7-1-2008

Adoption of Collaboration Technologies: Integrating Technology Acceptance and Collaboration Technology Research

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芽|Sprouts Working Papers on Information Systems ISSN 1535-6078

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Abstract
This paper integrates the technology acceptance model (TAM) with constructs from collaboration technology research to present a model of collaboration technology use. Specifically, constructs in four sets of characteristicsâ technology, individual and group, task, and situationalâ drawn from various media choice theories are presented as determinants of the TAM constructs of perceived usefulness, perceived ease of use, and attitude toward using collaboration technology. The model was tested among 349 short message service (SMS) users in Finland. The model was largely supported, with the most significant findings being the effects of the four technology characteristicsâ social presence, media richness, immediacy, and concurrencyâ on the TAM constructs. In addition to making an important contribution by integrating two of the more dominant streams of information systems research, the model presented here is focused on a specific class of technologyâ i.e., collaboration technologyâ and, therefore, answers recent calls for developing models that deepen our understanding about the technology artifact.

Keywords: INTEGRATING TECHNOLOGY ACCEPTANCE AND COLLABORATION

Permanent URL: http://sprouts.aisnet.org/3-8

Reference: Dennis, A.R., Venkatesh, V., Ramesh, V. (2003). "Adoption of Collaboration Technologies: Integrating Technology Acceptance and Collaboration Technology Research," Indiana University, USA . *Sprouts: Working Papers on Information Systems*, 3(8). http://sprouts.aisnet.org/3-8

ADOPTION OF COLLABORATION TECHNOLOGIES:

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ABSTRACT

This paper integrates the technology acceptance model (TAM) with constructs from collaboration technology research to present a model of collaboration technology use. Specifically, constructs in four sets of characteristics—technology, individual and group, task, and situational—drawn from various media choice theories are presented as determinants of the TAM constructs of perceived usefulness, perceived ease of use, and attitude toward using collaboration technology. The model was tested among 349 short message service (SMS) users in Finland. The model was largely supported, with the most significant findings being the effects of the four technology characteristics—social presence, media richness, immediacy, and concurrency—on the TAM constructs. In addition to making an important contribution by integrating two of the more dominant streams of information systems research, the model presented here is focused on a specific class of technology—i.e., collaboration technology—and, therefore, answers recent calls for developing models that deepen our understanding about the technology artifact.

INTRODUCTION

Technology acceptance is one of the most mature streams of information systems (IS) research (see Hu, Chau, Sheng, and Tam 1999; Venkatesh, Morris, Davis, and Davis 2003; Vessey, Ramesh, and Glass 2002). 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 acceptance and technology use, particularly since the late 1980s. A recent review and synthesis article indicated that there were at least *eight* models of technology acceptance (Venkatesh et al. 2003). In addition to noting the maturity of this stream of research, they 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 acceptance] of research into other established streams of work" (p. 470).

In the stream of research on technology acceptance, the technology acceptance model (TAM; Davis 1989; Davis, Bagozzi, and Warshaw 1989) is the most widely-employed theoretical model (Venkatesh et al. 2003). TAM has been applied to a wide range of technologies and has been very predictive of individual acceptance and technology use. One of the criticisms of TAM has been that although it can effectively predict system acceptance, it is not particularly useful in providing explanations that can be used to design interventions that foster acceptance (e.g., Venkatesh and Davis 1996, 2000). While it is widely recognized that perceived usefulness and perceived ease of use affect acceptance, until we better understand what determinants affect perceived usefulness and perceived ease of use, it will be difficult to provide *actionable and practical guidance* from TAM. There has been some research on a set of general determinants that apply to a wide range of technologies and classes of technologies (e.g., Venkatesh 2000; Venkatesh and Davis 2000). However, in using TAM for actionable guidance, it is essential to identify determinants that are tailored to specific classes of technologies that capture the nuances of the class of technologies and/or business processes (see Benbasat and Zmud 2002). Thus, as a first step, it is important to extend TAM toward specific classes of technologies (Dennis and Reinicke in press). A model focused on a specific class of technologies will produce a *narrower* but *stronger* model rather than a general model that attempts to address many classes of technologies simultaneously (see Newell 1969). Given this background, we integrate constructs from theories about collaboration technologies with TAM to present a model of acceptance of collaboration technologies to provide a rich understanding of the acceptance and technology use of this specific class of technology.

Technologies that facilitate collaboration via electronic means have become an essential component of day-to-day life (both in and out of the workplace). Thus, it is not surprising that this class of technologies has received considerable prior research attention over the past five years (Vessey et al. 2003). Several prior studies have examined the adoption of collaboration technologies such as voice mail, e-mail, and group support systems (e.g., Adams, Nelson, and Todd 1992; Chin and Gopal 1995; Straub, Limayem, and Karahanna 1995). These studies focused primarily on testing the boundary conditions of TAM—e.g., could TAM be applied to collaboration technologies—and are important contributions because they established TAM as one of the cornerstones of IS literature and a theoretical model applicable to a wide range of technologies. However, a model that integrates knowledge from technology acceptance research and collaboration technology research is lacking, a void that this paper seeks to address.

In conducting this research, we believe we have taken a step towards alleviating one of the criticisms of IS research raised by Benbasat and Zmud (2002), especially in a TAM context: "… 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" (p. 193). Specifically, our work accomplishes the goal of "… developing conceptualizations and theories of IT artifacts; and incorporating such conceptualizations and theories of IT artifacts" (Orlikowski and Iacono 2001, p. 130) by extending TAM to incorporate the specific artifact of collaboration technology—here, we study short message service (SMS). We, therefore, answer the call to integrate technology acceptance research with other important streams of research to create a cumulative tradition and body of knowledge (Keen 1980). In the spirit of the aforementioned recommendations, our goal here is to integrate TAM with theories about collaboration technologies to develop a better understanding of the acceptance and use of collaboration technologies. We develop a set of the determinants to TAM constructs by drawing from three specific theories: social presence theory, media richness theory (and its descendents such as channel expansion theory), and the task closure model. The objective of the model is to predict general collaboration technology use. We then test our model using one collaboration technology, short message service (SMS), which enables two-way, near real-time communication among individuals who typically use SMS on mobile phones or handheld computers (Doyle 2001). We end with a discussion of the model and its implications for future research and practice.

BACKGROUND

Collaboration Technology

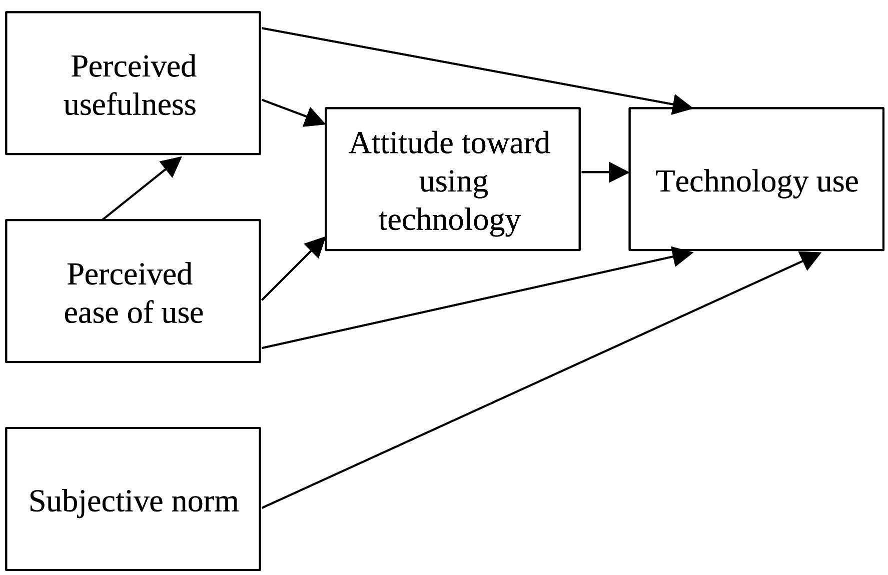
Based on a review of the literature, we believe that the first published use of the term *collaboration technology* can be attributed to Olson and Olson (1991). Collaboration technology is designed to assist two or more people to work together at the same place and time or at different places and/or different times (Dennis, George, Jessup, Nunamaker, and Vogel 1988; DeSanctis and Gallupe 1987). There are many different types of collaboration technology that that provide different capabilities to its users (Eden and Ackerman 2001), but in general, collaboration technology is a package of hardware, software, people, and/or processes that can provide one or more of the following: (a) support for communication among participants, such as electronic communication to augment or replace verbal communication; (b) information processing support, such as mathematical modeling or voting tools; and (c) support to help participants adopt and use the technology, such as agenda tools or real-time training (Dennis, Wixom, and Vandenberg 2001; DeSanctis and Gallupe 1987; Nunamaker, Dennis, Valacich, Vogel, and George 1991; Zigurs and Buckland 1998). A variety of terms have been used to refer to collaboration technology over the years—e.g., group decision support systems, group support systems, electronic meeting systems, groupware, computer-supported cooperative work, negotiation support systems—but these, as well specific systems such e-mail, voice-mail and video conferencing, now generally are 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 (see Dennis and Gallupe 1993). While many early collaboration initiatives were centered on decision room environments (Dennis and Gallupe 1993), in recent years, much attention has turned to collaboration technologies that support virtual teams and distributed work (e.g., e-mail, instant messaging, asynchronous discussion tools), a theme that was also present in the early research (Dennis and Gallupe 1993). Many reviews of collaboration technology research have been published over the years (see Dennis et al. 2001; Fjermestad and Hiltz 1998, 2000 for recent reviews).

Technology Acceptance Model

As noted earlier, TAM is one of the most widely-employed models of individual acceptance and use of technologies. The model was initially developed and tested in the 1980s (Davis 1986, 1989; Davis et al. 1989). Subsequently, the model has been extensively validated across a variety of settings and subjected to theoretical extensions (e.g., Venkatesh and Davis 2000; see Venkatesh et al. 2003 for a review). TAM incorporates four key predictors of intention to use technology: perceived usefulness, perceived ease of use, attitude toward using technology, and subjective norm (Davis et al. 1989; Venkatesh and Davis 2000; Venkatesh and Morris 2000). Intention, in turn, predicts technology use. These and other established TAM relationships are shown in Figure 1. The key constructs are defined as follows: perceived usefulness is the extent to which an individual perceives that using a system will enhance his or her productivity and perceived ease of use is the extent to which using a system is free of effort (Davis et al. 1989). Attitude toward using technology is the affective reaction—like or dislike—to using a specific system (Davis et al. 1989). Subjective norm is the perception of the extent to which important others think that the individual should use the target system (Taylor and Todd 1995; Venkatesh and Davis 2000).

Figure 1. Technology Acceptance Model

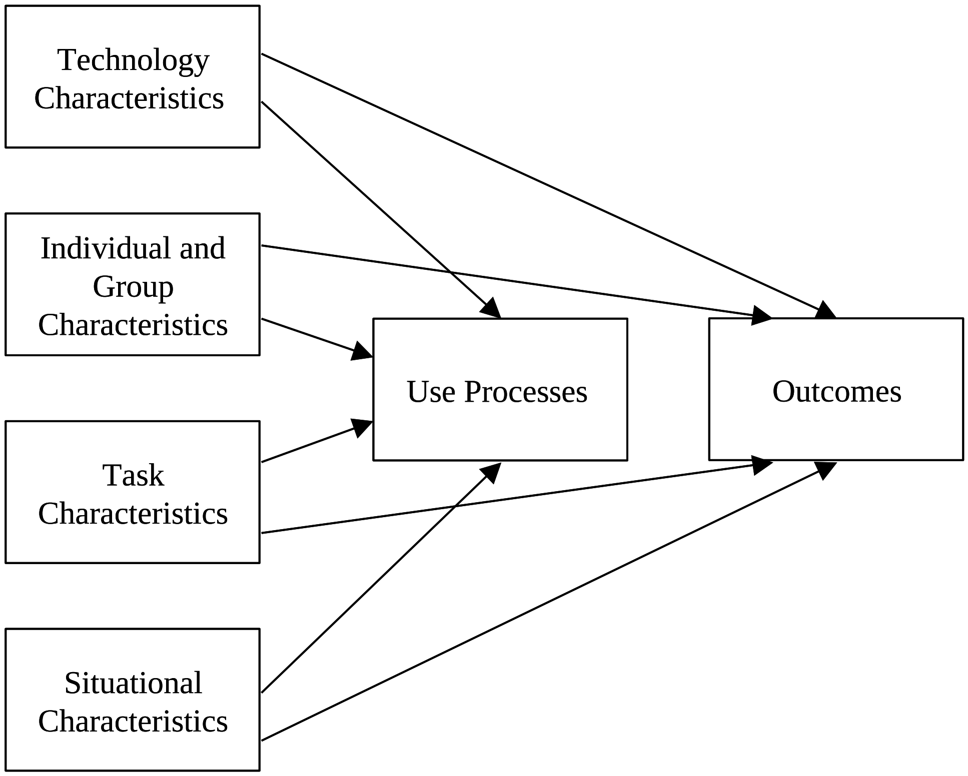


MODEL DEVELOPMENT

The key question of interest in this paper is: *Why do people choose to accept, adopt, and use collaboration technology?* Assuming that the choice is voluntary, people adopt collaboration technology—or any technology—because they believe it will be useful in improving the effectiveness, efficiency, and/or personal satisfaction of performing some task (Dennis et al. 2001; Dennis and Reinicke in press; Venkatesh et al. 2003). If we understand the factors that influence the effectiveness, efficiency, and/or personal satisfaction in using collaboration technology to perform a task, then we will likely understand the factors that have the potential to influence adoption, because perceived usefulness is the extent to which an individual recognizes a net gain in effectiveness, efficiency, and/or personal satisfaction from using the technology. These *effectiveness, efficiency,* and *personal satisfaction* motives correspond directly to core underpinnings of *perceived usefulness, perceived ease of use,* and *attitude toward using technology* respectively, thus making TAM particularly suitable as the basis for the model development.

Several factors have been suggested to influence performance of individuals and teams using collaboration technology (Dennis et al. 1991; Fjermestad and Hiltz 1998, 2000), most of which fall into four major characteristics: *technology, individual and group, task,* and *situational* such as organizational context (Dennis et al. 1988, 2001; Fjermestad and Hiltz 1998, 2000; Nunamaker et al. 1991; Zigurs and Buckland 1998). Figure 2, adapted from Dennis et al. (1988), illustrates how these factors affect technology use processes and the outcomes from group work. In their model, outcomes include both work performance—e.g., efficiency and effectiveness—as well as affect-based outcomes such as satisfaction and attitude, because both work performance as well as individual-level goals are important in influencing technology adoption (Dennis and Reinicke in press).

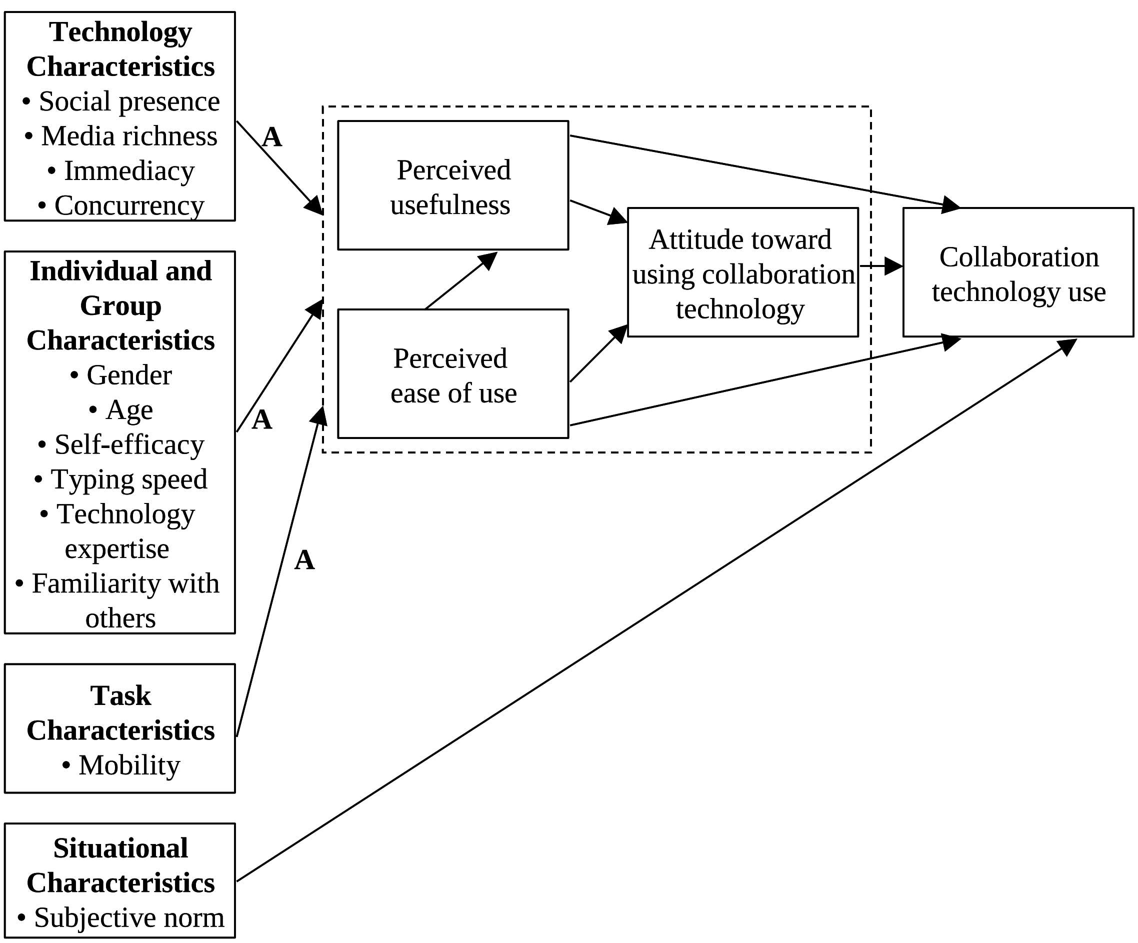
Figure 2. Factors Influencing Use and Outcomes of Collaboration Technology



In developing a model to explain the acceptance and use of collaboration technology, we began with the four sets of factors (Figure 2) argued to be important in influencing the successful use of collaboration technology—technology, individual and group, task, and situation. We integrate these factors with TAM to produce a basic theoretical framework. We employ the four key predictors from TAM identified earlier as determinants of technology use. The different characteristics are hypothesized to directly or indirectly influence perceived usefulness, perceived ease of use, attitude, and technology use. Figure 3 presents our research model.

Typically, TAM and other models of acceptance employ intention as a predictor of behavior. However, the role of intention is more critical in situations where the behavior has not been performed or the behavior cannot be measured. Even in psychology research from which TAM was adapted, it has been suggested that intention could be eliminated to study the impact of predictors on behavior (e.g., Ajzen 1991). In prior TAM research, there are precedents for using behavior as the key dependent variable and excluding intention (e.g., Straub et al. 1995). In keeping with this prior research and given our focus on outcomes, we exclude intention to use technology and instead focus on technology use itself as the key dependent variable of interest. In the sections below, we define the key constructs and then develop the theoretical arguments for these constructs and the relationships among them. We begin with a discussion of the key TAM relationships and then move to the collaboration technology-specific determinants to the various TAM constructs.

Figure 3. Proposed Research Model



Note: The notation A in the above figure indicates that there is a relationship from each of the technology characteristics to each of the three TAM constructs in the dashed box; similarly, there is a relationship between each of the individual and group characteristics and each of the three TAM constructs in the dashed box; also, there is a relationship between the task characteristic and each of the three TAM constructs in the dashed box.

Predicting Collaboration Technology Use: The Basic TAM Hypotheses

As noted earlier, TAM and its various adaptations include four predictors of predictors of technology use: perceived usefulness, perceived ease of use, attitude toward using technology, and subjective norm (Davis et al. 1989; Venkatesh and Davis 2000; Venkatesh and Morris 2000). In the context of personal technologies, perceived usefulness could also include productivity on household or personal activities not just workplace productivity (see Venkatesh and Brown 2001). Other models have also employed similar performance expectancy constructs as key predictors of technology use (e.g., Agarwal and Prasad 1998; Thompson, Higgins, and Howell 1991; see Venkatesh et al. 2003 for a review). Perceived usefulness has been one of the most consistent aspects of TAM across with a variety of different technologies (Venkatesh et al. 2003). Similarly, TAM and other models of technology acceptance include perceived ease of use as a direct predictor of intention/behavior (e.g., Agarwal and Prasad 1998; Thompson et al. 1991; see Venkatesh et al. 2003 for a review). Perceived ease of use can be a particularly important factor for personal technologies and in non-workplace settings (Venkatesh and Brown 2001). There is also significant evidence supporting the role of perceived ease of use as a determinant of perceived usefulness which is based on the rationale that easier a technology is to use, the more useful it can be (e.g., Davis et al. 1989; Venkatesh 2000; Venkatesh and Davis 2000).

Research has been equivocal about the role of attitude in TAM. Early TAM research suggested the exclusion of attitude from TAM because it did not fully mediate the role of perceived usefulness on intention (Davis et al. 1989). This direct effect of perceived usefulness on intention was attributed to performance expectancy having a direct influence on intention, regardless of the affective reaction, in workplace contexts. However, other research has found the effect of attitude on intention to be quite important (e.g., Mathieson 1991). Further, in social psychology, the role of attitude as a determinant of behavior has been well-documented (see Ajzen 2002 for a recent review). Also, Ajzen (2002) noted that in social behaviors, attitude captures both *affect* and *evaluation*. Given our focus on understanding the acceptance of collaboration technology by integrating TAM with collaboration theories that emphasize not only performance but also affect, the inclusion of attitude as a predictor of use is important.

The roles of perceived usefulness, perceived ease of use, and attitude will be examined as direct effects on collaboration technology use. As noted earlier, there are different versions of TAM that have been employed in published studies. One of the points of variation across the different versions of TAM is the mediational role of attitude. In some cases, attitude is not included (Venkatesh and Davis 2000); in others, perceived usefulness and perceived ease of use are expected to be fully mediated by attitude (Taylor and Todd 1995); in still others, perceived usefulness has a direct effect over and above attitude but the effect of ease of use on intention is fully mediated by attitude (Davis et al. 1989). Other theoretical perspectives on technology acceptance include attitude, a performance expectancy construct (e.g., perceived usefulness), and an effort expectancy construct (e.g., perceived ease of use) as direct predictors of intention or technology use (see Venkatesh et al. 2003). In order to examine the relative influence of these three constructs, we will include perceived usefulness, perceived ease of use, and attitude toward using technology as direct determinants of collaboration technology use.

Based on this, we present the following four hypotheses:

H1a: Perceived usefulness will positively influence collaboration technology use.

H1b: Perceived ease of use will positively influence collaboration technology use.

H1c: Perceived ease of use will positively influence perceived usefulness.

H1d: Attitude toward using collaboration technology will positively influence collaboration technology use.

In our model, consistent with the original specification of TAM and with subsequent empirical research, we expect that the determinants of attitude will include TAM predictors of perceived usefulness and perceived ease of use (Davis et al. 1989). Therefore:

H1e: Perceived usefulness will positively influence attitude toward using collaboration technology.

H1f: Perceived ease of use will positively influence attitude toward using collaboration technology.

The last predictor of technology use is subjective norm. Here, subjective norm is included as a *situational variable* (see Figure 2) since collaboration technology use will not only depend on the influence of others but also on the critical mass of users. Subjective norm is the extent to which an individual believes important others think he or she should use the technology in question (Venkatesh and Davis 2000). The role of social influence in technology acceptance studies has been somewhat unclear. Initially, Davis et al. (1989) did not consider subjective norm for inclusion in TAM since it was the least understood aspect of the theory of reasoned action. However, other models of technology acceptance have included various aspects of social influence (see Agarwal and Prasad 1998; Moore and Benbasat 1991; Thompson et al. 1991; Venkatesh et al. 2003). More recently, social influence has been incorporated in TAM—even then, social influence has played a role in technology acceptance only in the presence of certain moderating variables such as organizational mandate (Venkatesh and Davis 2000) or gender (Venkatesh and Morris 2000). Recently, Venkatesh and Brown (2001) found the role of social influence was significant in predicting acceptance of PCs in homes. However, interestingly, despite the importance of social influence as a predictor of intention/behavior in certain situations, it has consistently been found to be of limited importance in the presence of significant experience with the technology; in essence, the views of others weigh heavily in technology use decisions before one has acquired sufficient experience to feel confident about making an independent decision (e.g., Karahanna, Straub, and Chervany 1999; Venkatesh and Davis 2000; Venkatesh and Morris 2000; Venkatesh et al. 2003).

In contrast to prior studies, here, we expect social influence will be particularly important in the case of collaboration technologies, because they are "social" technologies. Unlike the individual technologies studied in 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, acceptance and technology use would be dampened. The converse is also true where increased normative pressure could be grounded in the "critical mass" necessary to foster technology use (Markus 1987). Therefore, we hypothesize:

H1g: Subjective norm will positively influence collaboration technology use.

Determinants of TAM Constructs in Prior Research

Although TAM has been well-established, far less is known about the underpinnings of the key determinants of TAM constructs. About a decade after the initial articles on TAM (i.e., Davis 1989; Davis et al. 1989), there have been articles that have identified some determinants of perceived usefulness and perceived ease of use (e.g., Karahanna and Straub 1999; Venkatesh 2000; Venkatesh and Davis 2000). Specifically, the determinants of perceived usefulness were identified to be cognitions and social influence (Venkatesh and Davis 2000); the determinants of perceived ease of use were identified to be individual's general technology beliefs and individual's perceptions of the system (Venkatesh 2000). Other work has incorporated general psychological variables such as trust as tied to the context of technology use (e.g., Koufaris 2002). However, in prior research, the constructs identified were *not* tied to the IT artifact, its conceptualization, and did not appreciate the nuances associated with the specific type of technology or class of technology. To address this gap in the research, we develop a set of determinants of perceived usefulness, perceived ease of use, and attitude that are specific to the context of collaboration technologies by drawing from prior research and theory on collaboration technology.

With regard to the determinants of attitude, Davis et al. (1989) employed perceived usefulness (H1e) and perceived ease of use (H1f); Taylor and Todd (1995) added compatibility as a determinant—however, they did not find this to be significant. The determinants of subjective norm are probably best established in the literature—IS, psychology, and marketing—with the influence of peers, supervisors, friends, and family being the most important (Ajzen 1991; Taylor and Todd 1995; Venkatesh and Brown 2001), with the latter two being most significant in non-workplace settings (Venkatesh and Brown 2001). Due to the practical constraints of the questionnaire length, as we will note later, we do not test these *established determinants* of subjective norm in the current work.

As we argued earlier, there are four basic sets of factors that have the potential to influence the effectiveness, efficiency, or satisfaction from using collaboration technology: *technology characteristics*, *individual and group characteristics*, *task characteristics* and *situational characteristics*. We present the case for the influence of the first three sets of characteristics on perceived usefulness, perceived ease of use, and attitude toward using the technology. As noted earlier, subjective norm is a situational characteristic here and has been predicted to have a direct influence on technology use. In the sections below, we describe each of the three remaining sets of characteristics and then select several specific constructs within each set that we believe will have a significant impact on use.

Technology Characteristics

Collaboration technologies are social technologies that provide a variety of capabilities that can be used in different ways by different groups and individuals (Ackermann and Eden 2001). Different groups and individuals can use the same technology in different ways with strikingly different outcomes (Dennis et al. 2001; DeSanctis and Poole 1994). Thus, in examining the characteristics of collaboration technology, we cannot speak of the characteristics inherent in the technology, but rather the characteristics as used and experienced by the users (Orlikowski 2000)—that is, not the *available technology characteristics*, but the *technology characteristics experienced by the users*. For simplicity, we will refer to these as *technology characteristics*, keeping in mind that the term refers to the technology characteristics as experienced by the users.

In searching for specific collaboration technology characteristics that would be determinants of the TAM constructs of perceived usefulness, perceived ease of use, and attitude, one of the most promising places to start is with theories that attempt to explain why users choose to use one communication medium over another—i.e., media choice. In this research, 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 descendents such as channel expansion theory), and the task closure model to develop *four specific technology characteristics*—social presence, media richness, immediacy, and concurrency—that are expected to influence collaboration technology use operating through the TAM constructs.

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 (Short, Williams, and Christie 1976). Collaboration technologies with high social presence convey a social and very personal environment for communication. Social presence is influenced by a technology's ability to transmit non-word cues (e.g., voice inflection) and non-verbal cues (e.g., gestures, facial expressions). Short et al. (1976) argue that face-to-face communication imparts the most social presence, followed by in order by technologies that provide both audio and video communication, those that provide only audio communication, and those that provide only text communication. Social presence is an experiential phenomenon; it is possible for different users to perceive different levels of social presence for a given technology depending on the situation.

Social presence is most important for activities requiring high personal involvement (e.g., getting to know someone); effectiveness, efficiency, and participant satisfaction are likely to be impaired if technologies low in social presence are used for these activities (Christie 1985; Fowler and Wackerbarth 1988). For example, using a text-only technology, which provides low social presence, for an activity requiring personal involvement is likely to result in reduced effectiveness, efficiency, and participant satisfaction. Thus, participants are likely to perceive that low social presence collaboration technologies (e.g., text-only technologies such as e-mail) have low usefulness and ease of use (i.e., effectiveness and efficiency) for performing activities requiring high social presence, and to have developed a low attitude (i.e., satisfaction) towards their use for such activities. Social presence is typically *not* important for activities that are primarily information processing activities (e.g., choosing among alternatives), so the use of low social presence collaboration technologies for these activities should have little effect on effectiveness, efficiency, and participant satisfaction (Christie 1985; Fowler and Wackerbarth 1988). Thus, for information processing activities, there should be *little* relationship between social presence and usefulness, ease of use, and attitude.

The value of social presence is therefore potentially moderated by the type of task one is performing, whether one with high personal involvement or one requiring information processing. Although it is possible to conceptually separate activities that require high personal involvement from those that are primarily information processing, most tasks performed by groups require some of both activities (McGrath 1991; Dennis and Valacich 1999). Of course, some tasks have more of one type of activity than the other at different times (e.g., a newly formed group whose members have never met), but in general, both types of activities are important in group work (McGrath 1991; Dennis and Valacich 1999). Therefore, we chose not to include task type as a moderator of the value of social presence in our model.[1]

In sum, collaboration technologies that provide greater social presence are likely to be perceived to be more useful and easier to use, and to engender more positive attitudes towards use for some but not all group activities. There is no theory or empirical evidence to suggest that increased social presence will impair perceptions of usefulness and ease of use or reduce attitude. We conclude that even though social presence is not important for all activities, it is *very* important for *some* activities and has few negative consequences for the rest, and therefore, on balance, increased social presence should have a positive impact. Therefore, we hypothesize:

H2a: Social presence will positively influence perceived usefulness.

H2b: Social presence will positively influence perceived ease of use.

H2c: Social presence will positively influence attitude toward using collaboration technology.

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[1] This was also done for practical reasons. The model (and resulting survey) is reasonably large without introducing task type as a moderator. Since social presence was not the central focus of the study, we chose to omit task type.

Media Richness

Media richness theory argued that collaboration technologies vary in media richness, defined as "the ability of information to change understanding within a time interval" (Daft and Lengel 1986, p. 560), and that four factors influenced media richness: the ability of the medium to transmit multiple cues (e.g., vocal inflection, gestures), immediacy of feedback, language variety, and the personal focus of the technology (Daft and Lengel 1986; Daft, Lengel, and Trevino 1987). Technologies offering greater media richness, the theory claimed, enabled users to communicate more quickly and to better understand ambiguous or equivocal messages and, therefore, their use would lead to favorable outcomes—i.e., efficiency, effectiveness, and satisfaction—on equivocal tasks. Although Daft and Lengel (1986) also argued that providing high media richness should impair performance for less equivocal tasks because it would provided too much superfluous information, there is little empirical support for this; increased media richness seems to be no more or no less useful for low equivocality tasks (Dennis and Kinney 1998; Fulk and Boyd 1991; Rice 1992; Rice and Shook 1990). As with social presence, media richness is an experiential phenomenon. Individual and group experiences can alter participants' perceptions of media richness (Contractor and Eisenberg 1990; Fulk, Steinfield, Schmitz, and Power 1987; Schmitz and Fulk 1991); technologies that are lean to one individual or group, may be richer to another.

Our arguments for the impact of media richness follow the same pattern as those for social presence. Under some conditions (high equivocality), use of collaboration technologies that provide higher media richness will be more effective and efficient, and lead to greater satisfaction. Therefore, under these conditions, users are more likely to perceive technologies high in media richness to be more useful and easier to use, and are more likely to develop a positive attitude toward their use. Under other conditions (low equivocality), use of collaboration technologies that provide higher media richness will be no more and no less effective, efficient, or satisfying than use of technologies providing lower richness and thus, there should be no impact on perceived usefulness, perceived ease of use, and attitude.

As with social presence, the value of media richness is therefore potentially moderated by the type of task one is performing, whether equivocal or uncertain. We conclude that even though media richness is not important for all activities, it is *very* important for *some* activities and has few negative consequences for the rest. As with social presence, we chose not to include task type (equivocal or uncertain) as a moderator of the value of media richness in our model.[2] We argue that, on balance, increased media richness should have a positive impact. Therefore, we hypothesize:

H2d: Media richness will positively influence perceived usefulness.

H2e: Media richness will positively influence perceived ease of use.

H2f: Media richness will positively influence attitude toward using collaboration technology.

Immediacy of Communication

Immediacy of communication refers to the extent to which a collaboration technology enables the user to quickly communicate with others (Rice 1987; Straub and Karahanna 1998). 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 (Straub and Karahanna 1998). While face-to-face meetings or telephone conversations may have greater social presence or greater media richness, they also require synchronous communication—both parties must be available at the same time (Rice 1987). Leaner

[2] This was again done for practical reasons. The model (and resulting survey) is reasonably large without introducing this task characteristic as a moderator. Since media richness was not the central focus of the study, we chose to omit task type.

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 (Reinsch and Beswick 1990).

As with social presence and media richness, immediacy is socially experienced. Immediacy depends on capabilities inherent in technology itself (it must be capable of immediacy) and also on the use. Although an e-mail may reach your mailbox almost instantaneously, the frequency with which you read your e-mail and the length time you choose to take before responding are characteristics of use, not inherent in the technology. Immediacy of communication is an important factor in the choice to use a specific collaboration technology (Straub and Karahanna 1998). Technologies that have higher immediacy will be perceived to be more effective and efficient and thus will be perceived to have greater usefulness and greater ease of use. Likewise, technologies with greater immediacy will engender greater affect, reflected in a stronger positive attitude toward their use. Therefore, we hypothesize:

H2g: Immediacy of communication will positively influence perceived usefulness.

H2h: Immediacy of communication will positively influence perceived ease of use.

H2i: Immediacy of communication will positively influence attitude toward using collaboration technology.

Concurrency

Concurrency is the ability of a collaboration technology to enable the user to perform other tasks concurrently while 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 (Waskul and Douglass 1997; Censer 2003). Although truly simultaneous work is probably impossible without some interference between the tasks (Pashler 1994; Wickens 2002), 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; 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. Furthermore, the social norms of the user's environment must also permit concurrent use or the user must be prepared to flaunt the norms. Concurrency is likely to be of value for some activities and not for others. For some activities, therefore, concurrency is likely to improve effectiveness and efficiency and induce user satisfaction. As with our arguments for social presence and media richness, this increase in performance is should be reflected in increased perceived usefulness and ease of use, and more positive attitudes toward the technology. There are some situations in which concurrency could impair performance. For example, imagine driving a car while sending e-mail on your handheld computer. We believe that uses of concurrency in cases in which it impairs performance are most likely to be aberrations from the general pattern of use, and not the normal pattern of use. Thus, while we believe that occasional misuse is possible (with the resulting decrease in performance), we believe the general pattern of use would be to use choose to use concurrency when it improve performance (or has little impact) and to avoid concurrency when it impairs performance. Thus, we hypothesize:

H2j: Concurrency will positively influence perceived usefulness.

H2k: Concurrency will positively influence perceived ease of use.

H2l: Concurrency will positively influence attitude toward using collaboration technology.

Individual and Group Characteristics

Individual and group characteristics are potentially important to the successful use of collaboration technology because different individuals and groups have different needs (Dennis et al. 1988; Dennis and Reinicke in press). General demographic factors (e.g., age, gender), can be important in understanding the use of collaboration technology (Dennis, Kinney, and Hung, 1999), but designing technology to meet the needs of specific user characteristics can be problematic (Huber 1983). We view demographic characteristics as useful control variables but ones not commonly used in the design and operation of collaboration technologies. Therefore, although demographic factors can be important, we focus on four specific factors in this set that are likely to have the greatest impact on use, three individual characteristics—technology expertise, typing speed, self-efficacy—and one group-oriented characteristic—familiarity with other group members.

Individual Characteristics

Technology expertise—the ability to use a specific technology—can play a role in the selection and use of a technology, and one's perceptions and attitudes towards it (Carlson and Zmud 1999; Reinsch and Beswick 1990). When one first begins to use a collaboration technology, performance and satisfaction often decrease because its use requires new skills and new patterns of interaction (Dennis and Garfield 2003). However, over time as expertise grows, the technology becomes easier to use and performance and attitudes toward the technology gradually become more positive (Dennis and Garfield 2003). As performance increases, so too should perceptions of ease of use and usefulness. Therefore, we hypothesize:

H3a: Technology expertise will positively influence perceived usefulness.

H3b: Technology expertise will positively influence ease of use.

H3c: Technology expertise will positively influence attitude toward using collaboration technology.

General technology use characteristics such as self-efficacy and typing speed can affect also a user's perception of ease of use and his or her attitude toward the technology (Venkatesh 2000; Venkatesh and Davis 1996). There is a significant body of theory and empirical evidence that shows that individuals with greater technology-related (e.g., computer) self-efficacy perceived technologies to be easier to use (Venkatesh 2000; Venkatesh and Davis 1996). Higher levels of ability and confidence typically result in more favorable affective reactions (e.g., Compeau and Higgins 1995). Similarly, better typists can more easily use a collaboration technology that requires typing and should develop more positive attitudes towards its use (Nunamaker et al. 1991; Williams 1977). There is less empirical evidence to suggest that self-efficacy and typing speed also have an impact on the perceived usefulness of collaboration technology, but we believe it to be justified given that higher levels of ability and confidence will contribute to more favorable performance expectancy. Therefore, we hypothesize:

H3d: Self-efficacy will positively influence perceived usefulness.

H3e: Self-efficacy will positively influence ease of use.

H3f: Self-efficacy will positively influence attitude toward using collaboration technology.

H3g: Typing speed will positively influence perceived usefulness.

H3h: Typing speed will positively influence ease of use.

H3i: Typing speed will positively influence attitude toward using collaboration technology.

Familiarity With Others

Familiarity with other group members is also important in influencing effectiveness, efficiency, and satisfaction. 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 (Dennis and Garfield 2003; DeSanctis and Poole 1994; Sproull and Kiesler 1986). Such shared norms reduce uncertainty and enable groups to more quickly focus on the task at hand, without needing to negotiate roles and expectations (McGrath 1991). 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 that lack familiarity with each other (Carlson and Zmud 1999). Thus, we would expect that as familiarity with others increases, so do the perceived usefulness and perceived ease of use of using collaboration technology to work with others, and positive attitudes about that use begin to develop.

H3j: Familiarity with others will positively influence perceived usefulness.

H3k: Familiarity with others will positively influence ease of use.

H3l: Familiarity with others will positively influence attitude toward using collaboration technology.

Task Characteristics

Task has long been recognized as an important factor affecting performance (i.e., usefulness) and satisfaction—i.e., attitude (Dennis et al. 1988, 2001; Fjermestad and Hiltz 1998; 2000; Zigurs and Buckland 1998). There are many ways in which we can examine and describe tasks (Daft and Lengel 1996; McGrath 1981; Zigurs and Buckland 1998). Most studies examining tasks have examined specific tasks or specific task characteristics related to the specific theory and collaboration technology under study (e.g., equivocality, analyzability, complexity). We follow the same approach. Rather than attempting to develop a complete model of tasks, we have chosen to select one task characteristic that should particularly relevant to the specific collaboration technology studied in the this paper: *mobility*. The mobility of a user is the extent to which the tasks performed by that user require him or her to be away from his or her work environment—i.e., to be mobile and out of the office. Highly mobile users will be more efficient and effective when they have access to collaboration technologies designed to support mobile users. This increased efficiency and effectiveness should result in more positive perceptions of usefulness and ease of use. Likewise, highly mobile users will be more satisfied when they have access to collaboration technologies designed to support mobile users and thus, will have more positive attitudes towards using the technology. Therefore, we hypothesize:

H4a: Mobility will positive influence perceived usefulness.

H4b: Mobility will positively influence perceived ease of use.

H4c: Mobility will positively influence attitude toward using collaboration technology.

Summary

Figure 3 presents our research model. We argue that the use of a collaboration technology is affected by the user's perceptions of usefulness and ease of use, along with the user's attitude toward the technology, and the situational characteristic of subjective norm about its use that exist in the user's environment. Perceived usefulness, perceived ease of use, and attitude, in turn, are influenced by *technology characteristics*—i.e., social presence, media richness, immediacy of communication, and concurrency, *individual characteristics*—i.e., demographics, technology expertise, self-efficacy, typing speed, and familiarity with his or her communication partners, and the *task characteristic*—i.e., mobility.

METHOD

There are many possible methods, technologies, and environments in which this research model could be studied. Our study was conducted in Finland. We choose to conduct a survey of the users of one emerging collaboration technology: short message service. In this section, we describe the technology, the participants, the measures, and data collection procedure.

Short Message Service (SMS)

SMS is primarily a mechanism that allows two-way, near real-time communication among people via mobile phones or computers[3] (Doyle 2001). SMS enables users to send short messages (up to 160 characters) 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 be used to leave messages for absent users. SMS use is less intrusive than phone conversations because SMS message exchanges are silent, and less distracting than e-mail because SMS messages are short (Doyle 2001; InfoSyncWorld 2002). One interesting social convention around SMS use is that, in many cases, it socially acceptable—or even expected—to receive and send SMS messages while performing other activities such as being in meetings (Ericsson 2001; InfoSyncWorld 2002). Asia leads the way in terms of the number of SMS exchanged with Europe coming in close second; North America is the laggard in SMS use, although use is rapidly increasing now that technical issues of interoperability have been resolved (Smartmobs 2003).

Participants

The population of interest in this study was SMS users. As noted earlier, we collected our data in Finland. Finland has a high penetration of mobile phones as well as the maturity of SMS use (A. T. Kearney 2002). Data were collected during a one-week period through an active solicitation process from individuals associated with a major university in Finland. The goal was

[3] SMS can also be used for providing automated message services such as, welcome messages, targeted advertising, voice mail notifications and can even support "commerce" applications such as ticket purchases (Doyle 2001). Our focus in this paper is on the use of SMS as a collaboration technology so we excluded non-collaboration-oriented uses of SMS.

to identify a broad range of users to provide variance in terms of gender, age, education, technology experience, and SMS experience. A total of 349 participants provided usable responses. Five hundred paper copies were distributed, 363 responses were received and of these 349 were usable, thus resulting in a return rate of almost 73% and a usable response rate of almost 70%. The average age of participants was 34.3, with a standard deviation of 9.01. Of the 349 participants, 125 (36%) were women.

Measures

The survey instrument used previously validated measures where available. All the items used in this work are shown in the Appendix. The TAM constructs of use[4], perceived usefulness, perceived ease of use, attitude toward using technology, and subjective norm were adapted from prior TAM research (Davis et al. 1989; Taylor and Todd 1995; Venkatesh et al. 2003). Self-efficacy was measured using a scale adapted from Compeau and Higgins (1995). In addition to the above measures, gender, age, technology expertise (years of SMS experience), and typing speed were measured using single items, which were acceptable given the factual nature of these constructs.

The scales related to technology characteristics, individual and group characteristics, and the task characteristic were adapted from the extensive computer-mediated communications literature, where applicable. In particular, the measures for social presence, media richness, and familiarity with others (communication partners) were adapted from Dennis and Kinney (1998) and Carlson and Zmud (1999). No scales were available to measure immediacy, concurrency, or mobility. We created the scales for these three constructs using standard procedures of scale

[4] In addition to data about actual use, qualitative data was also collected on the following aspects of SMS communication: breakdown of common tasks performed while using SMS for communication, e.g., setting up an appointment and a percentage breakdown of use of SMS for work related vs. personal communication. Data on the mobile phone used as well as the service provider used were also collected. However, the results from this data are not reported in this paper.

development. We created several candidate items, which we carefully examined for content validity. A subset of these items were circulated for peer feedback and card sorts in order to arrive at the final set of items that possessed face validity and content validity per the researchers.

Pre-tests and Pilot Study

Two pre-tests of the instrument were conducted to ensure that the measures were applicable in the current context. First, ten individuals (in 2 groups of 5) affiliated with the university were recruited to participate in this pre-test. 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, few questions were re-worded slightly. The updated questionnaire was then validated with the second group of pre-test 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 SMS. We were particularly interested in establishing the reliability and validity of the new scales—immediacy, concurrency, and mobility. The new scales were found to be reliable with Cronbach alpha exceeding .80; the other scales were also highly reliable with similar Cronbach alpha scores. Next, a principal components analysis with varimax rotation was conducted among the multi-item constructs from collaboration technology research—social presence, media richness, immediacy, concurrency, familiarity with others, and mobility. A clean factor structure was obtained with loadings greater than .70 and cross-loadings less than .35, thus supporting convergent and discriminant validity. A similar analysis was conducted among the TAM 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 convergent and discriminant validity of all constructs in a single test using exploratory factor analysis. However, this concern is somewhat alleviated for three reasons: (a) the new scales were developed in the context of collaboration technology research constructs and the likelihood of overlap was more with the constructs in that domain; (b) the technology acceptance constructs and collaboration technology constructs come from very different bodies of research where there has been minimal conceptual overlap thus far; and (c) the entire model and scales will be validated in actual data set using confirmatory factor analysis using the structural equation modeling technique of partial least squares (PLS).

Data Collection Procedure

As noted earlier, due to the need to ensure that our sample was representative of SMS users, we worked in collaboration with individuals affiliated with a leading university in Finland. Study participants were recruited by university administrators from a random list of contacts of the university. Potential participants were provided with paper copies of the survey and asked to return the completed survey to the personnel administering the study within one week. 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. As a result, we are unable to provide details of early and late respondents or non-respondents. Since the responses were received within a week, which is a fairly short amount of time, this issue is somewhat alleviated. Overall, we deemed this tradeoff acceptable in order to collect data from a "real-world sample." Any response biases are also somewhat alleviated given the high response rate of nearly 73% return rate and 70% usable response rate.

RESULTS

PLS Graph, Version 2.91.03.04 was used to analyze the data. PLS was preferred given the size of our sample relative to the number of items, latent variables, and relationships. Further, the use of formative indicators for one of the variables—i.e., technology use—required the use of a structural equation modeling technique. The first step was to examine reliability and validity through the measurement model. The internal consistency reliabilities (ICR) were .70 or greater for all relevant scales, thus supporting reliability. The loadings of all items on their constructs were greater than .70 and the cross-loadings were lower than .30 in all cases, thus providing evidence of convergent and discriminant validity. Technology use was modeled using formative indicators and the weights were found in the range of .32 to .53. Finally, the average variance extracted (AVE) for each construct modeled using reflective indicators was also in excess of .70 and they exceeded all inter-construct correlations. The descriptive statistics, ICRs, AVEs, and correlations are shown in Table 1.

Table 1. Descriptive Statistics, ICRs, AVEs, and Correlations

		Mean	Std	ICR	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
1	Age	28.27	9.44	N/A	N/A															
2	Gender	N/A	N/A	N/A	-0.03	N/A														
3	SMS Experience	4.49	1.94	N/A	0.02	0.09	N/A													
4	Typing Speed	3.97	1.66	N/A	-.21***	-.17**	.11*	N/A												
5	Self- efficacy	5.36	1.26	0.74	-.30***	0.00	.22***	.28***	0.79											
6	Media Richness	3.60	1.18	0.71	-.19***	-.08	0.05	.30***	.15**	0.73										
7	Familiarity with Others	4.95	1.16	0.70	-.36***	-.10	0.15**	.35***	.44***	.36***	0.71									
8	Social Richness	3.58	1.32	0.86	-.16**	-.17**	-.03	.24***	-.01	.57***	.34***	0.79								
9	Mobility	3.72	1.28	0.71	0.10	-.12*	0.03	0.05	0.05	.23***	0.07	.14**	0.73							
10	Immediacy	5.02	1.03	0.75	0.01	-.22***	0.10	.26***	.28***	.36***	.40***	.36***	0.10	0.81						
11	Concurrency	5.07	1.36	0.87	-.27***	-.13*	.15**	.43***	.57***	.26***	.44***	.13*	0.08	.37***	0.85					
12	Perceived Usefulness	4.45	1.21	0.89	-.17**	-.10	0.05	.28***	.24***	.45***	.34***	.41***	.23***	.50***	.31***	0.92				
13	Perceived Ease of Use	5.59	1.18	0.87	-.20***	-.19***	.25***	.41***	.57***	.23***	.47***	.11*	0.09	.46***	.57***	.33***	0.83			
14	Subjective Norm	3.77	1.34	0.78	-.08	-.16**	-.03	.16**	.13*	.37***	.27***	.44***	.30***	.39***	.15**	.51***	.16**	0.79		
15	Attitude	4.88	1.23	0.81	-.19***	-.17**	0.07	.36***	.30***	.45***	.52***	.51***	.15**	.59***	.39***	.61***	.50***	.41***	0.88	
16	Use	N/A	N/A	N/A	-.29***	-.19***	.23***	.38***	.29***	.41***	.42***	.38***	.16**	.45***	.34***	.57***	.42***	.33***	.57***	N/A

Notes:
1. ICR: Internal consistency reliability.
2. Diagonal elements are AVEs. Off-diagonal elements are correlations.
3. * p<.05; ** p<.01; *** p<.001.

The results from the analysis of the structural model are shown in Table 2. The various predictors in the model had a significant influence on the dependent variables. The variance in technology use explained by the TAM constructs was .49 and consistent with much prior technology adoption research (see Venkatesh et al. 2003). Perceived usefulness was predicted by task and technology characteristics, with the variance explained being about .39. Perceived ease of use was predicted most strongly by individual characteristics (see Venkatesh 2000) and technology characteristics as predicted in our model, with the variance explained being .50. Finally, the predictors of attitude were the beliefs in TAM (Davis et al. 1989), technology characteristics, and one individual characteristic, as predicted in our model, with the variance explained being .60.

Table 2. Structural Model Results

Dependent Variable	R^2	Independent Variables		Beta
Use	0.49	TAM Variables	Perceived Usefulness	.34***
			Perceived Ease of Use	.18**
			Attitude	.27***
			Subjective Norm	.02
Perceived Usefulness	0.39	Individual Characteristics	Age	-.09
			Gender	.04
			Self Efficacy	.04
			Typing Speed	.04
			Experience with SMS	-.02
			Familiarity with Others	.02
		Task Characteristics	Mobility	.15**
		Technology Characteristics	Social Presence	.12*
			Media Richness	.18**
			Immediacy	.33***
			Concurrency	.04
		TAM Variables	Perceived Ease of Use	.04
Perceived Ease of Use	0.50	Individual Characteristics	Age	-.03
			Gender	-.10*
			Self Efficacy	.27***
			Typing Speed	.13**
			Experience with SMS	.11*
			Familiarity with Others	.13*
		Task Characteristics	Mobility	.02
		Technology Characteristics	Social Presence	-.11*
			Media Richness	.01
			Immediacy	.23***
			Concurrency	.18**
Attitude	0.60	Individual Characteristics	Age	.00
			Gender	.01
			Self Efficacy	-.02
			Typing Speed	.05
			Experience with SMS	-.03
			Familiarity with Others	.15**
		Task Characteristics	Mobility	.00
		Technology Characteristics	Social Presence	.24***
			Media Richness	-.02
			Immediacy	.21***
			Concurrency	.01
		TAM Variables	Perceived Usefulness	.28***
			Perceived Ease of Use	.22***

*Note: * p<.05; ** p<.01; *** p<.001.*

H1(a) through H1(g) presented the various TAM hypotheses. With the exception of H1(c) and H1(g), the TAM hypotheses were supported. Of the proposed predictors of use, consistent with expectations and prior research, perceived usefulness was the strongest predictor. Also, as hypothesized, attitude and perceived usefulness had a direct effect on use. Among the different hypothesized predictors of use, only subjective norm was not significant. This non-significant relationship could likely be due to the greater level of familiarity and experience with the target technology, which is consistent with some prior empirical findings that revealed subjective norm to be non-significant after users had acquired a few months of experience with the target technology (see Venkatesh et al. 2003).

H2(a) through H2(l) presented the various hypotheses that tied the collaboration technology characteristics as experienced by the user—social presence, media richness, immediacy, and concurrency—to the TAM constructs of perceived usefulness, perceived ease of use, and attitude toward using technology. Most of these hypotheses were also supported. Specifically, social presence, media richness, and immediacy predicted perceived usefulness; social presence, immediacy, and concurrency predicted perceived ease of use; social presence and immediacy predicted attitude. Of these, the one surprising direction was the negative effect of social presence on perceived ease of use.

H3(a) through H3(l) presented the various hypotheses relating individual and group characteristics—technology expertise, self-efficacy, typing speed, and familiarity with others—to the three TAM constructs. These hypotheses were less supported, with predictors being significant in predicting perceived ease of use only, consistent with the theoretical underpinnings of the construct (see Venkatesh 2000). The only other significant effect was the prediction of attitude by familiarity. None of the individual characteristics predicted *attitude toward using* *technology*. This pattern was quite likely due to the full mediation of those effects primarily by perceived ease of use. Among the demographic variables of gender and age, gender was the only significant predictor and even there, only had an influence on perceived ease of use.

Finally, H4(a) through H4(c) presented hypotheses relating one task characteristic—mobility—to the TAM constructs. H4(a) that tied mobility to perceived usefulness was the only one of the three supported.

DISCUSSION

The key objective of this work was to develop and test a model of the adoption/use of collaborative technologies by incorporating both perceptual and technological characteristics such that it is applicable to the class of technologies under examination, i.e., collaborative technologies. Specifically, the model integrated TAM (Davis et al. 1989; Venkatesh and Davis 2000) with constructs tied to an integrated framework of collaboration technology research (Dennis et al. 1998). The validity of the model was established via a study of SMS as the target collaboration technology, thus revealing some unique findings related to SMS and similar synchronous communication technologies, and some findings that generalize to the broad class of collaboration technologies. In addition to overall support for the model, there were several interesting findings—some consistent with prior research, others consistent with our model, and a few surprising ones. In the remainder of this section, we discuss the limitations, scientific contributions and implications, and practical implications of our work.

Scientific Contributions and Implications

Our study makes several important general contributions to IS research. Integrating two of the most dominant streams of research in IS—TAM and collaboration technology research—is a key contribution. This work responds to call for such work by recent articles that have provided an in-depth analysis of the directions for future work in IS (Benbasat and Zmud 2002; Orlikowski and Iacono 2001; Venkatesh et al. 2003). An even more general contribution, we hope, is that this paper serves as an important exemplar 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 ever *International Conference on Information Systems (ICIS)* in 1980 (Keen 1980). While TAM and its generalizability have not been in doubt for some years now, its robustness is furthered here by tying the TAM constructs to important constructs from collaboration technology research.

The proposed model here integrated constructs from TAM with theories related to collaboration technology research—social presence theory, media richness theory (and its descendents such as channel expansion theory), and the task closure model. We identified specific constructs within each of four sets of characteristics—technology, individual and group, task, and situation. In the process, we developed the conceptualization and scales for three new constructs—immediacy, concurrency, and mobility—related to collaboration technology that was suited particularly to the emerging context of wireless communication tools. Thus, in addition to contributing by developing an integrated model of adoption of collaboration technology, the current work contributes to research in the domain of collaboration technology.

The results presented in Table 2 are consistent with prior literature on TAM constructs and provide additional evidence regarding the generalizability of these constructs. The TAM relationships held true with two exceptions. It is possible that subjective norm did not play a role because the sample in this study had significant prior experience with using SMS and in such cases, as we discussed earlier in the paper, subjective norm has typically been non-significant (see Venkatesh and Davis 2000; Venkatesh and Morris 2000). This pattern has been borne out in the context of collaboration technology research as well (see Carlson and Zmud 1999). The other non-significant relationship is from perceived ease of use to perceived usefulness, a relationship that likely was the casualty of shared variance across the various determinants of perceived usefulness. Unlike much other TAM and technology adoption research (e.g., Venkatesh et al. 2003), we found attitude to also be significant even though perceived usefulness and perceived ease of use were included as predictors. This is consistent with our theorization that effectiveness (usefulness), efficiency (ease of use), and attitude (satisfaction) will jointly determine collaboration technology use.

Immediacy of communication was the most significant predictor of perceived usefulness, thus suggesting that the ability to communicate quickly with others is a key driver behind the widespread use of SMS technology. Another important finding was regarding the relationship between perceived media richness and perceived usefulness as well the somewhat weaker link between social presence and perceived usefulness. These results serve to confirm prior findings in the literature that suggest that people can overcome limitations of the media (e.g., low media richness or social presence) and successfully communicate very personal information and develop personal relationships (Walther and Burgoon 1992).

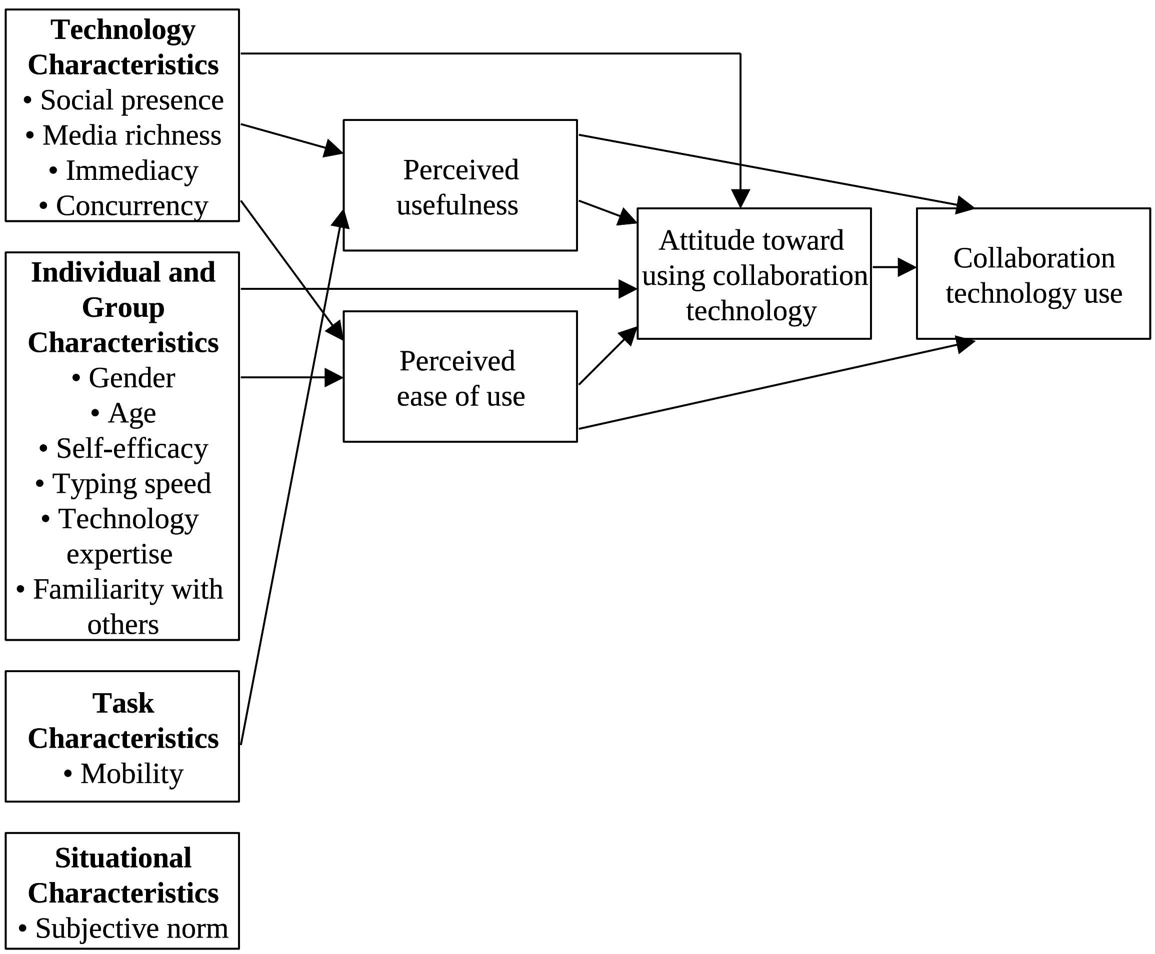
The above results also suggest that while the traditional constructs of social presence and media richness are key characteristics in predicting usefulness of collaboration technologies, they are not the only predictors. Researchers should also consider the role that immediacy plays in predicting usefulness of a collaborative technology, especially as new tools continue to emerge and existing tools continue to evolve. There have been a number of synchronous communication tools with significant impact on the way communication takes place—however, the subtleties associated with using synchronous communication tools (such as instant messaging) more like asynchronous tools, e.g., by not responding immediately should be explored and understood more fully. A final observation that needs to be made here is the effect of, mobility, a task characteristic specific to the context studied, as a predictor of perceived usefulness. This last result suggests that SMS represents a viable complement to other modes of "connected" communication, such as email, especially when the user is out of the office.

The key predictors of perceived ease of use were individual characteristics, specifically, self-efficacy and typing speed. This suggests that increasing familiarity with the use of mobile phones and in particular getting users used to typing using the limited input capabilities of the mobile phone keypad are important to overcoming the ease of use issues usually associated with mobile phone technologies (Buchanan, Farant, Jones, Thimbelby, Marsden, and Pazzani 2001). Familiarity with others was also a weak predictor of ease of use, thus highlighting the community-oriented nature of the technology. Both immediacy and concurrency emerged as predictors of perceived ease of use, likely due to the extent to which communication is instantaneous and being conducted as the same as other activities create the perception of little effort. While immediacy is a construct that is generic to all classes of collaborative technologies concurrency is something that is more specific to SMS use. Thus, as with perceived usefulness, these results highlight the need to use generic and context-specific characteristics in technology adoption studies.

As noted previously, consistent with prior literature, TAM constructs were strong predictors of attitude in our study. In addition, immediacy and social presence as well as familiarity with others strongly influenced attitude. Clearly, social presence presents an aspect of affective reactions that are not captured by the effectiveness and efficiency dimensions. Similarly, the partial mediation of the effect of immediacy on attitude by perceived usefulness and perceived ease of use is due to the affective response to the ability to communicate immediately that extends beyond effectiveness and the efficiency implications of immediacy.

Based on the findings, we conclude with Figure 4 as the final, revised model of collaboration technology use.

Figure 4. Final Model



There are some important implications for IS research from such investigations of the IT artifact (see Benbasat and Zmud 2002). Even as we developed the model and examined our findings, as noted earlier, we identified some findings that were perhaps unique to collaboration technologies and some that were perhaps unique to SMS. While this furthers our understanding of the use of this specific class of technology—i.e., collaboration technology—and the particular technology—SMS, it raises issues related to science vs. consulting (business problem-solving). One of the major strengths of theories and models such as TAM is their ability to be applicable across a wide variety of settings, including technologies. However, as theories become more focused on specific IT artifacts and nuances of such technologies, their generalizability becomes limited, even though it is more applicable to the specific class of technology under investigation. While the specificity of the model is a strength of the current work, IS researchers need to consider where the line must be drawn to distinguish between general, broad theories and theories tailored to specific artifacts.

Limitations and Future Research Directions

Some limitations and associated future research directions should be noted. Although data were gathered from a real-world sample, the possibility of selection bias cannot be ruled out. However, the high response rate alleviates this concern to some extent. The study was conducted in Finland, a country at the cutting-edge in terms of mobile technologies, applications, and use. The generalizability to other countries, however, must be examined. 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 study is conducted in less developed countries, the pattern of findings and/or pertinent constructs may be entirely different. This calls for research to address the issue by an examination of the deeper cross-cultural generalizability issues. One other limitation is the cross-sectional nature of the study. Future research should be conducted to test the model longitudinally. However, this concern is alleviated to some extent as the TAM constructs have been shown to influence technology use in longitudinal studies (e.g., Venkatesh and Morris 2000; Venkatesh et al. 2003).

Some additional future research directions should be noted. Even as we discussed our theory, we noted the potential for different moderators. We emphasize that as an important direction for future research to help us reach a more comprehensive model of use of collaboration technology. We used a few candidate constructs in each of the four characteristics. Future research is necessary to identify other potential constructs. This is particularly pertinent as some of the hypothesized relationships were non-significant. Of the four sets of characteristics, perhaps, the weakest in our model are situational characteristics since we used only one situational variable here. Further work is necessary to identify other appropriate situational variables.

We studied a particular collaboration technology and the generalizability to other collaboration technologies merits attention. Perhaps, one of the most critical future research endeavors that we recommend is an examination of the use of collaboration technologies in organizational settings. It will be important to examine the generalizability of this model of general collaboration technology use to that context while being sensitive to specific organizational context variables as recommended by Dennis et al. (1998). We conceptualized collaboration technology use quite broadly and further work is necessary to possibly separate work use from leisure use and examine these determinants given that some recent work has shown that determinants of these two types of use can be quite different (see Venkatesh and Brown 2001; Venkatesh et al. 2003).

Implications for Practice

A key finding in our study is regarding the overwhelming importance of immediacy, i.e., the ability to achieve near real-time communication on usefulness and ease-of-use perceptions of SMS. This combined with the importance of being able to attend to an SMS concurrent with performing other tasks indicates a huge growth potential for SMS, especially as the percentage of users with SMS enabled mobile phones grows. If one were to draw a parallel to Instant Message, another technology that has potentially increased in popularity due to its "immediacy" characteristics, then SMS is likely to establish a strong foothold in communications within corporations in addition to use for social communications. This will bring with it the concerns regarding of security and traceability of SMS messages. Thus, carriers would be well advised to pay close attention to some of these problems now.

Another interesting observation from our study is the relatively low mean value for richness perceptions of SMS as a communications medium. From a practical perspective, this provides significant hope for the potential penetration of Multimedia Messaging Service (MMS). MMS has many of the same characteristics as SMS but provides a richer communications experience. Our data suggests that such a richer experience is likely to be perceived as being more useful than SMS. A key issue, however, is that in providing this service the carriers should ensure that the immediacy aspect of the technology is not comprised. For example, they need to ensure that their networks are capable of receiving and sending the larger MMS messages as fast as they are able to send SMS messages before marketing service on a large scale.

Another interesting finding is regarding the role of self-efficacy on ease of use perceptions. Our results suggest that users comfortable with using mobile phones in general and SMS in particular have positive perceptions of ease of use, despite the limitations of the device such as smaller keyboard, screen size etc. This suggests that if SMS has to catch on in the United States, vendors need to find ways to provide users with exposure to this technology. Encouraging the use of SMS to cast votes during the American Idol season (AT & T Wireless 2003) is clearly a step in the right direction. In addition, it likely that younger users, who tend to be more comfortable with technology, will lead the way, and should hence be targeted by mobile phone vendors. Evidence regarding this is already emerging. For example, Mobinet (2002) shows that SMS use is highest among users in the 18-24 age group.

CONCLUSIONS

In this paper, we developed and validated a model of the use of collaborative technologies. The model was developed by integrating TAM constructs with existing and new constructs, drawn from media choice theories, applicable to the general class of collaboration technologies. The model itself was validated in the context of an emerging technology, SMS. The results from our study have several important implications for research on collaboration technologies and provide practical guidelines regarding collaboration technology use in general and SMS use in particular. As far as we are aware, our study represents the first attempt to integrate these two dominant streams of IS research. We hope that this paper paves the way for future studies in this critical area.

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APPENDIX: CONSTRUCTS AND MEASURES

Use

On average, how many SMS messages do you send per day for communication? ________
On average, how many SMS messages do you receive per day for communication? ________
On average, how much time do you spend each day sending and reading SMS messages for communication? ________
I am a frequent user of SMS for communication.
I consider myself to be a heavy user of SMS for communication.

Perceived Usefulness

I find SMS to be useful for communication.
Using SMS enables me to accomplish everyday tasks more quickly.
Using SMS increases my productivity.

Perceived Ease of Use

Using SMS does not require a lot of mental effort.
I find SMS to be easy to use.
Using my mobile phone for SMS is easy for me.

Attitude

Using SMS for communication is a good idea.
Working with SMS is fun.
I like using SMS for communication.

SMS Experience

How many years have you used SMS for communication? _____________

Self-efficacy

I can complete an SMS task (e.g., sending message) if there was no one around to tell me what to do.
I can complete an SMS task (e.g., sending message) even if there was not a lot of time to complete it.
I could complete an SMS task (e.g., sending message) if I had just the built-in help facility for assistance.

Typing Speed

I consider my SMS text input speed to be extremely fast.

Familiarity with Others

I feel comfortable discussing personal or private issues with my SMS communication partners.
I feel comfortable using informal communication (such as slang or abbreviations) with my SMS communication partners.
Overall, I feel that I know my SMS communication partners well.

Mobility

I am often away from a computer.
I do not have much time to check e-mail during the day.
I do not have much time to talk to my friends during the day.

Social Presence

Using SMS to interact with others creates a warm environment for communication.
Using SMS to interact with others creates a sociable environment for communication.
Using SMS to interact with others creates a personal environment for communication.

Media Richness

When we disagree, using SMS makes it easy for us (my communication partners and I) to come to agreement.
When we disagree, using SMS helps my communication partner and I to come to a common position.
I can easily communicate ideas using SMS.

Immediacy of Communication

SMS messages enable me to quickly reach communication partners.
When I send someone in SMS message, they usually respond quickly.
When someone sends me an SMS message, I try to respond immediately.

Concurrency

I can easily send SMS messages while participating in other activities.
I can use SMS while performing another task.
I can easily read SMS messages while participating in other activities.

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