study 3: Artifact Awareness and the Perception of Work Competence

Study 3 investigates how artifact-generated awareness impacts people's perception of work competence of other team members. The impression of a person's work competence plays a pivotal role for communication and relationship building in teams (Cramton and Orvis 2003; Jarvenpaa and Leidner 1999; Robert et al. 2009). In particular, individuals are more likely to exchange knowledge with team members that appear to be competent (Jarvenpaa and Leidner 1999). Generally, people make judgments about others with respect to their actions (Funder 1995). In teams, knowing what other team members are doing severely shapes people's perception of their work competence (Robert et al. 2009). Analogously, technology that conveys aware-

ness about other's activities may also influence the impression of work competence (Marlow et al. 2013). While awareness can be generated from several sources (Cooper and Haines 2008; Gutwin and Greenberg 2002), study 3 focuses on the generation of awareness on the basis of artifacts. Artifact awareness displays (AADs) were found to play a major role in forming the online reputations of collaborators in online software developer communities. Knowing about what, how much, where, and when a person contributed to an artifact can help to make inferences of the person's level of competence (Marlow and Dabbish 2013; Marlow et al. 2013). Awareness literature has identified a broad spectrum of awareness cues (Gutwin and Greenberg 2002; Schmidt 2002; Seebach et al. 2011), but it is not known what kind of awareness cues can be provided specifically by artifacts. With respect to teams, not only awareness of an individual's activities in isolation is important, but also how these activities relate to the activities of other team members (Gutwin and Greenberg 2002). Prior artifact awareness displays (e.g. Tee et al. 2009; Treude and Storey 2010), have focused only on the representation of artifact interactions of individuals, but not on the visualization of the interactions of the whole team. In general, a systematic exploration of the efficacy of these displays is not existent.

> ***Research Question 3****: What kind of awareness information can be generated from artifacts to support the perception of other team members' work competence, how should the awareness information be represented in a display and how does the design of such displays influence awareness of team members?*

3 OVERVIEW OF THE DISSERTATION

Table 1 gives an overview of the three studies that comprise the dissertation at hand. All three studies have in common that they aim to create theories of principles for designing information technology for the creation of awareness (Gregor and Jones 2007; Hevner et al. 2004; Markus and Majchrzak 2002). Each study therefore,

presents prototype designs that are grounded in theory and conducts an empirical evaluation of these prototypes (Gregor and Jones 2007; Hevner et al. 2004).

Following *chapter one* with the introduction, *chapter two* presents study 1 which examines how awareness technology has to be designed to enhance coordination in virtual teams and whether task complexity moderates the impact of awareness features. With the objective of improving coordination through awareness, a prototype of an awareness-enhanced collaboration environment was developed on the basis of theory on awareness and coordination in virtual teams. Next to the conventional functions for supporting teamwork, as documented by Zigurs and Buckland (1998), this prototype provides for specific active and passive awareness features that are aimed at leveraging task awareness and presence awareness in virtual teams. To explore the effectiveness of these specific features for increasing awareness and eventually coordination, the awareness-enhanced environment was evaluated against a basic environment with conventional IT-support (Zigurs and Buckland 1998). The evaluation was conducted in a two-factor experiment with participants that were randomly assigned to teams. Factor one was the used technology, i.e. the basic environment versus the awareness-enhanced environment and factor two was the task, i.e. the participating teams worked either on a fuzzy task that was very complex or on a problem task that was less complex. Data was collected using a questionnaire instrument which was administered to the participants after the accomplishment of the group task at the end of the experiment. In that way, the perception of task awareness, presence awareness, coordination quality, and team satisfaction could be measured for each experimental condition. For fuzzy task groups, it could be demonstrated that the proposed awareness features indeed influence coordination quality via perceived task and presence awareness. In contrast, groups working on the problem task did not benefit much from special awareness functions. Moreover, the interactions in the team shared artifacts were measured and it was found that in the problem task setting, the team arti-

facts were a more valuable source of awareness than the proposed awareness functions.

In *chapter three*, study 2 investigates the design of privacy in awareness technology used to improve knowledge sharing within and across teams. Study 2 also compared two prototypes. Informed by literature on awareness and information privacy, a collaboration environment is presented that allows for better access control to awareness information. This privacy-enhanced prototype builds on the awareness-enhanced design presented in study 1. It extends the awareness features by additional privacy control. The study followed a single factor experiment design, in which the used technology was manipulated. For assessing the benefits of privacy control, the privacy-enhanced prototype was compared with the awareness-enhanced prototype from study 1. Study 2 was also conducted in the fuzzy task setting of study 1. Thus, both studies share the data of the participant groups that used the awareness-enhanced prototype with the exception of one quad which was omitted in study 2 since privacy control did not play a role for that group. The findings indicate that privacy leads to a higher usage of awareness functions which increases awareness and eventually knowledge sharing. Moreover, the study yields interesting findings regarding the impact of awareness functions with privacy control on the usage of other functions.

In *chapter four*, study 3 focuses on the design of artifact awareness displays and how these displays may form people's impressions of others. Drawing on literature on awareness and on cognitive load theory, two artifact awareness displays were designed: a graphical display and a textual display. These artifact awareness displays visualize the interactions of groups with an artifact. Both displays were evaluated in an experiment, where participants had to rate each team member from the group they saw in the display. The participants' ratings were collected using a questionnaire which was available while seeing the display. The experiment followed a two-factor factorial design. Factor one was technology, i.e. participants were randomly assigned to either the graphical display or the textual display. Factor two was complexity,

which was manipulated by varying the size of the team viewed in the display, i.e. participants either saw a big or a small group in the display. The comparison of artifact activity ratings with the actual activity of the viewed team members showed that participants using the graphical display were more accurate on rating how consistent team members contributed to an artifact and to what extent team members co-edited with others.

Chapter five summarizes the contributions of study 1, 2 and 3 by elaborating on the general implications for research and practice.

	Study 1: Enhancing Coordination through Awareness – The Moderating Effect of Task Complexity	*Study 2: Who should see what? – Designing Privacy in Awareness Technology*	*Study 3: Artifact Awareness Displays – How they influence our perception of other team members' work competence*
Problem	Design and impact of awareness technology for improving coordination in teams with different tasks	Design and impact of privacy in awareness technology for enhancing knowledge sharing within and across teams	Design and impact of artifact awareness displays for supporting the perception of work competence of team members
Theoretical Foundation	Theory on awareness, theory on coordination in virtual teams	Theory on awareness, theory on information privacy	Theory on awareness, cognitive load theory
Method	Prototype design, empirical testing in two factor experiment design	Prototype design, empirical testing in single factor experiment design	Prototype design, empirical testing in two factor experiment design
Data Sources	Teamwork on problem task: -26 quads using prototype 1 -26 quads using prototype 2 Teamwork on fuzzy task: -15 triads using prototype 1 -18 triads using prototype 2	Teamwork on problem task: -25 quads using prototype 2 (from study 1) -25 quads using prototype 3	156 Participants: -80 using a graphical awareness display -76 participants using a textual awareness display
Data Analysis	Quantitative data analysis, partial least squares	Quantitative data analysis, partial least squares	Quantitative data analysis, hierarchical regression
Publication Status	To be submitted to Journal of the Association of Information Systems, a prior version has been presented at the European Conference on Information Systems 2012 in Barcelona (Meyer and Dibbern 2012)	To be submitted to Decision Support Systems	To be submitted to the International Conference on Information Systems 2013
Contributors	Meyer, Dibbern	Meyer	Meyer, Dabbish, Kraut
Own Contribution	Major	Major	Major

Table 1: Overview of studies conducted within the scope of this dissertation