Predicting Collaboration Technology Use: Integrating Technology Adoption and Collaboration Research

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Abstract: The paper presents a model integrating theories from collaboration research (i.e., social presence theory, channel expansion theory, and the task closure model) with a recent theory from technology adoption research (i.e., unified theory of acceptance and use of technology, abbreviated to UTAUT) to explain the adoption and use of collaboration technology. We theorize that collaboration technology characteristics, individual and group characteristics, task characteristics, and situational characteristics are predictors of performance expectancy, effort expectancy, social influence, and facilitating conditions in UTAUT. We further theorize that the UTAUT constructs, in concert with gender, age, and experience, predict intention to use a collaboration technology, which in turn predicts use. We conducted two field studies in Finland among (1) 349 short message service (SMS) users and (2) 447 employees who were potential users of a new collaboration technology in an organization. Our model was supported in both studies. The current work contributes to research by developing and testing a technology-specific model of adoption in the collaboration context.

Key words and phrases: channel expansion theory, collaboration technologies, social presence theory, task closure model, technology acceptance, technology adoption, unified theory of acceptance and use of technology.

Technology adoption[1] is one of the most mature streams in information systems (IS) research (see [65, 76, 77]). The benefit of such maturity is the availability of frameworks and models that can be applied to the study of interesting problems. While practical contributions are certain to accrue from such investigations, a key challenge for researchers is to ensure that studies yield meaningful scientific contributions. There have been several models explaining technology adoption and use, particularly since the late 1980s [76]. In addition to noting the maturity of this stream of research, Venkatesh et al. identified several important directions for future research and suggested that "one of the most important directions for future research is to tie this mature stream [technology adoption] of research into other established streams of work" [76, p. 470] (see also [70]).

In research on technology adoption, the technology acceptance model (TAM) [17] is the most widely employed theoretical model [76]. TAM has been applied to a range of technologies and has been very predictive of individual technology adoption and use. The unified theory of acceptance and use of technology (UTAUT) [76] integrated eight distinct models of technology adoption and use, including TAM. UTAUT extends TAM by incorporating social influence and facilitating conditions. UTAUT is based in the rich tradition of TAM and provides a foundation for future research in technology adoption. UTAUT also incorporates four different moderators of key relationships. Although UTAUT is more integrative, like TAM, it still suffers from the limitation of being predictive but not particularly useful in providing explanations that can be used to design interventions that foster adoption (e.g., [72, 73]).

There has been some research on general antecedents of perceived usefulness and perceived ease of use that are technology independent (e.g., [69, 73]). But far less attention has been paid to technology-specific antecedents that may provide significantly stronger guidance for the successful design and implementation of specific types of systems. Developing theory that is more focused and context specific—here, technology specific—is considered an important frontier for advances in IS research [53, 70]. Building on UTAUT to develop a model that will be more helpful will require a better understanding of how the UTAUT factors play out with different technologies [7, 76]. As a first step, it is important to extend UTAUT to a specific class of technologies [70, 76]. A model focused on a specific class of technology will be *more explanatory* compared to a general model that attempts to address many classes of technologies [70]. Such a focused model will also provide designers and managers with levers to augment adoption and use. One example is collaboration technology [20], a technology designed to assist two or more people to work together at the same place and time or at different places or different times [25, 26].

Technologies that facilitate collaboration via electronic means have become an important component of day-to-day life (both in and out of the workplace). Thus, it is not surprising that collaboration technologies have received considerable research attention over the past decades [24, 26, 77]. Several studies have examined the adoption of collaboration technologies, such as voice mail, e-mail, and group support systems (e.g., [3, 4, 44, 56, 63]). These studies focused on organizational factors leading to adoption (e.g., size, centralization) or on testing the boundary conditions of TAM (e.g., could TAM be applied to collaboration technologies). Given that adoption of collaboration technologies is not progressing as fast or as broadly as expected [20, 54], it seems a different approach is needed. It is possible that these two streams could inform each other to develop a more complete understanding of collaboration technology use, one in which we can begin to understand *how* collaboration factors influence adoption and use.

A model that integrates knowledge from technology adoption and collaboration technology research is lacking, a void that this paper seeks to address. In doing so, we answer the call for research by Venkatesh et al. [76] to integrate the technology adoption stream with another dominant research stream, which in turn will move us toward a more cumulative and expansive nomological network (see [41, 70]). We also build on the work of Wixom and Todd [80] by examining the important role of technology characteristics leading to use. The current study will help us take a step toward alleviating one of the criticisms of IS research discussed by Benbasat and Zmud, especially in the context of technology adoption research: “we should neither focus our research on variables outside the nomological net nor exclusively on intermediate-level variables, such as ease of use, usefulness or behavioral intentions, without clarifying the IS nuances involved" [6, p. 193]. Specifically, our work accomplishes the goal of "developing conceptualizations and theories of IT [information technology] artifacts; and incorporating such conceptualizations and theories of IT artifacts" [53, p. 130] by extending UTAUT to incorporate the specific artifact of collaboration technology and its related characteristics. In addition to the scientific value, such a model will provide greater value to practitioners who are attempting to foster successful use of a specific technology.

Given this background, the primary objective of this paper is to develop and test a model to understand collaboration technology adoption that integrates UTAUT with key constructs from theories about collaboration technologies. We identify specific antecedents to UTAUT constructs by drawing from social presence theory [64], channel expansion theory [11] (a descendant of media richness theory [16]), and the task closure model [66], as well as a broad range of prior collaboration technology research. We test our model in two different studies conducted in Finland: the use of short message service (SMS) among working professionals and the use of a collaboration technology in an organization.

Background

Collaboration Technology

Collaboration technology is a package of hardware and software that can provide one or more of the following: (1) support for communication among participants, such as electronic communication to augment or replace verbal communication; (2) information-processing support, such as mathematical modeling or voting tools; and (3) support to help participants adopt and use the technology, such as agenda tools or real-time training (e.g., [24, 26, 81]). A variety of terms have been used to refer to collaboration technology over the years—such as group decision support systems, group support systems, electronic meeting systems, groupware, computer-supported cooperative work, and negotiation support systems—but these, as well as specific systems, such as e-mail, voice mail, and videoconferencing, are generally encompassed under the larger umbrella term of *collaboration technology*.

Collaboration technology has been the subject of formal research at least since the 1970s, although its emergence as a key domain of research did not occur until the 1980s [18]. Many reviews of collaboration technology research have been published over the years outlining the development of research and highlighting trends in the empirical results [21, 24, 31, 32]. While early collaboration technology research initiatives were centered on decision room environments [18], attention has more recently turned to collaboration technologies that support virtual teams and distributed work (e.g., e-mail, instant messaging, asynchronous discussion tools).

As collaboration technologies have evolved, our understanding of what contributes to their use has not kept pace [62]. Past research has found that the use of collaboration technology can produce strikingly different outcomes [21, 24, 31, 32]. Communication tools, such as e-mail, produce outcomes different from what is produced by more complete systems that include information-processing support tools [21]. Likewise, the nature of the task—such as decision making versus idea generation [21]—can influence the value of a particular technology. Thus, the fit of the technology to the task is important [24, 81]. Past research [24] suggests several key observations. First, if the technology fits the needs of the task, then the use of collaboration technology can improve decision quality and increase the number of ideas generated compared to not using it [24]. But, if the technology is a poor fit, little is gained, at least initially (see also [35]). Further, the aspects of the technology that the group chooses to use and how they use them affect outcomes. Second, if groups new to a collaboration technology receive no support in choosing what aspects of the technology to use and guidance on how to use them, they take longer to complete tasks than groups working without technology [24]. If these same groups receive support (or if they have prior experience with the technology and task), they take less time and are more satisfied [24]. Thus, use is a key factor affecting group performance.

Unified Theory of Acceptance and Use of Technology

Venkatesh et al. [76] proposed a unified model—namely, UTAUT—that incorporates four key predictors of intention to use technology: performance expectancy, effort expectancy, social influence, and facilitating conditions. Intention, in turn, predicts technology use. Performance expectancy is the extent to which an individual perceives that using a system will enhance his or her productivity, and thus lead to performance gains—performance expectancy is conceptually and empirically identical to perceived usefulness from TAM [76]. Effort expectancy is the extent to which using a system is free from effort—effort expectancy is conceptually and empirically identical to perceived ease of use from TAM [76]; note that high effort expectancy suggests high ease of use and *not* high effort. Social influence is the extent to which an individual perceives that important others think that he or she should use the target system [67, 73]. Facilitating conditions is the perception regarding the availability of organizational and technical resources to support use of the target system [76]. Further, UTAUT argues that the various relationships are moderated by a combination of gender, age, experience, and voluntariness [76]. Several studies have reported use of systems in organizations as being either voluntary [69, 73, 76] or mandatory [9, 73, 76]. Given that our work focuses on voluntary contexts, we exclude voluntariness from our model.

As noted earlier, the key question of interest in this paper is: *Why do people choose to use collaboration technology?* In general, people adopt a technology because they believe it will be useful in improving the effectiveness and efficiency of performing some task [20, 76]. These *effectiveness* and *efficiency* motives correspond directly to core underpinnings of *performance expectancy* and *effort expectancy,* respectively, thus making UTAUT particularly suitable as the basis for the model development. UTAUT also accounts for social influences and environmental factors not considered in the original conceptualization of TAM. Further, UTAUT has explained over 70 percent variance in intention to use several different technologies [76], thus making it a robust and comprehensive model.

Model Development

UTAUT IS A GENERAL MODEL OF TECHNOLOGY ADOPTION AND USE. UTAUT and related theories (e.g., TAM) have been successfully applied in a wide range of settings and across diverse technologies. Yet there is nothing in the model that differentiates across the characteristics of a use situation (i.e., a specific technology, its potential users, and context of use). There is nothing in UTAUT by itself that directly helps us in understanding what leads to the adoption of collaboration technology. UTAUT argues that beliefs about performance and effort influence the decision to adopt and use, but what influences these beliefs? In order to understand the factors that influence the performance and effort beliefs, we need to turn to theories that focus on the situation of use. In this case, we need to begin with theories about collaboration and link the key factors from these theories to the key factors of UTAUT to understand how situational factors influence the ultimate decision to adopt and use collaboration technology. In sum, we argue that UTAUT mediates the relationship between the characteristics of a use situation and the ultimate adoption and use of a technology. Therefore, our model of collaboration technology adoption and use begins with the characteristics of situations in which the technology might be used. We focus on factors that have been important in past collaboration research—characteristics of the collaboration technology, its potential users, their tasks, and the context. We argue that these characteristics do not directly affect adoption and use, but rather influence UTAUT factors (e.g., performance and effort expectancy), which in turn influences adoption and use. Thus, UTAUT is the mediating mechanism through which the situational characteristics influence adoption and use.

Several factors have been suggested to influence the performance and satisfaction of individuals and groups using collaboration technology [24, 31, 32]. These factors largely fall into four major characteristics—*technology, individual and group, task,* and *situational* (e.g., organizational context) [24, 25, 31, 32, 81]. Figure 1, adapted from Dennis et al. [25], illustrates how these factors affect technology use and the outcomes from group work. In developing a model to explain the adoption and use of collaboration technology, we began with the four sets of factors argued to be important in influencing the successful use of collaboration technology—technology, individual and group, task, and situational (Figure 1). Research on collaboration technology has examined how these factors affect performance (e.g., [37, 50]) but has not examined how they influence adoption and use. We suggest that the mechanisms by which the aspects of collaboration technology influence adoption and use are the cognitions identified in UTAUT. Some evidence supporting this view is found in prior research—for example, Fulk [34] found that perceptions of richness influenced perceptions of usefulness, which ultimately affected use of e-mail.

We develop a model relating collaboration technology constructs to key constructs in UTAUT using the framework of Dennis et al. [25]. Figure 2 presents our research model. In the sections that follow, we define the key constructs and develop the theoretical arguments for the proposed relationships. We begin with a discussion of the key UTAUT relationships and then move to the collaboration technology–specific antecedents of the four key predictors in UTAUT.

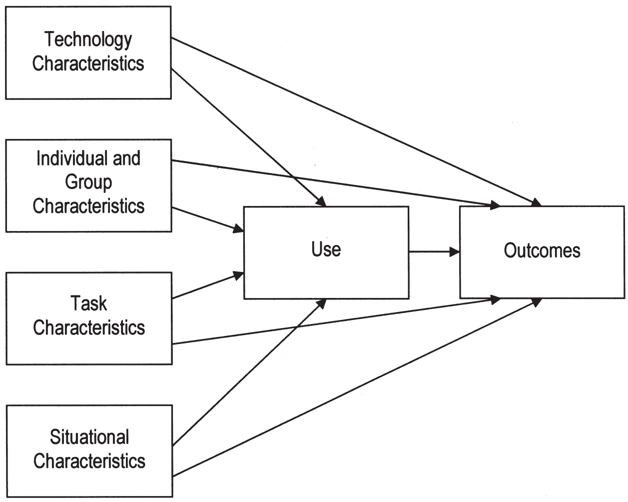

Figure 1. Factors Influencing Use and Outcomes of Collaboration Technology

Predicting Collaboration Technology Use: Adapting UTAUT Hypotheses

Performance expectancy, the extent to which use is expected to improve work performance, has been one of the most consistent predictors of behavioral intention across technologies (see [76]), including communication technologies (e.g., [39]). The more individuals expect that using a technology will improve their performance, the more likely they are to use it [76]. Gender and age moderate this relationship [76]—men, particularly younger men, have a greater focus on their tasks, productivity, and effectiveness [51, 75, 76]. Therefore, men, especially younger men, will place greater importance on performance expectancy in evaluating IS in general [52, 74]. This same pattern can be expected in the effect of performance expectancy on intention to use a collaboration technology, as such technologies have the potential to be minimally disruptive to one's work in terms of time relative to alternatives, such as a face-to-face meeting, and potentially help increase productivity. Thus, we hypothesize:[2]

> *Hypothesis 1a: The effect of performance expectancy on intention to use collaboration technology will be moderated by gender and age such that it is strongest for younger men.*

Effort expectancy, the extent to which use is expected to be free of effort, has been shown to be a predictor of intention [68, 69; see 76 for a review]. Effort expectancy can be particularly important in the context of personal technologies and non-workplace settings [70] and has been identified as an important predictor in the context of communication technologies [61]. Effort expectancy has both a direct effect on intention and an indirect effect through performance expectancy [76]. As a technology is perceived to take more effort to use, the less likely individuals are to intend to use it

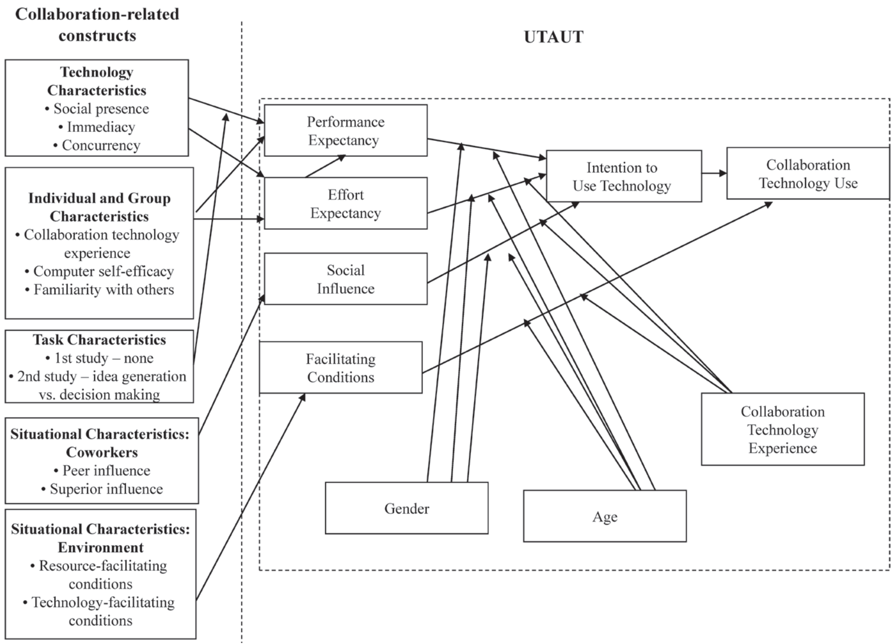

Figure 2. Research Model

[76]. Also, the more effort it takes to use a technology, the less useful the technology is perceived to be [17, 69, 73].

As with performance expectancy, UTAUT hypothesized that the effect of effort expectancy on intention to use will be moderated by gender and age; effort expended using a technology is more salient to women than men [52, 74] and to older workers than younger workers [76]. Therefore, the effect of effort expectancy on intention to use a collaboration technology will be stronger for women and for older workers. We expect such effects to possibly be intensified in the context of collaboration technology use as women and older individuals particularly value communication as an important aspect of their day-to-day functioning. Further, there is evidence to suggest that effort expectancy has less of an effect on those with greater experience, because as experience increases, users have overcome the initial hurdles to use and effort expectancy becomes less important [76]. Thus, we hypothesize:

> *Hypothesis 1b: The effect of effort expectancy on intention to use collaboration technology will be moderated by gender, age, and experience such that the effect will be strongest for older women with little experience.*

The role of social influence, the extent to which the individual perceives that important others believe he or she should use the system, has been somewhat unclear. Initially, Davis et al. [17] did not include subjective norm, also called social influence [76], in TAM, because it was the least understood aspect of the theory of reasoned action (see [17]). However, other models have included various aspects of social influence (see [68, 76]). More recently, social influence has been incorporated in TAM, but only in the presence of certain moderating variables, such as organizational mandate [73] or gender [74]. Outside the workplace context, in predicting adoption of PCs in homes, social influence has been found to be important [7, 70]. Despite the importance of social influence as a predictor of intention and behavior in certain situations, it has been found to be of limited importance for those with significant technology experience—that is, the views of others weigh heavily in adoption decisions before one has acquired sufficient experience to feel confident about making an independent decision [73, 74, 76].

We expect social influence will be important for collaboration technologies because they are "social" technologies. Unlike the individual technologies studied in much prior research, communication technologies cannot be used alone. If the normative pressure is negative to the point of dissuading use, then there may be no potential communication partners. In such a case, intention to use a target collaboration technology could be dampened. The converse is also true, where increased normative pressure, evidenced via a "critical mass" of users [47], could lead to higher intention to use [44].

Gender, age, and experience moderate the relationship between social influence and intention [76]. Women and older individuals not only place greater value on relationships but they also value information from peers and friends more highly [76]. Like effort expectancy, it can be expected that such an effect will play a role in the context of collaboration technologies as such technologies, as noted earlier, are "social" technologies and a critical mass of communication partners is quite important. Older individuals, women in particular, will look to their peers and friends for reinforcing messages to drive their own use. Increasing experience will dampen the relationship between social influence and intention as experience allows the individual to rely on his or her own judgment rather than that of others [76]. Thus, we hypothesize:

Hypothesis 1c: The effect of social influence on behavioral intention to use collaboration technology will be moderated by gender, age, and experience such that the effect will be strongest for older women with little experience.

The role of facilitating conditions, the extent to which the individual believes the organization and technical infrastructure support use of the system, has also been somewhat unclear. For example, Taylor and Todd [67] found support for perceived behavioral control, which is conceptually similar to facilitating conditions [76], in predicting both intention and use, whereas Thompson et al. [68] found facilitating conditions to be a nonsignificant predictor of use and Venkatesh [69] found that effort expectancy fully mediated the relationship between facilitating conditions and intention. Recently, Brown and Venkatesh [7] demonstrated the importance of facilitating conditions in household adoption of PCs, even in the presence of effort expectancy. While the results of prior work have been mixed, we expect that facilitating conditions will be relevant for collaboration technology use. Due to the networked nature of these technologies, the absence of technical resources to support their use will have a strong negative effect on use. Likewise, if organizational support for collaborating via technology is lacking, individuals will likely turn to the collaboration modes that are supported within the organization. Venkatesh et al. [76] argue that, with experience, individuals are more able to seek out and find the assistance they need to use the technology. Morris and Venkatesh [51] also show that as people age, the importance to them of assistance to enable technology use increases. Thus, we hypothesize:

> *Hypothesis 1d: The effect of facilitating conditions on collaboration technology use will be moderated by age and experience, such that the effect is stronger for older users, particularly those with little experience.*

Antecedents of UTAUT Constructs in Prior Research

UTAUT is based on almost two decades of research on technology adoption and use. Yet little is known about the key antecedents that influence the UTAUT constructs. As noted earlier, some work has identified general, technology-independent antecedents of performance expectancy and effort expectancy (e.g., [40, 69, 73]). Specifically, the antecedents of performance expectancy were identified to be cognitions and social influence [73], and the antecedents of perceived ease of use were identified to be individual's general technology beliefs and individual's perceptions of the system [69]. Other work has incorporated general psychological variables, such as trust tied to the *context* of technology use (e.g., [43]). However, the constructs identified in prior research were *not* tied to the technology or its conceptualization, and the research did not consider the nuances associated with the specific type of technology or class of technology being studied. To address this gap in the research, we develop a set of antecedents of performance expectancy and effort expectancy that are drawn from prior research on collaboration technologies. It should be noted that although social influence and facilitating conditions are part of UTAUT, they represent external influences that relate to the social and organizational environment. Therefore, we do not expect the collaboration technology–related constructs to influence either of those constructs. Our model does, however, incorporate task and situational factors. As noted earlier, in our model there are four sets of factors that we theorize to influence the intention to use collaboration technology—*technology characteristics, individual and group characteristics, task characteristics,* and *situational characteristics.* In the sections below, we describe the characteristics and then identify specific constructs within each set that we believe will have an effect on intention to use collaboration technologies.

Technology Characteristics

Collaboration technologies have both innate physical and socially derived characteristics [22, 34]. Many, or even most, of the characteristics that have been ascribed to collaboration technologies are not innate physical characteristics, but are instead socially derived characteristics, such as social presence and immediacy of feedback [11, 22, 34]. The perceptions of these socially derived collaboration technology characteristics can differ from person to person based on the person's skills, knowledge, and personality and on the way he or she chooses to use the technology [34]. One person may perceive that a specific collaboration technology tool has high social presence, while another person using the same tool may perceive that it has low social presence. In fact, it is not uncommon for a given person's perceptions to change over time, so a tool that is seen as having low social presence today may be seen as having medium social presence next month—or even next week [11, 35]. Thus, in assessing the characteristics of a collaboration technology, it is important to *not* focus on the innate, supposedly "objective" physical characteristics of a specific technology, but rather on the socially derived characteristics as perceived by individual users, which typically differ from person to person [11, 22, 34].

A vast body of research has consistently shown that various characteristics of the technology as experienced by users can potentially influence various outcomes [24, 26, 69]. Such *user perceptions of the technology characteristics* comprise the first set of factors that may influence adoption and use. In order to identify specific collaboration technology characteristics that would be antecedents of the UTAUT constructs of performance expectancy and effort expectancy, one of the most promising places to start is with theories that attempt to explain why individuals choose to use one communication medium over another—that is, media choice. In the current study, we examine three of the more important theories that have shaped the choice of collaboration technologies in general—social presence theory; media richness theory and its descendants, such as channel expansion theory; and the task closure model. We leverage this research to identify *three specific technology characteristics*—social presence, immediacy, and concurrency. We theorize that these three characteristics of collaboration technology will influence the intention to use it via the UTAUT cognitions of performance and effort expectancies. These three characteristics are also expected to interact with the task, which we discuss below.

Social Presence

Social presence theory argues that collaboration technologies differ in their ability to convey the psychological impression of the physical presence of their users [64]. Collaboration technologies with high social presence convey a social and personal environment for communication. Social presence is influenced by a technology's ability to transmit nonword cues (e.g., voice inflection) and nonverbal cues (e.g., gestures, facial expressions). Short et al. [64] argue that the greatest social presence is provided by face-to-face communication, followed by technologies that provide both audio and video communication, followed by those that provide only audio communication, and least by those that provide only text communication. Social presence is an experiential phenomenon in that it is possible for different users to perceive different levels of social presence for a given technology (cf. [11]).

Use of collaboration technologies with low social presence can reduce effectiveness, efficiency, and participant satisfaction because the collaboration technologies can slow interaction and make communication more difficult [13, 33, 64]. Further, with the collaboration technology acting as an interface between people, the greater the social presence it exhibits, the more useful the technology is often seen [36]. Prior research has demonstrated the positive relationship between social presence and usefulness (performance expectancy) [39]. Although there is no empirical evidence to suggest that high social presence will affect effort expectancy, Kock [42] argues that collaboration technologies are more difficult for individuals to use because they are far removed from our natural face-to-face communication tendencies. Thus, collaboration technologies that are higher in social presence will come closer to mimicking natural communication and should be easier to use [42]. So, participants are likely to perceive that collaboration technologies with low social presence (e.g., text-only technologies, such as e-mail) have lower performance and effort expectancies than do technologies with higher social presence (e.g., videoconferencing, telepresence) because of the limitations that lower social presence spawns. Thus, we hypothesize:

Hypothesis 2a: Social presence will positively influence performance expectancy.

Hypothesis 2b: Social presence will positively influence effort expectancy.

Immediacy of Communication

Immediacy of communication refers to the extent to which a collaboration technology enables the user to quickly communicate with others [22, 61, 66]. The task closure model of media selection argues that people choose to use collaboration technologies based on the ability to reach their communication partner and complete the task at hand [66]. Although face-to-face meetings or telephone conversations may have greater social presence, they require synchronous communication—that is, both parties must be available at the same time [61]. Leaner technologies, such as voice mail and e-mail, offer the ability to communicate asynchronously so that even if parties are not readily available, communication may occur and may often prove a faster way to complete a task rather than attempting to find a shared time to communicate [58].

As with social presence, immediacy is socially experienced. Immediacy depends on capabilities inherent in the technology itself (it must be capable of immediacy) and also on the way it is used. Although an e-mail may reach an individual's mailbox almost instantaneously, the frequency with which he or she reads e-mail and the length of time he or she chooses to take before responding are characteristics of use and not inherent in the technology. Immediacy of communication is an important factor in the choice to use a collaboration technology [66]. Technologies with higher immediacy capability will be perceived to be more effective and efficient and, thus, will be perceived to have greater performance and effort expectancies. Thus, we hypothesize:

Hypothesis 2c: Immediacy of communication will positively influence performance expectancy.

Hypothesis 2d: Immediacy of communication will positively influence effort expectancy.

Concurrency

Concurrency is the ability of a collaboration technology to enable an individual to perform other tasks at the same time as using the technology. For example, one can simultaneously engage in multiple separate "chat" sessions or chat while also using e-mail, talking on the telephone, or doing other work [59, 78]. Although truly simultaneous work is probably impossible without some interference between the tasks [55, 79], concurrent work in which the user focuses his or her attention on one task for a few seconds and shifts to focus on another task for a few seconds and so on is possible under some circumstances, thus leading to the performance of multiple activities concurrently.

As with immediacy, concurrency is both a social and a technological capability—that is, the technology must have the capability to support concurrent use and the user must have the skills and desire to use it concurrently with other work. Further, the social norms of the user's environment must permit concurrent use or the user must be prepared to flaunt the norms. As with our arguments for social presence, the ability to work concurrently should be reflected in favorable assessments of performance and effort expectancies given that enabling concurrency, when needed, should lead to greater effectiveness, efficiency, and satisfaction, which should contribute to better performance and effort expectancy cognitions. Thus, we hypothesize:

Hypothesis 2e: Concurrency will positively influence performance expectancy.

Hypothesis 2f: Concurrency will positively influence effort expectancy.

Individual and Group Characteristics

Individual and group characteristics are potentially important to the successful use of collaboration technologies because different individuals and groups have different needs [24, 25]. We focus on three specific factors that are likely to have the greatest effect on intention to use collaboration technologies. They are two individual characteristics—technology experience and self-efficacy—and one group-oriented characteristic—familiarity with communication partners. Demographic factors, such as age and gender, will also be important in understanding intention and use of a collaboration technology [23]; as noted earlier, these are included as moderators in UTAUT.

Individual Characteristics

Technology experience, the ability to use a specific type of technology, can play a role in the selection and use of a technology, and in one's perceptions of the technology [11, 16, 58]. When an individual first begins to use a new collaboration technology, performance and satisfaction often decrease because its use requires new skills and new patterns of interaction [19]. However, an individual will bring to bear his or her experience from other related technologies; this mechanism is termed *anchoring* in the psychology literature [69]. Over time, an individual's experience with the specific technology will grow and it will gradually become easier to use, and performance will also improve [19]. Thus, we hypothesize:

Hypothesis 3a: Collaboration technology experience will positively influence performance expectancy.

Hypothesis 3b: Collaboration technology experience will positively influence effort expectancy.

Computer self-efficacy, an individual's belief in his or her ability to use technology to accomplish a task [14, 15], can also affect users' perceptions of performance and effort expectancies [14, 69, 72]. Although computer self-efficacy is not specific to collaboration technology, there is empirical evidence that shows that individuals with greater computer self-efficacy perceive technologies to be easier to use [69, 72]. Thus, computer self-efficacy will positively influence effort expectancy [76]. Similarly, there is empirical evidence to suggest that computer self-efficacy has an influence on performance expectancy. Compeau and Higgins [14] demonstrated that computer self-efficacy had a positive effect on outcome expectations, a construct similar to performance expectancy [76], because as an individual's perceptions of his or her ability to use a technology increase, task performance also increases. Thus, we hypothesize:

Hypothesis 3c: Computer self-efficacy will positively influence performance expectancy.

Hypothesis 3d: Computer self-efficacy will positively influence effort expectancy.

Familiarity with Communication Partners

As individuals work together, they gradually develop an understanding of each other and jointly develop a set of norms and expectations around the use of collaboration technology [11, 19, 27]. Such shared norms reduce uncertainty and enable groups to more quickly focus on the task at hand without needing to negotiate roles and expectations [49]. The development of this familiarity and shared norms enables groups to use technologies more efficiently and effectively. Participants familiar with each other are more likely to be able to use even lean technology to communicate rich messages than those who lack familiarity with each other [11]. Thus, we expect that, as familiarity with others increases, the performance and effort expectancies associated with using collaboration technology increase. Thus, we hypothesize:

Hypothesis 3e: Familiarity with communication partners will positively influence performance expectancy.

Hypothesis 3f: Familiarity with communication partners will positively influence effort expectancy.

Task Characteristics

Task has long been recognized as an important factor influencing performance [24, 25, 26, 31, 32, 81]. There are many ways in which we can examine and describe tasks [25, 81]. Most research examining tasks has focused on specific tasks or specific task characteristics (e.g., equivocality, analyzability, complexity) depending on the theoretical lens or collaboration technology under study. Following Dennis et al. [24], we examine two types of tasks commonly performed with collaboration technologies—idea generation/conferencing and decision making (see also [4]). Idea-generation tasks are additive tasks in that the outputs of individual group members are aggregated to form the group output; multiple, divergent results are desired and the group need not come to consensus on one "correct" outcome. With decision making, group members must work together to develop a shared understanding of the issues and select among possible actions to choose one or more. While divergent opinions may be useful as intermediate products, the ultimate outcome requires the group to agree on a course of action. We posit that task plays an important role as a moderator of the technology characteristics to performance expectancy relationship. Generally, it is important for the technology to be appropriate for the task for which it is used [24, 81]. Thus, when a task fits better with certain technology characteristics, we expect that those technology characteristics will have a stronger influence on performance expectancy.

Social presence is most important for task activities requiring high personal interaction [13, 33, 64]. Social presence is typically *not* important for activities that are primarily information-processing activities requiring little interaction and feedback [13, 33, 64]. Idea-generation tasks are primarily conveyance processes in which group members provide information to others [22]; although group members need to interact with each other, the group does not need to reach a shared consensus. In contrast, decision-making tasks have a greater need for convergence processes in which group members must understand each other and reach shared agreement [22]. Because decision-making tasks require group members to come to consensus and engage in more interaction than idea-generation tasks, social presence will be more important for decision-making tasks than for idea-generation tasks [24, 62]. Thus, we hypothesize:

> *Hypothesis 4a: The effect of social presence on performance expectancy will be moderated by tasks such that social presence will be more important for decision-making tasks.*

As discussed earlier, immediacy will have a positive influence on performance expectancy. As with social presence, we expect that this relationship will be stronger for tasks that require interaction. Decision-making tasks, where all group members must come to an agreement on a course of action(s), will have a greater need for immediacy than will idea-generation tasks that are additive and do not require the group to come to agreement, because members must converge on a shared understanding and greater immediacy is more conducive to the development of shared understanding [22, 24, 62]. Thus, we hypothesize:

Hypothesis 4b: The effect of immediacy of communication on performance expectancy will be moderated by tasks such that immediacy of communication will be more important for decision-making tasks.

As with social presence and immediacy, concurrency is likely to be of greater value for some tasks. Counter to our arguments for social presence and immediacy, we expect that concurrency is *less* important for decision making, which requires the development of group agreement, than for idea generation, which does not. Decision making, and the development of group agreement, is best performed with technologies that promote synchronicity, a shared pattern of coordinated synchronous behavior with a common focus [22]. Concurrency inhibits the development of synchronicity because it enables group members to work on different tasks simultaneously. Technologies that inhibit concurrency are more likely to induce members to work together with a common focus [22]. This suggests that technologies with higher concurrency will be perceived to have fewer performance benefits for decision-making tasks. Thus, we hypothesize:

Hypothesis 4c: The effect of concurrency on performance expectancy will be moderated by tasks such that concurrency will be less important for decision-making tasks.

Situational Characteristics

Situational characteristics represent the context in which the collaboration technology is implemented [25]. A variety of factors comprise the context [3, 4, 25, 56]. We focus on co-worker factors and organizational environment factors. Co-worker factors are the influence of peers and superiors. The influence of these important people in the organizational context can directly affect the social influence, which ultimately influences intention to use a collaboration technology [4, 67]. We expect peers and superiors to be the key influences on the overall perception of social influence—when peers and co-workers believe an individual should use the system, he or she will be more likely to do so. Thus, we hypothesize:

Hypothesis 5a: The influence of peers will positively influence the perception of social influence.

Hypothesis 5b: The influence of superiors will positively influence the perception of social influence.

Other situational characteristics are experienced at the organizational level, such as incentives, organizational culture, and the degree to which technology use is encouraged [4]. Consider, for example, an agile and innovative organization versus a less innovative organization. The situational characteristics in these organizations are likely to be markedly different when it comes to implementing and using technology. Likewise, organizations in which employees are rewarded for technology use are likely to be different from those in which there are few incentives [3, 4, 56]. Two important aspects of the environment are resource- and technology-facilitating conditions. Facilitating conditions, in the context of technology adoption, refers to the extent to which various situational factors enable adoption and use of the system [76]. Resource-facilitating conditions are the availability of money and infrastructure, whereas technology-facilitating conditions relate to technical compatibility issues [67]. As demonstrated by Taylor and Todd [67], these two components are expected to contribute to perceptions of facilitating conditions in that as the resources and technology available to support system use increase, so will the perception of facilitating conditions. Thus, we hypothesize:

Hypothesis 5c: Resource-facilitating conditions will positively influence the perception of facilitating conditions.

Hypothesis 5d: Technology-facilitating conditions will positively influence the perception of facilitating conditions.

System Use

System use was included in our model as the ultimate dependent variable for the sake of completeness and also because use is typically measured objectively [76], thus serving as a meaningful variable to assess criterion validity. The predictors of system use have been well established in prior research, and the theoretical logic underlying these hypotheses has also been extensively discussed in much prior research [76]. Specifically, UTAUT posits that there is a positive direct effect of behavioral intention on use. Thus, we hypothesize:

Hypothesis 6: Behavioral intention will positively influence use.

Summary

Figure 2 presents our research model. In addition to contextualizing UTAUT to collaboration technologies, we present determinants of the four key UTAUT predictors—performance expectancy, effort expectancy, social influence, and facilitating conditions. Performance expectancy and effort expectancy are influenced by *technology characteristics* (social presence, immediacy, and concurrency) and *individual and group characteristics* (technology experience, computer self-efficacy, and familiarity with communication partners). Task characteristics are expected to moderate the relationship between technology characteristics and performance expectancy. The situational variables attributed to co-workers (influence of peers and superiors) are expected to influence social influence while the situational variables attributed to the environment are expected to influence facilitating conditions.

Method

We conducted two studies. The objective of the first study was to test our model in the context of a general collaboration tool used to support day-to-day communication—short message service (SMS). The first study did not incorporate a specific task and the data were cross-sectional. The second study was conducted to complement the first study, with the objective of testing the model in the context of an organizational implementation of a collaboration technology that allowed for an examination of task differences. Further, we collected use data six months after we collected data about perceptions and intentions.

Measures

The survey instrument used previously validated measures where available. The items used in Study 2, the organizational study, are shown in the Appendix, with similar adapted items being used in Study 1. The constructs of intention to use, performance expectancy, effort expectancy, social influence, and facilitating conditions were measured using scales adapted from Davis et al. [17] and Venkatesh et al. [76]. Our measure of use was adapted and extended from prior research on technology adoption [17, 76] that used four items examining intensity, frequency, duration, and choice. These items were reflective indicators of the latent variable of use. The choice item is new and measured the percentage of time the individual chose to use SMS relative to the overall need. We felt that different employees may need to collaborate to a different extent, thus potentially constraining how much they would choose to use a collaboration tool. By considering choice as part of use, we account for an important aspect of an individual's collaboration in the context of work that is not typically considered in measures of use, be it self-reported or actual [76]. By paying attention to all aspects of the behavior—that is, the act of using and the choice to use—we are enhancing the content validity of the measure relative to previous measures of use [38].

The scales for technology characteristics, individual and group characteristics, and situational characteristics were adapted from prior research where possible. The measures for social presence and familiarity with others (communication partners) were adapted from Short et al. [64] and Carlson and Zmud [11], respectively. Resource-facilitating conditions, technology-facilitating conditions, peer influence, and superior influence were adapted from prior work [67, 76]. Computer self-efficacy was measured using a scale adapted from Compeau and Higgins [15]. The effect of task was assessed only in the second study by asking participants to answer the survey questions one time considering an idea-generation task and one time considering a decision-making task. The order of the tasks was randomized and no significant order effect was found. Gender and age were measured using single items. No scales were available to measure experience, immediacy, and concurrency. We created the scales for these three constructs using standard procedures of scale development [28]. We created several candidate items, which we carefully examined for content validity. These items were circulated for peer feedback and card sorts in order to arrive at the final set of items, which possessed face validity and content validity.

Pretests and Pilot Study

Two pretests of the instrument were conducted to ensure that the measures were applicable in the current context. First, ten individuals (in two groups of five) affiliated with the university were recruited to participate in this pretest. Each individual was asked to complete the questionnaire and then provided the opportunity to comment on any aspect of the questionnaire. The primary feedback from the first group was with regard to the use of some "complex" English words/terms in the questions. Based on this feedback, a few questions were slightly reworded. The updated questionnaire was then validated with the second group of pretest participants and feedback solicited. No significant suggestions were made and, thus, no further changes were made.

The revised survey was administered among 111 undergraduate students. The focus of the pilot study was to examine the reliability and validity of the scales in the context of a collaboration technology—here, SMS. We were particularly interested in establishing the reliability and validity of the new scales—immediacy and concurrency. The new scales were found to be reliable, with Cronbach's alpha exceeding 0.80. The other scales were also highly reliable, with similar Cronbach's alpha scores. Next, a principal components analysis with varimax rotation was conducted among the multi-item constructs from collaboration technology research—that is, social presence, media richness, immediacy, concurrency, and familiarity with others. A clean factor structure was obtained, with loadings greater than 0.70 and cross-loadings less than 0.35, thus supporting internal consistency and discriminant validity. A similar analysis was conducted among the UTAUT predictors and a clean factor structure was obtained there as well.

Given the total number of items from all multi-item constructs in the model, the sample size in this pilot study was not sufficient to test internal consistency and discriminant validity of all constructs in a single test using exploratory factor analysis. However, this concern is somewhat alleviated for three reasons: (1) the new scales were developed in the context of collaboration technology research and the likelihood of overlap was more with the constructs in that domain, (2) the technology adoption constructs and collaboration technology constructs come from very different bodies of research where there has been minimal conceptual overlap thus far, and (3) the entire model and scales will be validated in the actual data set using confirmatory factor analysis in partial least squares (PLS).

Study 1

Setting and Target System

Our first study examined users of one emerging collaboration technology—SMS. SMS is primarily a tool/service that allows two-way, near real-time communication among people via mobile phones or computers [29].[3] SMS enables users to send short text messages that are displayed almost instantly on the target user's device. SMS is similar to other collaboration technologies, such as instant messaging and Web conferencing, in that it is real time but can also be used to leave messages for absent users.

SMS use is less intrusive than phone conversations because SMS message exchanges can be silent and less distracting than e-mail [29]. One interesting social convention around SMS use is that, in many cases, it is socially acceptable—or even expected—to receive and send SMS messages while performing other activities, such as being in meetings [30, 59]. Asia leads the way in the number of SMS messages exchanged, with Europe coming in a close second. SMS use in North America is substantially lower, but it is rapidly increasing now that technical issues of interoperability have been resolved [60].

Participants

We surveyed voluntary users of SMS in Finland. Finland has a high penetration of mobile phones and maturity of SMS use [2]. Data were collected during a one-week period through an active solicitation process from individuals, primarily alumni, associated with a major university in Finland. The goal was to identify a broad range of users from a wide variety of organizations to provide variance in terms of gender, age, education, technology experience, and SMS experience. Of the 500 paper copies distributed, 363 responses were received, and of these 349 were usable, resulting in a return rate of almost 73 percent and a usable response rate of almost 70 percent.[4] Of the 349 participants, 36 percent were women, and the average age of participants was 34.3 (standard deviation [SD] = 9.01).

Data Collection Procedure

As noted earlier, we sought to identify participants such that they were representative of the population of SMS users. We worked in collaboration with a leading university in Finland and solicited participation from a list of individuals provided by the users. Potential participants were provided with paper copies of the survey and asked to return the completed survey in one week to a specific individual who was coordinating the administration of the survey. Due to privacy concerns, the university did not share information about the participants who chose to complete the study (or who declined to participate) or date of response. We were, therefore, unable to compare early and late respondents or nonrespondents. As the responses were received within a week, which is a fairly short amount of time, this issue is somewhat alleviated. Further, response biases are somewhat alleviated given the high response rate. Overall, we deemed this trade-off acceptable in order to collect real-world data.

Study 2

Setting and Target System

Our second study was conducted in a Fortune 500 technology company in Finland. The company has a traditional, hierarchical structure and was organized as several business units in two different geographic locations in Finland. The target system was a collaboration technology that was developed in-house. The system design and development process took about eight months and included employees at different organizational levels as part of the design team. The objective was to provide an additional option for employee collaboration beyond traditional options, such as telephone, videoconferencing, and desktop messaging. As the employees were primarily working in technology design, coding, testing, and related areas, collaboration was an important aspect of their day-to-day work. They needed to collaborate with peers and group members in the same location and at other organizational locations in Finland, other parts of Europe, and the United States. Use of the system at the time of the study was voluntary.

The system provided features to chat, conduct an audioconference, conduct a videoconference, have a shared whiteboard, save meeting notes in multimedia format, and use some of the functionalities of other organizational applications (application exposure). The last feature was particularly important relative to an off-the-shelf commercial tool (e.g., MSN messenger) as the organization had several unique applications—some of which were developed in-house and some of which were purchased from commercial vendors—that supported the work of the employees. Use was not mandated by the organization. The initial eight-month period after the beta testing was completed was designated as the trial period for the system, after which the organization would make a decision regarding mandating system use.

Participants

The population of interest was knowledge workers. Our sampling frame was all knowledge workers in a business unit in the firm where we were collecting data. As the firm decided to follow a phased implementation plan, we were restricted to one business unit for our data collection. There were 883 employees in that business unit who were classified as knowledge workers. Of these, 830 agreed to participate and participated in the initial survey, and 447 of them provided responses to the second survey, which collected use data. This resulted in an effective final response rate just under 51 percent relative to the entire sample and just under 54 percent relative to the initial survey.[5] Of the 830 participants, 227 were women (27.4 percent); 125 of these women responded to the follow-up survey, resulting in about 28 percent of the final sample being women. The average age of the participants was 33.8 (SD = 9.94) and 34.6 (SD = 10.41) in the initial and follow-up surveys, respectively. The key demographic characteristics were comparable across the two surveys. Thus, the threat of nonresponse bias was diminished.

Data Collection Procedure

As noted earlier, the data were collected in conjunction with the rollout of a new collaboration tool in a business unit in a company in Finland. A one-day training class was provided to employees, staggered over a period of three months, to accommodate the entire business unit. The training was provided by the in-house IT group and each training group comprised a primary instructor who conducted all the training sessions and two technical assistants who were different across different training sessions. These assistants only provided technical help when someone was stuck or when someone had a procedural question. The training discussed the various features of the collaboration tool, including features that enabled application and data exposure across collaborators. The training included an opportunity for the participants to try the system. Immediately after the training was completed, the employees responded to a survey administered by the organization to gather feedback regarding the training and the system. The perceptual data were collected in conjunction with the organizationally administered survey. We solicited participants' contact information in order to follow up with the employees regarding their use of the system. Because use could not be measured on the survey administered immediately after the training, a follow-up survey to measure use was conducted six months after the initial survey. As the original training was staggered over three months, the follow-up was correspondingly staggered. Data were collected via e-mail and phone calls to the various participants. Up to six e-mails and six phone calls were attempted to contact the respondents over a two-week period.

The employees of the company were generally quite proficient in English. However, as both Finnish and Swedish are official languages of Finland, the firm suggested that the respondents be offered those language options as well to fill out the questionnaire. This was consistent with the organization's policy when it came to availability of various policies and forms. Professional translators translated the instructions and questions from English to Finnish and Swedish. Their translation procedure included a translation back to English by a different translator, and no discrepancies were found.

Results

PLS Graph version 3, Build 1126, was used to analyze the data from both studies. Testing interaction effects was possible in PLS. All constructs were modeled using reflective indicators. Interaction terms were created using data at the indicator level after the data were centered to minimize threats of multicollinearity [1]. We tested the model shown in Figure 2—one difference is that task was examined only in Study 2. In Study 2, repeated measures were treated as separate sample cases, which would be problematic with ordinary least squares (OLS) regression, because this violates the OLS assumption that the sample cases are independent [1]. However, with PLS "no assumptions are made regarding the joint distribution of the indicators or the independence of sample cases" [12, p. 332]. As a result, use of PLS is appropriate here.[6]

The measurement model results from both studies supported reliability and validity. In both studies, the factor loadings and cross-loadings supported discriminant validity, with loadings greater than 0.70 and cross-loadings lower than 0.30. Also, the internal consistency reliability (ICR) of all the constructs was greater than 0.75, thus confirming that the scales were reliable in both studies. Finally, in both studies, the average variance extracted (AVE) for each construct modeled using reflective indicators was in excess of 0.70 and the square root of the AVE for each construct exceeded all interconstruct correlations. The descriptive statistics, ICRs, AVEs, and correlations are shown in Tables 1a and 1b for Studies 1 and 2, respectively. Most construct means were a little over 4, with a standard deviation over 1. Most correlations were significant. UTAUT constructs were more highly correlated with intention to use the system than they were with collaboration constructs. Also, as expected, the collaboration constructs were correlated with the various UTAUT constructs.

Due to the nature of the data collection, we tested for common method bias using Harman's one-factor test [57]. If a substantial amount of common method variance (CMV) exists, either a single factor will emerge from the factor analysis or a single, general factor will account for the majority of the covariance in the independent and dependent variables [57]. The single factor accounted for 24 percent of the variance and did not account for the majority of the covariance, thus suggesting that common method bias is not a concern in our data set.

To further alleviate concerns about common method bias, we employed the marker variable technique [45, 46] and tested the hypotheses based on the corrected correlations. Specifically, we chose the second-smallest positive correlation among the constructs as a conservative estimate of CMV to produce the CMV-adjusted correlation matrix [45]. Following Malhotra et al. [46], we produced a CMV-adjusted correlation matrix and then used it to estimate CMV-adjusted path coefficients and explained variance. The results show that after controlling for CMV effects, the explained variances do indeed decrease, but the drop is not substantial and is just over 10 percent. The path coefficients are consistent with those that were found without the CMV adjustment. We conclude that concerns about common method bias are alleviated.

Prior to our model tests, consistent with the recommendation of Aiken and West [1], we mean-centered the variables that were part of interaction terms. All variance inflation factors (VIFs) in our structural model tests were less than 5, thus alleviating concerns about multicollinearity. Tables 2a and 2b show the results of our structural model tests for both studies. The successful prediction of collaboration technology use in these two studies provides criterion validity and is important given that many of the constructs in this work were perceptual constructs. The results related to prediction of behavioral intention are consistent with the UTAUT hypotheses that were adapted to this context, thus supporting Hypotheses 1a, 1b, and 1c. Further, the results are consistent with the key predictors of use in UTAUT, thus supporting Hypotheses 6 and 1d. Specifically, behavioral intention had a positive, significant influence on use (H6), and the effect of facilitating conditions on use was moderated by age and experience in both studies (H1d).

In Study 1, technology characteristics and effort expectancy[7] predicted performance expectancy, thus supporting Hypotheses 2a, 2c, and 2e. In Study 2, only immediacy had a main effect on performance expectancy (regardless of task), thus supporting Hypothesis 2c. All the technology characteristics were moderated by task and consistent with the predictions of Hypotheses 4a and 4b, but were in the opposite direction of Hypothesis 4c. Contrary to Hypothesis 4c, concurrency had a stronger effect on performance expectancy for decision-making tasks. In both studies, effort expectancy was predicted by all of the technology and individual and group characteristics,

Table 1a. Study 1: ICRs, AVEs, Descriptive Statistics, and Correlations

	ICR	M	SD	Use	BI	PE	EE	SI	FC	SP	Imm
Collaboration technology use (Use)	0.84	4.85	1.28	0.88							
Behavioral intention (BI)	0.89	4.95	1.20	0.50***	0.84						
Performance expectancy (PE)	0.86	4.66	1.08	0.46***	0.46***	0.88					
Effort expectancy (EE)	0.90	4.89	1.16	0.30***	0.31***	0.34***	0.85				
Social influence (SI)	0.80	4.55	1.22	0.34***	0.43***	0.21**	0.14*	0.85			
Facilitating conditions (FC)	0.80	4.28	1.20	0.30***	0.30***	0.16*	0.26***	0.20**	0.84		
Social presence (SP)	0.75	3.90	1.10	0.22**	0.21***	0.24***	0.13*	0.12	0.24***	0.84	
Immediacy (Imm)	0.77	4.99	1.03	0.15*	0.25**	0.36***	0.16*	0.12*	0.16*	0.25***	0.87
Concurrency (Conc)	0.74	4.93	0.77	0.13*	0.13*	0.33***	0.18**	0.21**	0.08	0.19**	0.25***
Technology experience (TE)	0.73	4.51	1.03	0.22**	0.29***	0.22**	0.21**	0.16*	0.20**	0.16*	0.25***
Computer self-efficacy (CSE)	0.81	4.60	0.88	0.21**	0.25***	0.19**	0.21***	0.20**	0.35***	0.19**	0.21***
Familiarity with partners (FP)	0.80	4.19	1.02	0.22***	0.26***	0.22***	0.17**	0.21***	0.13*	0.14*	0.07
Gender (Gen)	NA	NA	NA	–0.21**	–0.22**	–0.15*	–0.25***	0.28***	–0.15*	0.17*	–0.18**
Age	NA	32.1	6.90	–0.19**	–0.13*	–0.17**	–0.26***	0.27***	–0.17**	–0.20**	–0.16*
Peer influence (PI)	0.78	4.77	0.80	0.15*	0.19**	0.10	0.14*	0.40***	0.19**	0.05	0.03
Supervisor influence (SupI)	0.79	2.95	1.14	0.04	0.04	0.14*	0.10	0.48***	0.24**	0.04	0.07
Resource-facilitating conditions (RFC)	0.75	4.55	1.08	0.19**	0.25***	0.19**	0.16*	0.14*	0.29***	0.15*	0.12
Technology-facilitating conditions (TFC)	0.74	4.07	1.02	0.19**	0.23***	0.21**	0.21**	–0.15**	0.37***	0.12	0.04

	Conc	TE	CSE	FP	Gen	Age	PI	SupI	RFC	TFC
Collaboration technology use (Use)										
Behavioral intention (BI)										
Performance expectancy (PE)										
Effort expectancy (EE)										
Social influence (SI)										
Facilitating conditions (FC)										
Social presence (SP)										
Immediacy (Imm)										
Concurrency (Conc)	0.85									
Technology experience (TE)	0.19**	0.84								
Computer self-efficacy (CSE)	0.25***	0.49***	0.84							
Familiarity with partners (FP)	0.15*	0.24***	0.05	0.85						
Gender (Gen)	–0.17*	–0.25***	–0.31***	0.36***	NA					
Age	–0.21***	0.24***	–0.21***	0.40***	0.31***	NA				
Peer influence (PI)	0.05	–0.20**	–0.19**	0.16*	0.24***	0.20**	0.85			
Supervisor influence (SupI)	0.03	–0.05	–0.08	0.16*	0.19**	0.14*	0.03	0.89		
Resource-facilitating conditions (RFC)	0.05	0.16*	0.24***	0.04	–0.28***	–0.22***	0.09	0.12	0.87	
Technology-facilitating conditions (TFC)	0.02	0.21**	0.17**	0.03	–0.16*	–0.24***	0.12	0.03	0.25***	0.87

Notes: ICR = internal consistency reliability; M = mean; SD = standard deviation; NA = not applicable. Diagonal elements are the square root of the AVEs (average variance extracted). Off-diagonal elements are correlations. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 1b. Study 2: ICRs, AVEs, Descriptive Statistics, and Correlations

	ICR	M	SD	Use	BI	PE	EE	SI	FC	SP	Imm
Collaboration technology use (Use)	0.88	4.47	1.12	0.87							
Behavioral intention (BI)	0.88	4.58	1.03	0.53***	0.86						
Performance expectancy (PE)	0.85	4.43	1.01	0.44***	0.48***	0.88					
Effort expectancy (EE)	0.84	4.88	1.22	0.32***	0.34***	0.35***	0.88				
Social influence (SI)	0.82	3.99	1.41	0.35***	0.40***	0.20**	0.13*	0.85			
Facilitating conditions (FC)	0.81	4.13	1.33	0.29***	0.31***	0.17*	0.24***	0.21***	0.87		
Social presence (SP)	0.82	3.80	1.02	0.20*	0.22***	0.25***	0.14*	0.08	0.22***	0.84	
Immediacy (Imm)	0.77	4.66	1.00	0.15*	0.20**	0.39***	0.14*	0.14*	0.18**	0.22***	0.85
Concurrency (Conc)	0.73	4.90	0.94	0.08	0.10	0.34***	0.16*	0.20**	0.14*	0.18**	0.23***
Technology experience (TE)	0.75	4.45	1.12	0.21**	0.23***	0.21**	0.26***	0.16*	0.17*	0.15*	0.22***
Computer self-efficacy (CSE)	0.83	5.10	0.97	0.20**	0.22***	0.18**	0.25***	0.19**	0.34***	0.18**	0.20**
Familiarity with partners (FP)	0.82	4.10	1.04	0.19**	0.23***	0.28***	0.22***	0.24***	0.10	0.13*	0.10
Gender (Gen)	NA	NA	NA	–0.21**	–0.20**	–0.19**	–0.23***	0.25***	–0.21***	0.17*	–0.15*
Age	NA	34.3	7.80	–0.18**	–0.15*	–0.16*	–0.28***	0.29***	–0.20**	–0.19**	–0.15*
Task	NA	NA	NA	–0.16*	–0.18**	–0.15*	–0.14*	0.06	0.03	–0.10	–0.13*
Peer influence (PI)	0.82	5.01	0.85	0.13*	0.15*	0.08	0.12*	0.42***	0.17*	0.09	0.05
Supervisor influence (SupI)	0.85	3.23	1.22	0.08	0.11	0.08	0.10	0.44***	0.20**	0.10	0.06
Resource-facilitating conditions (RFC)	0.80	4.44	1.10	0.15*	0.18**	0.16*	0.15*	0.14*	0.28***	0.14*	0.10
Technology-facilitating conditions (TFC)	0.73	4.50	1.08	0.16*	0.22***	0.20**	0.19**	–0.15*	0.39***	0.15*	0.07

	Conc	TE	CSE	FP	Gen	Age	Task	PI	SupI	RFC	TFC
Collaboration technology use (Use)											
Behavioral intention (BI)											
Performance expectancy (PE)											
Effort expectancy (EE)											
Social influence (SI)											
Facilitating conditions (FC)											
Social presence (SP)											
Immediacy (Imm)											
Concurrency (Conc)	0.84										
Technology experience (TE)	0.17*	0.89									
Computer self-efficacy (CSE)	0.24***	0.43***	0.84								
Familiarity with partners (FP)	0.12	0.25***	–0.28***	0.85							
Gender (Gen)	–0.15*	–0.26***	0.05	0.35***	NA						
Age	–0.22**	–0.22**	–0.22***	0.38***	0.30***	NA					
Task	–0.13*	0.03	–0.05	0.02	0.05	0.10	NA				
Peer influence (PI)	0.08	–0.17**	0.20**	0.13*	0.22***	0.23***	0.03	0.85			
Supervisor influence (SupI)	0.03	–0.07	0.18**	0.15*	0.18**	0.16*	0.05	0.04	0.86		
Resource-facilitating conditions (RFC)	0.09	0.19*	0.20**	0.03	–0.24***	–0.19**	0.05	0.09	0.10	0.84	
Technology-facilitating conditions (TFC)	0.05	0.20**	0.18**	0.04	–0.17*	–0.23***	0.02	0.10	0.07	0.22***	0.85

Notes: ICR = internal consistency reliability; M = mean; SD = standard deviation; NA = not applicable. Diagonal elements are the square root of the AVEs (average variance extracted). Off-diagonal elements are correlations. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 2a. Results of Study 1

	Dependent variables					
	System use	Behavioral intention	Performance expectancy	Effort expectancy	Social influence	Facilitating conditions
R^2	0.33	0.50	0.21	0.33	0.20	0.15
Behavioral intention (BI)	0.40***					
Performance expectancy (PE)		0.08				
Effort expectancy (EE)		0.04	0.13*			
Social influence (SI)		0.10				
Facilitating conditions (FC)	0.14*					
Gender (GDR)		–0.02				
Age (AGE)	0.04	0.04				
Technology experience (EXP)	0.04	0.07	0.02	0.15*		
PE × GDR		0.10				
PE × AGE		–0.07				
GDR × AGE		0.02				
PE × GDR × AGE		0.26***				
EE × GDR		0.04				
EE × AGE		0.04				
EE × EXP		0.02				

GDR × EXP		–0.03				
AGE × EXP	0.04	–0.04				
GDR × AGE × EXP		0.02				
EE × GDR × AGE × EXP		0.31***				
SI × GDR		0.03				
SI × AGE		0.04				
SI × EXP		0.01				
SI × GDR × AGE × EXP		0.29***				
FC × AGE × EXP	0.21**					
Social presence			0.13*	0.21**		
Immediacy			0.31***	0.26***		
Concurrency			0.16**	0.20**		
Familiarity with others			0.08	0.15**		
Computer self-efficacy			0.04	0.22***		
Peer influence					0.35***	
Supervisor influence					0.30***	
Resource-facilitating conditions						0.18**
Technology-facilitating conditions						0.28***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; blank cells are not applicable.

Table 2b. Results of Study 2

	Dependent variables					
	System use	Behavioral intention	Performance expectancy	Effort expectancy	Social influence	Facilitating conditions
R^2	0.33	0.53	0.37	0.41	0.20	0.17
Behavioral intention (BI)	0.44***					
Performance expectancy (PE)		0.09				
Effort expectancy (EE)		0.02	0.14*			
Social influence (SI)		0.07				
Facilitating conditions (FC)	0.10					
Gender (GDR)		–0.03				
Age (AGE)	0.07	0.07				
Technology experience (EXP)	–0.06	0.03	0.03	0.13*		
PE × GDR		0.05				
PE × AGE		–0.02				
GDR × AGE		0.06				
PE × GDR × AGE		0.29***				
EE × GDR		0.06				
EE × AGE		0.07				
EE × EXP		0.03				
GDR × EXP		0.04				

AGE × EXP	0.04	–0.07				
GDR × AGE × EXP		0.04				
EE × GDR × AGE × EXP		0.30***				
SI × GDR		0.03				
SI × AGE		0.02				
SI × EXP		0.04				
SI × GDR × AGE × EXP		0.27***				
FC × AGE × EXP	0.17*					
Social presence			0.09	0.21**		
Immediacy			0.18**	0.29***		
Concurrency			0.08	0.22***		
Task (idea generation [IG] versus decision making [DM])			0.06			
Social presence × task (IG versus DM)			0.27***			
Immediacy × task (IG versus DM)			0.29***			
Concurrency × task (IG versus DM)			0.33***			
Familiarity with others			0.04	0.13*		
Computer self-efficacy			0.03	0.22***		
Peer influence					0.33***	
Supervisor influence					0.31***	
Resource-facilitating conditions						0.19**
Technology-facilitating conditions						0.33***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; blank cells are not applicable.

consistent with Hypotheses 2b, 2d, 2f, 3b, 3d, and 3f. Consistent with Hypotheses 5a and 5b, peer influence and superior influence had a positive effect on social influence in both studies. Also, consistent with Hypotheses 5c and 5d, facilitating conditions were predicted by resource- and technology-facilitating conditions in both studies.

Although we focused on the overall model test and did not specifically theorize about full or partial mediation, implicit in our model depiction is that the four predictors in UTAUT—namely, performance expectancy, effort expectancy, social influence, and facilitating conditions—will fully mediate the effect of the various collaboration technology constructs on behavioral intention. Further, we expect behavioral intention to fully mediate the effects of performance expectancy, effort expectancy, and social influence on technology use. In order to test for such full mediation, we used the approach recommended by Baron and Kenny [5]. In addition to the results already reported, we found that the various collaboration constructs had a similar effect on intention as they did on the UTAUT predictors, and when the effects of the collaboration technology constructs were included over and above the UTAUT predictors, none of the collaboration constructs had an effect on behavioral intention. Likewise, we found the UTAUT predictors had similar effects on technology use as they did on behavioral intention. Further, when behavioral intention and facilitating conditions (along with the moderators) were included as predictors of technology use, none of the UTAUT predictors had an effect on technology use. Overall, these additional analyses provide support for the mediation pattern shown in our model.

Discussion

The key objective of this paper was to develop and test a model to understand collaboration technology use. The model integrated UTAUT [76] with theories from collaboration technology research [11, 16, 25, 64, 66]. The model was supported in two studies examining two different collaboration technologies that used different subject pools. The results from the two studies were similar. We found that UTAUT is the conduit through which collaboration technology research constructs of technology, individual/group, task, and situational characteristics influence behavioral intention and use of that collaboration technology.

Contributions and Implications

This study makes several important contributions to IS research. Integrating two of the most dominant streams of research in IS—that is, technology adoption and collaboration technology—is a key contribution. Specifically, this work integrated UTAUT with theories from collaboration research—social presence theory [64], channel expansion theory [11] (a descendant of media richness theory [16]), and the task closure model [66]. This study responds to a call for such work by recent articles that have provided an in-depth analysis of the directions for future work in IS [6, 70]. An even more general contribution, we hope, is that this paper serves as an example of integrative research that ties together dominant streams and models of IS research and moves us toward a cumulative tradition, a call that was issued at the first International Conference on Information Systems (ICIS) in 1980 [41]. UTAUT and its generalizability have not been in doubt, due to its foundation in TAM and related models of adoption and use, and its robustness is furthered here by tying the UTAUT constructs to important constructs from collaboration technology research. Moreover, we demonstrate that UTAUT fully mediates the relationship between technology characteristics and use, thus providing insights that could drive future research about the IT artifact and levers influencing adoption and use of collaboration technologies.

This study complements previous models that use the general antecedents of performance expectancy and effort expectancy (e.g., [40, 69, 73]) and provides evidence that collaboration technology–specific factors play an important role in influencing cognitions that drive technology use. First, the three collaboration technology characteristics directly influenced performance expectancy and effort expectancy. More interesting, perhaps, is that they also interacted with the task. In Study 1, higher social presence, increased immediacy, and greater concurrency led to increased performance expectancy and effort expectancy.[8] In Study 2, which considered task interactions for performance expectancy, we found that (1) higher social presence only increased performance expectancy for decision-making tasks; (2) increased immediacy had beneficial performance expectancy effects for both task types, but stronger effects for decision-making tasks; and (3) counter to our hypotheses, greater concurrency led to greater performance expectancy only for decision-making tasks.

We conclude that these three collaboration technology characteristics—social presence, immediacy, and concurrency—are important factors influencing the adoption and use of collaboration technology. Social presence and immediacy have long been linked to perceptions of performance and user satisfaction, particularly for decision-making tasks [13, 33, 64]. However, they have not been previously linked to the decision to adopt or use a collaboration technology. This is an important contribution of this work. More puzzling, perhaps, is the role played by concurrency—the ability to perform multiple tasks. Concurrency is a newer construct that has received far less attention. We have argued that decision-making tasks would benefit more than idea generation from a shared focus of attention [22] and that concurrency would impede the development of this shared focus. We found concurrency to have a direct effect on effort expectancy but, counter to our hypotheses, to increase performance expectancy for decision-making tasks and not idea-generation tasks. These results highlight the important role of task and technology characteristics in research on technology adoption and use.

Individual and group characteristics played an important role in influencing effort expectancy but, contrary to our hypotheses, not performance expectancy. Not surprisingly, greater self-efficacy led to greater effort expectancy. However, it was surprising that experience with collaboration technologies did not. It may be that the use of collaboration technologies (e.g., audioconferencing, instant messaging, e-mail) is relatively widespread and that once one gains even a little experience with them, additional experience has little marginal benefit. Computer self-efficacy is a broader assessment of overall technology competency, especially as it incorporates the element of confidence. UTAUT explicitly argues that computer self-efficacy will *not* influence intention to use a technology [76]. Our research shows that computer self-efficacy plays a role as an antecedent in influencing how different individuals perceive the effort expected of the same technology: individuals with greater computer self-efficacy perceived both collaboration technologies to require less effort. Finally, group members with greater familiarity with their communication partners perceived the collaboration technology to require less effort. This is probably because they could rely on well-established norms and deep understanding of each other so that communication could be less explicit and express the same meaning with fewer words (cf. [11]). The inclusion of individual and group characteristics in our model provides insights into the antecedents of performance expectancy and effort expectancy in the context of collaboration technologies. As an aside, we note that younger group members and men were more likely to perceive collaboration technology to require less effort to use, which is consistent with prior research with other technologies [51, 52].

The situational conditions surrounding collaboration technologies influenced intention and use. Co-workers, both peers and supervisors, worked through social influence to affect intention to use. Both peer and supervisor opinion influenced intention—in about equal proportion—so all potential communication partners exert an influence on use. Environmental characteristics, such as facilitating conditions (moderated by age, gender, and experience), also influenced intention to use. Technology-facilitating conditions (compatibility with other technologies) had a greater effect than did resource-facilitating conditions (time and money). The effect of technology compatibility is a more immediate day-to-day consideration than the resources, which may explain its greater effect in this context.

Overall, UTAUT proved effective in predicting intention to use. The three groups of collaboration technology–specific antecedents—technology, task, and individual/group characteristics—were significant antecedents influencing performance and effort expectancy. Performance expectancy, moderated by gender and age, and effort expectancy, moderated by gender, age, and experience, had significant effects on the intention to use. The consistency of findings across these two studies and technologies contributes to the cumulative tradition and ongoing assessment of UTAUT.

Limitations

The strengths of this study are that it is a field study, conducted in two contexts, with participants drawn from multiple organizations, using two different collaboration technologies, with very different characteristics. However, our study has a few limitations that should be noted. This study was conducted in Finland, a country at the cutting edge in terms of technological sophistication. This raises a question regarding generalizability to other countries. This generalizability issue is even deeper than just being an issue of external validity; it is possible that the sample studied here represents mostly innovators and as the model is tested in countries that have less technology-savvy populations, the pattern of findings or pertinent constructs may be different. This calls for research to address the issue by an examination of the deeper cross-cultural generalizability issues.

We examine two very different collaboration technologies—that is, SMS and a proprietary collaboration tool—but they represent only a subset of the types of collaboration technologies available. Given the reasonably consistent results across the two studies, we expect similar findings with other types of collaboration technologies. However, the unique characteristics of blogs and wikis, for example, may suggest refinements to the model. In addition, we characterized the collaboration tasks based on their objectives—that is, idea generation and decision making. Other results may become apparent if the focus turns to the nature of interaction with the tool (e.g., synchronous versus asynchronous). This issue does raise an interesting question of just how detailed research needs to be when theorizing about the IT artifact.

It is important to note that we analyzed user assessments of the technology characteristics, thus relying on the socially derived characteristics rather than the innate physical characteristics. By examining the socially derived characteristics, we were able to focus on a single technology, yet still achieve variability in the assessments. It is conceivable that an examination of the innate physical characteristics of the media would yield different results. Thus, we encourage future research to examine the differential effects of socially derived and innate physical characteristics of different media.

Finally, the model might have omitted constructs. Constraints imposed by the research settings precluded us from having an excessively long survey instrument. As a result, we had to necessarily scope our model to include key constructs and keep the number of items per construct at a reasonable level. It is possible that other collaboration constructs would offer alternative perspectives. However, this concern is somewhat alleviated due to the strong ties to established theoretical perspectives in our construct selection process. Thus, we call for future studies to consider other constructs in the space of collaboration research to extend and augment the model presented in this work.

Implications for Future Research

Several additional and important directions emerge from the findings in this work. Our research begs the question about how use and its antecedents will unfold with even greater experience. While we measured use and employed it as the ultimate dependent variable in our model, the model and test here still represent only one point in time. Future work with multiple waves of data is essential to deepen our understanding of the antecedents of use as experience grows. This could predict trajectories of use based on perceived characteristics of the collaboration technology or UTAUT constructs.

A number of opportunities exist for expanding our model. We selected three technology characteristics specific to collaboration technology that we believed were important. Our results show them to be significant factors. However, there are many other collaboration technology characteristics, such as rehearsability and synchronicity [22], that may play a role. Future research needs to expand our model to investigate other collaboration technology characteristics.

As we noted, task characteristics can be notoriously difficult, if not impossible, to control in field studies, and therefore experimental research will be essential to further investigation of the role of task. Moreover, it will be important to carefully consider the nature of the task being studied. Incorporating aspects such as uncertainty or interdependence could prove valuable in uncovering the nature of the role played by task in influencing use.

Given the important moderating role of task, future research should clearly articulate the focal task when trying to explain use. Prior work has demonstrated the importance of the fit between task and technology, specifically in collaboration settings [24]. Prior work has also shown that fit may be less important—or even unimportant—over time [35]. Our results suggest that the nature of the task can alter the relationships between the technology-specific characteristics and the UTAUT antecedents. So, although fit may or may not be an important factor influencing ongoing performance (cf. [24, 35]), fit does play a role in users' perceptions of performance expectancy and, ultimately, their choice to use a collaboration technology. As additional technology-specific characteristics are examined, future work should be mindful of the task and its potential moderating effect on the choice to use a technology.

The range of situational characteristics that could be studied is expansive—some examples include organizational culture, innovation culture, and voluntariness. While some variance can indeed exist in perceptions about these situational characteristics even within a single organization, we were limited by the practical constraints of questionnaire length, and thus we chose to focus on certain constructs. The ideal approach to study situational characteristics will be to study collaboration technology use in different organizations to gain variance in the situational characteristics—for example, Venkatesh et al. [76] studied implementations in different organizations to understand voluntary versus mandatory use situations.

We considered only one moderator of the relationships between collaboration constructs and UTAUT constructs—task. Considering additional moderators is an important direction for future research. Given research on channel expansion theory [11], it is possible that relationships among technology perceptions, technology experience, and partner experience might have an important influence on use. This experience evolves over time such that partners familiar with each other perceive lean media as rich. This would argue for future research to examine these important interactions and explore the effect of time and changing perceptions on our model.

Another next step will be to evaluate interventions related to the constructs in our model and other commonly used interventions and their effect on the various constructs studied here. For example, altering technology characteristics, such as social presence, immediacy, and concurrency, or developing procedures to improve group member familiarity, may prove valuable for enhancing collaboration technology use. It is also important to consider that people often employ multiple collaboration technologies to interact with the same communication partner(s). The use of one collaboration tool may have important implications for the perceptions and use of another tool [48]. As research moves forward, it will be important to consider the multimedia nature of collaboration.

We conceptualized collaboration technology use quite broadly, and further research is necessary to separate work use from leisure use and examine the antecedents of each [71]. Recent research has shown that antecedents of these two types of use can be quite different [70, 76] and the work versus leisure nature of communication is likely to have an effect on collaboration technology use [8]. It will be important to examine the generalizability of this model of general collaboration technology use to different contexts while being sensitive to specific organizational context variables, such as incentive systems and organizational culture, as recommended by Dennis et al. [25].

Last but not least, given that collaboration is an inherently multiuser phenomenon, we call for research to investigate collaboration technology use at the group level by integrating both individual and group-level constructs in a multilevel model [10]. Group-level constructs are not simply aggregated individual values, but rather exist at a separate level that the group as a whole co-creates (e.g., decision performance, time, mindfulness). Future research needs to incorporate some aspect of "groupness" that evolves from the interaction among members [63].

Implications for Practice

Much prior research on technology adoption has shown that performance expectancy and effort expectancy are predictive of intention and use. While such predictive validity is valuable, we argued that actionable guidance can better emerge by understanding a set of technology-specific factors that influence these expectations. The support for our collaboration technology model underscores the possibility that collaboration technology use can be enhanced or eroded depending on the underlying technology, individual/group, task, and situational characteristics. Thus, the results of this study highlight the key levers that organizations can use to improve the adoption and use of collaboration technologies.

One potential lever is training in the area of technology characteristics. Organizations will benefit by showing their employees how to exploit the characteristics of various technologies. For example, across both studies, we found that immediacy is an important antecedent to performance expectancy, regardless of task. Thus, it would seem that educating employees about the speed of collaboration associated with the use of various technologies could be valuable. There were noticeable differences in the perceptions of immediacy within, as well as between, technologies, implying that different respondents experience the same technology differently [11, 22]. Different users are slower or faster in responding to messages, whether they are SMS messages or messages in a more full-featured collaboration system. Establishing group or organizational norms for immediacy and educating users about them might influence the adoption of collaboration technologies.

In addition, the significance of social presence suggests that providing employees with examples of how to increase social presence would be valuable (e.g., via language and emoticons). Further, when introducing collaboration technologies, organizations will benefit by providing opportunities for employees to work with both the technology and a set of familiar communication partners in order to positively influence perceptions of effort expectancy. Finally, the interaction of the technology characteristics with the task in influencing performance expectancy highlights the need for organizations to provide training regarding the fit between various collaboration technologies and the tasks employees face.

Another lever is associated with designing collaboration tools. It is clear that perceptions of the technology characteristics have a significant influence on both effort expectancy and performance expectancy. As designers develop collaborative tools, they should be aware of the importance of social presence, immediacy, and concurrency. It should be possible to draw from the vast body of knowledge in human–computer interaction to identify specific design practices that could target each of these three factors. Thus, developing tools that enable a variety of interactions, potentially including pictures and avatars, could be quite valuable.

Finally, organizations can also use the model presented here as a guide to evaluate how effective their current training and design practices are in driving the key factors that influence collaboration technology use. Targeted upgrades could be made to collaboration systems without overhauling the entire system so as to emphasize key drivers. Similar focused modifications can be made to training programs that emphasize the critical factors identified in this work. For instance, one such modification to a traditional collaboration technology design may be to increase its ability to be used concurrently with other tasks. SMS has greater concurrency than traditional collaboration technology in part because it easily can be used on mobile devices (e.g., one can use SMS on a mobile phone while walking to a meeting). Moving traditional collaboration technologies to mobile devices would increase their concurrency. Likewise, changing the organizational culture to encourage the use of collaboration technology in meetings to perform other tasks simultaneously [59] would also increase concurrency.

Conclusions

We developed and validated a model of the use of collaborative technologies. The model was developed by integrating UTAUT constructs with constructs drawn from collaboration technology theories—specifically, social presence theory, media richness theory and its descendants, and the task closure model. The constructs were selected to be applicable to the general class of collaboration technologies. The model was validated in two different settings, using two different collaboration tools. Specifically, we found that UTAUT mediated the effects of various constructs from collaboration research on intention to use a collaboration technology. The results from our study have important implications for research on collaboration technologies and provide practical guidance regarding collaboration technology use in general. This work integrates major streams of work into a single nomological network, and the proposed integrated model provides guidance for the design of collaboration technologies to foster adoption.

Notes

1. The terms "acceptance" and "adoption" are frequently used interchangeably in the literature. In this paper, we primarily use the term "adoption," but we stay true to the original sources when it comes to model names, such as the unified theory of acceptance and use of technology (UTAUT).

2. We explicate the UTAUT hypotheses for the context of this study and highlight the underlying logic. Given the vast amount of technology adoption research and our focus on the integration of collaboration technology research and UTAUT, we refer the reader to Venkatesh et al. [76] for a detailed discussion of the general logic underlying the UTAUT hypotheses.

3. SMS can also be used for providing automated message services, such as welcome messages, targeted advertising, and voice mail notifications, and can even support "commerce" applications such as ticket purchases [29]. Our focus in this paper is on the use of SMS as a collaboration technology, so we excluded non-collaboration-oriented uses of SMS.

4. As pointed out by an anonymous reviewer, this is a fairly high response rate for a survey with no incentives. We attribute this to the respondents' loyalty to their university as well as follow-up calls made by the university to encourage responses.

5. As in Study 1, this is a high response rate. In this case, strong top management support for the collaboration technology and for our study are the reasons for the response rate.

6. In Study 2, we collected user reactions to the collaboration technology for two separate, different task contexts, so we had two records per respondent in our data set. One concern with including multiple responses from a single participant is that it is possible that there may be correlated errors and consequent spurious relationships, although such correlation does not impair the use of PLS [12]. Nonetheless, to ensure there was nothing unusual in our specific data set that would cause problems, we conducted an additional empirical analysis to simulate a between-subjects test of the model. We built 100 data sets that randomly included one of the responses from each respondent and conducted a separate PLS analysis on each of these 100 data sets. For 98 of these data sets, the results were identical to what we have reported from our full model test. Thus, the use of both responses from each respondent does not seem to cause inflated significance for our data set.

7. Note that effort expectancy is coded such that a higher value means lower effort expectancy or easier to use.

8. Remember that effort expectancy is reverse coded, so higher effort expectancy means less effort is expected.

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Appendix: Constructs and Measures

<COLLABORATION TOOL> IS REPLACED WITH THE ACTUAL SYSTEM NAME in the company. Study 2 items are shown; Study 1 items were similar.

Use

I rate my intensity of use of <collaboration tool> to be: Very light . . . Very heavy (seven-point scale)
How frequently do you use <collaboration tool>: Never . . . Very frequently (seven-point scale)
On an average week, how much time (in hours) do you use <collaboration tool>?
Of the opportunities you have to use collaboration tools, including a telephone, what percentage of time do you choose <collaboration tool>?

Intention to Use (seven-point Likert agreement scale)

I intend to use the <collaboration tool> in the next 6 months.
I predict I would use the system in the next 6 months.
I plan to use the system in the next 6 months.

Performance Expectancy (seven-point Likert agreement scale)

I believe <collaboration tool> will be useful for communication.
Using <collaboration tool> will enable me to accomplish work tasks more quickly.
Using the collaboration tool will increase my productivity.

Effort Expectancy (seven-point Likert agreement scale)

Using <collaboration tool> will *not* require a lot of mental effort.
I believe <collaboration tool> will be easy to use.
Using <collaboration tool> will be easy for me.

Social Influence (seven-point Likert agreement scale)

People who influence my behavior think that I should use <collaboration tool>.
People who are important to me think that I should use <collaboration tool>.
The senior management of this business thinks I should use <collaboration tool>.

Facilitating Conditions (seven-point Likert agreement scale)

I have the resources necessary to use <collaboration tool>.
I have the knowledge necessary to use <collaboration tool>.
A specific person (or group) is available for assistance with difficulties with <collaboration tool>.

Social Presence (seven-point Likert agreement scale)

Using <collaboration tool> to interact with others creates a warm environment for communication.
Using <collaboration tool> to interact with others creates a sociable environment for communication.
Using <collaboration tool> to interact with others creates a personal environment for communication.

Immediacy (seven-point Likert agreement scale)

<Collaboration tool> enables me to quickly reach communication partners.
When I communicate with someone using <collaboration tool>, they usually respond quickly.
When someone communicates with me using <collaboration tool>, I try to respond immediately.

Concurrency (seven-point Likert agreement scale)

I can easily use <collaboration tool> while participating in other activities.
I can easily communicate using <collaboration tool> while I am doing other things.
I can use <collaboration tool> while performing another task.

Technology Experience (seven-point scale)

My experience with audioconferencing is: None at all . . . Very extensive
My experience with videoconferencing is: None at all . . . Very extensive
My experience with messaging tools (e.g., MSN messenger) is: None at all . . . Very extensive
My experience with technologies similar to <collaboration tool> is: None at all . . . Very extensive

Computer Self-efficacy (seven-point Likert agreement scale)

I could complete a task using a computer if there was no one around to tell me what to do.
I could complete a task using a computer even if there was not a lot of time to complete it.
I could complete a task using a computer if I had just the built-in help facility for assistance.

Familiarity with Communication Partners (seven-point Likert agreement scale)

I feel comfortable discussing personal or private issues with co-workers with whom I collaborate.
I feel comfortable using informal communication (such as slang or abbreviations) with co-workers with whom I collaborate.
Overall, I feel that I know my collaborators well.

Peer Influence (seven-point Likert agreement scale)

My friends think I should use <collaboration tool>.
My peers think I should use <collaboration tool>.
My co-workers believe I should use <collaboration tool>.

Superior Influence (seven-point Likert agreement scale)

I believe the top management would like me to use <collaboration tool>.
My supervisor suggests that I use <collaboration tool>.
There is pressure from the organization to use <collaboration tool>.

Resource-Facilitating Conditions (seven-point Likert agreement scale)

There isn't sufficient access to use <collaboration technology>.
Using <collaboration tool> is very resource intensive for me.
I am not able to use <collaboration tool> when I need it.

Technology-Facilitating Conditions (seven-point Likert agreement scale)

<Collaboration tool> is not compatible with other tools and technologies that I use.
<Collaboration tool> is not compatible with other software that I use.
I have trouble using <collaboration tool> seamlessly with other applications.