User Acceptance of Information Technology: Toward a Unified View

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USER ACCEPTANCE OF INFORMATION TECHNOLOGY: TOWARD A UNIFIED VIEW[1]

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Abstract

Information technology (IT) acceptance research has yielded many competing models, each with different sets of acceptance determinants. In this paper, we (1) review user acceptance literature and discuss eight prominent models, (2) empirically compare the eight models and their extensions, (3) formulate a unified model that integrates elements across the eight models, and (4) empirically validate the unified model. The eight models reviewed are the theory of reasoned action, the technology acceptance model, the motivational model, the theory of planned behavior, a model combining the technology acceptance model and the theory of planned behavior, the model of PC utilization, the innovation diffusion theory, and the social cognitive theory. Using data from four organizations over a six-month period with three points of measurement, the eight models explained between 17 percent and 53 percent of the variance in user intentions to use information technology. Next, a unified model, called the Unified Theory of Acceptance and Use of Technology (UTAUT), was formulated, with four core determinants of intention and usage, and up to four moderators of key relationships. UTAUT was then tested using the original data and found to outperform the eight individual models (adjusted R^2 of 69 percent). UTAUT was then confirmed with data from two new organizations with similar results (adjusted R^2 of 70 percent). UTAUT thus provides a useful tool for managers needing to *assess the likelihood of success for new technology introductions and helps them understand the drivers of acceptance in order to proactively design interventions (including training, marketing, etc.) targeted at populations of users that may be less inclined to adopt and use new systems. The paper also makes several recommendations for future research including developing a deeper understanding of the dynamic influences studied here, refining measurement of the core constructs used in UTAUT, and understanding the organizational outcomes associated with new technology use.*

Keywords: Theory of planned behavior, innovation characteristics, technology acceptance model, social cognitive theory, unified model, integrated model

Introduction

The presence of computer and information technologies in today's organizations has expanded dramatically. Some estimates indicate that, since the 1980s, about 50 percent of all new capital investment in organizations has been in information technology (Westland and Clark 2000). Yet, for technologies to improve productivity, they must be accepted and used by employees in organizations. Explaining user acceptance of new technology is often described as one of the most mature research areas in the contemporary information systems (IS) literature (e.g., Hu et al. 1999). Research in this area has resulted in several theoretical models, with roots in information systems, psychology, and sociology, that routinely explain over 40 percent of the variance in individual intention to use technology (e.g., Davis et al. 1989; Taylor and Todd 1995b; Venkatesh and Davis 2000). Researchers are confronted with a choice among a multitude of models and find that they must "pick and choose" constructs across the models, or choose a "favored model" and largely ignore the contributions from alternative models. Thus, there is a need for a review and synthesis in order to progress toward a unified view of user acceptance.

The current work has the following objectives:

(1) *To review the extant user acceptance models:* The primary purpose of this review is to assess the current state of knowledge with respect to understanding individual acceptance of new information technologies. This review identifies eight prominent models and discusses their similarities and differences. Some authors have previously observed some of the similarities across models.[2] However, our review is the first to assess similarities and differences across all eight models, a necessary first step toward the ultimate goal of the paper: the development of a unified theory of individual acceptance of technology. The review is presented in the following section.

(2) *To empirically compare the eight models:* We conduct a within-subjects, longitudinal validation and comparison of the eight models using data from four organizations. This provides a baseline assessment of the relative explanatory power of the individual models against which the unified model can be compared. The empirical model comparison is presented in the third section.

(3) *To formulate the Unified Theory of Acceptance and Use of Technology (UTAUT):* Based upon conceptual and empirical similarities across models, we formulate a unified model. The formulation of UTAUT is presented in the fourth section.

(4) *To empirically validate UTAUT:* An empirical test of UTAUT on the original data provides preliminary support for our contention that UTAUT outperforms each of the eight original models. UTAUT is then cross-validated using data from two new organizations. The empirical validation of UTAUT is presented in the fifth section.

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[2]For example, Moore and Benbasat (1991) adapted the perceived usefulness and ease of use items from Davis et al.'s (1989) TAM to measure relative advantage and complexity, respectively, in their innovation diffusion model.

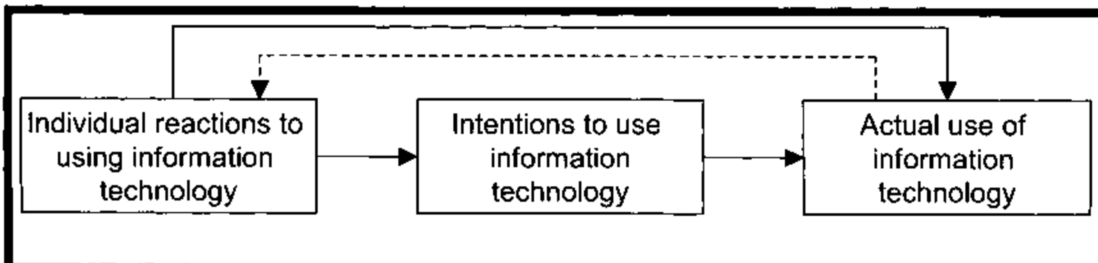

Figure 1. Basic Concept Underlying User Acceptance Models

Review of Extant User Acceptance Models

Description of Models and Constructs

IS research has long studied *how* and *why* individuals adopt new information technologies. Within this broad area of inquiry, there have been several streams of research. One stream of research focuses on individual acceptance of technology by using intention or usage as a dependent variable (e.g., Compeau and Higgins 1995b; Davis et al. 1989). Other streams have focused on implementation success at the organizational level (Leonard-Barton and Deschamps 1988) and task-technology fit (Goodhue 1995; Goodhue and Thompson 1995), among others. While each of these streams makes important and unique contributions to the literature on user acceptance of information technology, the theoretical models to be included in the present review, comparison, and synthesis employ intention and/or usage as the key dependent variable. The goal here is to understand usage as the dependent variable. The role of intention as a predictor of behavior (e.g., usage) is critical and has been well-established in IS and the reference disciplines (see Ajzen 1991; Sheppard et al. 1988; Taylor and Todd 1995b). Figure 1 presents the basic conceptual framework underlying the class of models explaining individual acceptance of information technology that forms the basis of this research. Our review resulted in the identification of eight key competing theoretical models. Table 1 describes the eight models and defines their theorized determinants of intention and/or usage. The models hypothesize between two and seven determinants of acceptance, for a total of 32 constructs across the eight models. Table 2 identifies four key moderating variables (experience, voluntariness, gender, and age) that have been found to be significant in conjunction with these models.

Prior Model Tests and Model Comparisons

There have been many tests of the eight models but there have only been four studies reporting empirically-based comparisons of two or more of the eight models published in the major information systems journals. Table 3 provides a brief overview of each of the model comparison studies. Despite the apparent maturity of the research stream, a comprehensive comparison of the key competing models has not been conducted in a single study. Below, we identify five limitations of these prior model tests and comparisons, and how we address these limitations in our work.

- *Technology studied:* The technologies that have been studied in many of the model development and comparison studies have been relatively simple, individual-oriented information technologies as opposed to more complex and sophisticated organizational technologies that are the focus of managerial concern and of this study.

Table 1. Models and Theories of Individual Acceptance

Theory of Reasoned Action (TRA)	Core Constructs	Definitions
Drawn from social psychology, TRA is one of the most fundamental and influential theories of human behavior. It has been used to predict a wide range of behaviors (see Sheppard et al. 1988 for a review). Davis et al. (1989) applied TRA to individual acceptance of technology and found that the variance explained was largely consistent with studies that had employed TRA in the context of other behaviors.	Attitude Toward Behavior	"an individual's positive or negative feelings (evaluative affect) about performing the target behavior" (Fishbein and Ajzen 1975, p. 216).
	Subjective Norm	"the person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein and Ajzen 1975, p. 302).
Technology Acceptance Model (TAM)		
TAM is tailored to IS contexts, and was designed to predict information technology acceptance and usage on the job. Unlike TRA, the final conceptualization of TAM excludes the attitude construct in order to better explain intention parsimoniously. TAM2 extended TAM by including subjective norm as an additional predictor of intention in the case of mandatory settings (Venkatesh and Davis 2000). TAM has been widely applied to a diverse set of technologies and users.	Perceived Usefulness	"the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis 1989, p. 320).
	Perceived Ease of Use	"the degree to which a person believes that using a particular system would be free of effort" (Davis 1989, p. 320).
	Subjective Norm	Adapted from TRA/TPB. Included in TAM2 only.
Motivational Model (MM)		
A significant body of research in psychology has supported general motivation theory as an explanation for behavior. Several studies have examined motivational theory and adapted it for specific contexts. Vallerand (1997) presents an excellent review of the fundamental tenets of this theoretical base. Within the information systems domain, Davis et al. (1992) applied motivational theory to understand new technology adoption and use (see also Venkatesh and Speier 1999).	Extrinsic Motivation	The perception that users will want to perform an activity "because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions" (Davis et al. 1992, p. 1112).
	Intrinsic Motivation	The perception that users will want to perform an activity "for no apparent reinforcement other than the process of performing the activity per se" (Davis et al. 1992, p. 1112).

Table 1. Models and Theories of Individual Acceptance (Continued)

Theory of Planned Behavior (TPB)	Core Constructs	Definitions
TPB extended TRA by adding the construct of perceived behavioral control. In TPB, perceived behavioral control is theorized to be an additional determinant of intention and behavior. Ajzen (1991) presented a review of several studies that successfully used TPB to predict intention and behavior in a wide variety of settings. TPB has been successfully applied to the understanding of individual acceptance and usage of many different technologies (Harrison et al. 1997; Mathieson 1991; Taylor and Todd 1995b). A related model is the Decomposed Theory of Planned Behavior (DTPB). In terms of predicting intention, DTPB is identical to TPB. In contrast to TPB but similar to TAM, DTPB "decomposes" attitude, subjective norm, and perceived behavioral control into its the underlying belief structure within technology adoption contexts.	Attitude Toward Behavior	Adapted from TRA.
	Subjective Norm	Adapted from TRA.
	Perceived Behavioral Control	"the perceived ease or difficulty of performing the behavior" (Ajzen 1991, p. 188). In the context of IS research, "perceptions of internal and external constraints on behavior" (Taylor and Todd 1995b, p. 149).
Combined TAM and TPB (C-TAM-TPB)		
This model combines the predictors of TPB with perceived usefulness from TAM to provide a hybrid model (Taylor and Todd 1995a).	Attitude Toward Behavior	Adapted from TRA/TPB.
	Subjective Norm	Adapted from TRA/TPB.
	Perceived Behavioral Control	Adapted from TRA/TPB.
	Perceived Usefulness	Adapted from TAM.

Table 1. Models and Theories of Individual Acceptance (Continued)

Model of PC Utilization (MPCU)	Core Constructs	Definitions
Derived largely from Triandis' (1977) theory of human behavior, this model presents a competing perspective to that proposed by TRA and TPB. Thompson et al. (1991) adapted and refined Triandis' model for IS contexts and used the model to predict PC utilization. However, the nature of the model makes it particularly suited to predict individual acceptance and use of a range of information technologies. Thompson et al. (1991) sought to predict usage behavior rather than intention; however, in keeping with the theory's roots, the current research will examine the effect of these determinants on intention. Also, such an examination is important to ensure a fair comparison of the different models.	Job-fit	"the extent to which an individual believes that using [a technology] can enhance the performance of his or her job" (Thompson et al. 1991, p. 129).
	Complexity	Based on Rogers and Shoemaker (1971), "the degree to which an innovation is perceived as relatively difficult to understand and use" (Thompson et al. 1991, p. 128).
	Long-term Consequences	"Outcomes that have a pay-off in the future" (Thompson et al. 1991, p. 129).
	Affect Towards Use	Based on Triandis, affect toward use is "feelings of joy, elation, or pleasure, or depression, disgust, displeasure, or hate associated by an individual with a particular act" (Thompson et al. 1991, p. 127).
	Social Factors	Derived from Triandis, social factors are "the individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations" (Thompson et al. 1991, p. 126).
	Facilitating Conditions	Objective factors in the environment that observers agree make an act easy to accomplish. For example, returning items purchased online is facilitated when no fee is charged to return the item. In an IS context, "provision of support for users of PCs may be one type of facilitating condition that can influence system utilization" (Thompson et al. 1991, p. 129).

Table 1. Models and Theories of Individual Acceptance (Continued)

Innovation Diffusion Theory (IDT)	Core Constructs	Definitions
Grounded in sociology, IDT (Rogers 1995) has been used since the 1960s to study a variety of innovations, ranging from agricultural tools to organizational innovation (Tornatzky and Klein 1982). Within information systems, Moore and Benbasat (1991) adapted the characteristics of innovations presented in Rogers and refined a set of constructs that could be used to study individual technology acceptance. Moore and Benbasat (1996) found support for the predictive validity of these innovation characteristics (see also Agarwal and Prasad 1997, 1998; Karahanna et al. 1999; Plouffe et al. 2001).	Relative Advantage	"the degree to which an innovation is perceived as being better than its precursor" (Moore and Benbasat 1991, p. 195).
	Ease of Use	"the degree to which an innovation is perceived as being difficult to use" (Moore and Benbasat 1991, p. 195).
	Image	"The degree to which use of an innovation is perceived to enhance one's image or status in one's social system" (Moore and Benbasat 1991, p. 195).
	Visibility	The degree to which one can see others using the system in the organization (adapted from Moore and Benbasat 1991).
	Compatibility	"the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters" (Moore and Benbasat 1991, p. 195).
	Results Demon-strability	"the tangibility of the results of using the innovation, including their observability and communicability" (Moore and Benbasat 1991, p. 203).
	Voluntariness of Use	"the degree to which use of the innovation is perceived as being voluntary, or of free will" (Moore and Benbasat 1991, p. 195).

Table 1. Models and Theories of Individual Acceptance (Continued)

Social Cognitive Theory (SCT)	Core Constructs	Definitions
One of the most powerful theories of human behavior is social cognitive theory (see Bandura 1986). Compeau and Higgins (1995b) applied and extended SCT to the context of computer utilization (see also Compeau et al. 1999); while Compeau and Higgins (1995a) also employed SCT, it was to study performance and thus is outside the goal of the current research. Compeau and Higgins' (1995b) model studied computer use but the nature of the model and the underlying theory allow it to be extended to acceptance and use of information technology in general. The original model of Compeau and Higgins (1995b) used usage as a dependent variable but in keeping with the spirit of predicting individual acceptance, we will examine the predictive validity of the model in the context of intention and usage to allow a fair comparison of the models.	Outcome Expectations—Performance	The performance-related consequences of the behavior. Specifically, performance expectations deal with job-related outcomes (Compeau and Higgins 1995b).
	Outcome Expectations—Personal	The personal consequences of the behavior. Specifically, personal expectations deal with the individual esteem and sense of accomplishment (Compeau and Higgins 1995b).
	Self-efficacy	Judgment of one's ability to use a technology (e.g., computer) to accomplish a particular job or task.
	Affect	An individual's liking for a particular behavior (e.g., computer use).
	Anxiety	Evoking anxious or emotional reactions when it comes to performing a behavior (e.g., using a computer).

Table 2. Role of Moderators in Existing Models

Model	Experience	Voluntariness	Gender	Age
Theory of Reasoned Action	Experience was not explicitly included in the original TRA. However, the role of experience was empirically examined using a cross-sectional analysis by Davis et al. (1989). No change in the salience of determinants was found. In contrast, Karahanna et al. (1999) found that attitude was more important with increasing experience, while subjective norm became less important with increasing experience.	Voluntariness was not included in the original TRA. Although not tested, Hartwick and Barki (1994) suggested that subjective norm was more important when system use was perceived to be less voluntary.	N/A	N/A
Technology Acceptance Model (and TAM2)	Experience was not explicitly included in the original TAM. Davis et al. (1989) and Szajna (1996), among others, have provided empirical evidence showing that ease of use becomes nonsignificant with increased experience.	Voluntariness was not explicitly included in the original TAM. Within TAM2, subjective norm was salient only in mandatory settings and even then only in cases of limited experience with the system (i.e., a three-way interaction).	Gender was not included in the original TAM. Empirical evidence demonstrated that perceived usefulness was more salient for men while perceived ease of use was more salient for women (Venkatesh and Morris 2000). The effect of subjective norm was more salient for women in the early stages of experience (i.e., a three-way interaction).	N/A
Motivational Model	N/A	N/A	N/A	N/A

Table 2. Role of Moderators in Existing Models (Continued)

Model	Experience	Voluntariness	Gender	Age
Theory of Planned Behavior	Experience was not explicitly included in the original TPB or DTPB. It has been incorporated into TPB via follow-on studies (e.g., Morris and Venkatesh 2000). Empirical evidence has demonstrated that experience moderates the relationship between subjective norm and behavioral intention, such that subjective norm becomes less important with increasing levels of experience. This is similar to the suggestion of Karahanna et al. (1999) in the context of TRA.	Voluntariness was not included in the original TPB or DTPB. As noted in the discussion regarding TRA, although not tested, subjective norm was suggested to be more important when system use was perceived to be less voluntary (Hartwick and Barki 1994).	Venkatesh et al. (2000) found that attitude was more salient for men. Both subjective norm and perceived behavioral control were more salient for women in early stages of experience (i.e., three-way interactions).	Morris and Venkatesh (2000) found that attitude was more salient for younger workers while perceived behavioral control was more salient for older workers. Subjective norm was more salient to older women (i.e., a three-way interaction).
Combined TAM-TPB	Experience was incorporated into this model in a between-subjects design (experienced and inexperienced users). Perceived usefulness, attitude toward behavior, and perceived behavioral control were all more salient with increasing experience while subjective norm became less salient with increasing experience (Taylor and Todd 1995a).	N/A	N/A	N/A

Table 2. Role of Moderators in Existing Models (Continued)				
Model	**Experience**	**Voluntariness**	**Gender**	**Age**
Model of PC Utilization	Thompson et al. (1994) found that complexity, affect toward use, social factors, and facilitating conditions were all more salient with less experience. On the other hand, concern about long-term consequences became increasingly important with increasing levels of experience.	N/A	N/A	N/A
Innovation Diffusion Theory	Karahanna et al. (1999) conducted a between-subjects comparison to study the impact of innovation characteristics on adoption (no/low experience) and usage behavior (greater experience) and found differences in the predictors of adoption vs. usage behavior. The results showed that for adoption, the significant predictors were relative advantage, ease of use, trialability, results demonstrability, and visibility. In contrast, for usage, only relative advantage and image were significant.	Voluntariness was not tested as a moderator, but was shown to have a direct effect on intention.	N/A	N/A
Social Cognitive Theory	N/A	N/A	N/A	N/A

Table 3. Review of Prior Model Comparisons

Model Comparison Studies	Theories/ Models Compared	Context of Study (Incl. Technology)	Participants	Newness of Technology Studied	Number of Points of Measurement	Cross-Sectional or Longitudinal Analysis	Findings
Davis et al. (1989)	TRA, TAM	Within-subjects model comparison of intention and use of a word processor	107 students	Participants were new to the technology	Two; 14 weeks apart	Cross-sectional analysis at the two points in time	The variance in intention and use explained by TRA was 32% and 26%, and TAM was 47% and 51%, respectively.
Mathieson (1991)	TAM, TPB	Between-subjects model comparison of intention to use a spreadsheet and calculator	262 students	Some familiarity with the technology as each participant had to choose a technology to perform a task	One	Cross-sectional	The variance in intention explained by TAM was 70% and TPB was 62%
Taylor and Todd (1995b)	TAM, TPB/DTPB	Within-subjects model comparison of intention to use a computing resource center	786 students	Many students were already familiar with the center	For a three-month period, all students visiting the center were surveyed—i.e., multiple measures per student.	Cross-sectional	The variance in intention explained by TAM was 52%, TPB was 57%, and DTPB was 60%
Plouffe et al. (2001)	TAM, IDT	Within-subjects model comparison of behavioral intention to use and use in the context of a market trial of an electronic payment system using smart card.	176 merchants	Survey administered after 10 months of use	One	Cross-sectional	The variance in intention explained by TAM was 33% and IDT was 45%

- *Participants:* While there have been some tests of each model in organizational settings, the participants in three of the four model comparison studies have been students—only Plouffe et al. (2001) conducted their research in a nonacademic setting. This research is conducted using data collected from employees in organizations.

- *Timing of measurement:* In general, most of the tests of the eight models were conducted well after the participants' acceptance or rejection decision rather than during the active adoption decision-making process. Because behavior has become routinized, individual reactions reported in those studies are retrospective (see Fiske and Taylor 1991; Venkatesh et al. 2000). With the exception of Davis et al. (1989), the model comparisons examined technologies that were already familiar to the individuals at the time of measurement. In this paper, we examine technologies from the time of their initial introduction to stages of greater experience.

- *Nature of measurement:* Even studies that have examined experience have typically employed cross-sectional and/or between-subjects comparisons (e.g., Davis et al. 1989; Karahanna et al. 1999; Szajna 1996; Taylor and Todd 1995a; Thompson et al. 1994). This limitation applies to model comparison studies also. Our work tracks participants through various stages of experience with a new technology and compares all models on all participants.

- *Voluntary vs. mandatory contexts:* Most of the model tests and all four model comparisons were conducted in voluntary usage contexts.[3] Therefore, one must use caution when generalizing those results to the mandatory settings that are possibly of more interest to practicing managers. This research examines both voluntary and mandatory implementation contexts.

[3]Notable exceptions are TRA (Hartwick and Barki 1994) and TAM2 (Venkatesh and Davis 2000) as well as studies that have incorporated voluntariness as a direct effect (on intention) in order to account for perceived nonvoluntary adoption (e.g., Agarwal and Prasad 1997; Karahanna et al. 1999; Moore and Benbasat 1991).

Empirical Comparison of the Eight Models

Settings and Participants

Longitudinal field studies were conducted at four organizations among individuals being introduced to a new technology in the workplace. To help ensure our results would be robust across contexts, we sampled for heterogeneity across technologies, organizations, industries, business functions, and nature of use (voluntary vs. mandatory). In addition, we captured perceptions as the users' experience with the technology increased. At each firm, we were able to time our data collection in conjunction with a training program associated with the new technology introduction. This approach is consistent with prior training and individual acceptance research where individual reactions to a new technology were studied (e.g., Davis et al. 1989; Olfman and Mandviwalla 1994; Venkatesh and Davis 2000). A pretested questionnaire containing items measuring constructs from all eight models was administered at three different points in time: post-training (T1), one month after implementation (T2), and three months after implementation (T3). Actual usage behavior was measured over the six-month post-training period. Table 4 summarizes key characteristics of the organizational settings. Figure 2 presents the longitudinal data collection schedule.

Measurement

A questionnaire was created with items validated in prior research adapted to the technologies and organizations studied. TRA scales were adapted from Davis et al. (1989); TAM scales were adapted from Davis (1989), Davis et al. (1989),

X	O	X	O	X	O	X	O
Training	User Reactions	System Use	User Reactions/ Usage Measurement	System Use	User Reactions/ Usage Measurement	System Use	Usage Measurement
	1 week		1 month		3 months		6 months

Figure 2. Longitudinal Data Collection Schedule

Table 4. Description of Studies

Study	Industry	Functional Area	Sample Size	System Description
Voluntary Use				
1a	Entertainment	Product Development	54	Online meeting manager that could be used to conduct Web-enabled video or audio conferences in lieu of face-to-face or traditional phone conferences
1b	Telecomm Services	Sales	65	Database application that could be used to access industry standards for particular products in lieu of other resources (e.g., technical manuals, Web sites)
Mandatory Use				
2a	Banking	Business Account Management	58	Portfolio analyzer that analysts were required to use in evaluating existing and potential accounts
2b	Public Administration	Accounting	38	Proprietary accounting systems on a PC platform that accountants were required to use for organizational bookkeeping

and Venkatesh and Davis (2000); MM scales were adapted from Davis et al. (1992); TPB/DTPB scales were adapted from Taylor and Todd (1995a, 1995b); MPCU scales were adapted from Thompson et al. (1991); IDT scales were adapted from Moore and Benbasat (1991); and SCT scales were adapted from Compeau and Higgins (1995a, 1995b) and Compeau et al. (1999). Behavioral intention to use the system was measured using a three-item scale adapted from Davis et al. (1989) and extensively used in much of the previous individual acceptance research. Seven-point scales were used for all of the aforementioned constructs' measurement, with 1 being the negative end of the scale and 7 being the positive end of the scale. In addition to these measures, perceived voluntariness was measured as a manipulation check per the scale of Moore and Benbasat (1991), where 1 was nonvoluntary and 7 was completely voluntary. The tense of the verbs in the various scales reflected the timing of measurement: future tense was employed at T1, present tense was employed at T2 and T3 (see Karahanna et al. 1999). The scales used to measure the key constructs are discussed in a later section where we perform a detailed comparison (Tables 9 through 13). A focus group of five business professionals evaluated the questionnaire, following which minor wording changes were made. Actual usage behavior was measured as duration of use via system logs. Due to the sensitivity of usage measures to network availability, in all organizations studied, the system automatically logged off inactive users after a period of 5 to 15 minutes, eliminating most idle time from the usage logs.

Results

The perceptions of voluntariness were very high in studies 1a and 1b (1a: M = 6.50, SD = 0.22; 1b: M = 6.51, SD = 0.20) and very low in studies 2a and 2b (1a: M = 1.50, SD = 0.19; 1b: M = 1.49, SD = 0.18). Given this bi-modal distribution in the data (voluntary vs. mandatory), we created two data sets: (1) studies 1a and 1b, and (2) studies 2a and 2b. This is consistent with Venkatesh and Davis (2000).

Partial least squares (PLS Graph, Version 2.91.03.04) was used to examine the reliability and validity of the measures. Specifically, 48 separate validity tests (two studies, eight models, three time periods each) were run to examine convergent and discriminant validity. In testing the various models, only the direct effects on intention were modeled as the goal was to examine the prediction of intention rather than interrelationships among determinants of intention; further, the explained variance (R^2) is not affected by indirect paths. The loading pattern was found to be acceptable with most loadings being .70 or higher. All internal consistency reliabilities were greater than .70. The patterns of results found in the current work are highly consistent with the results of previous research.

PLS was used to test all eight models at the three points of measurement in each of the two data sets. In all cases, we employed a bootstrapping method (500 times) that used randomly selected subsamples to test the PLS model.[4] Tables 5 and 6 present the model validation results at *each of the points of measurement*. The tables report the variance explained and the beta coefficients. Key findings emerged from these analyses. First, all eight models explained individual acceptance, with variance in intention explained ranging from 17 percent to 42 percent. Also, a key difference across studies stemmed from the voluntary vs. mandatory settings—in mandatory settings (study 2), constructs related to social influence were significant whereas in the voluntary settings (study 1), they were not significant. Finally, the determinants of intention varied over time, with some determinants going from significant to nonsignificant with increasing experience.

Following the test of the baseline/original specifications of the eight models (Tables 5 and 6), we examined the moderating influences suggested (either explicitly or implicitly) in the literature—i.e., experience, voluntariness, gender, and age (Table 2). In order to test these moderating influences, stay true to the model extensions (Table 2), and conduct a complete test of the existing models and their extensions, the data were pooled across studies and time periods. Voluntariness was a dummy variable used to separate the situational contexts (study 1 vs. study 2); this approach is consistent with previous research (Venkatesh and Davis 2000). Gender was coded as a 0/1 dummy variable consistent with previous research (Venkatesh and Morris 2000) and age was coded as a continuous variable, consistent with prior research (Morris and Venkatesh 2000). Experience was operationalized via a dummy variable that took ordinal values of 0, 1, or 2 to capture increasing levels of user experience with the system (T1, T2, and T3). Using an ordinal dummy variable, rather than categorical variables, is consistent with recent research (e.g., Venkatesh and Davis 2000). Pooling the data across the three points of measurement resulted in a sample of 645 (215 × 3). The results of the pooled analysis are shown in Table 7.

Because pooling across time periods allows the explicit modeling of the moderating role of experience, there is an increase in the variance explained in the case of TAM2 (Table 7) compared to a main effects-only model reported earlier (Tables 5 and 6). One of the limitations of pooling is that there are repeated measures from the

[4]The interested reader is referred to a more detailed exposition of bootstrapping and how it compares to other techniques of resampling such as jackknifing (see Chin 1998; Efron and Gong 1983).

Table 5. Study 1: Predicting Intention in Voluntary Settings							
		Time 1 (N = 119)		Time 2 (N = 119)		Time 3 (N = 119)	
Models	**Independent variables**	R^2	**Beta**	R^2	**Beta**	R^2	**Beta**
TRA	Attitude toward using tech.	.30	.55***	.26	.51***	.19	.43***
	Subjective norm		.06		.07		.08
TAM/ TAM2	Perceived usefulness	.38	.55***	.36	.60***	.37	.61***
	Perceived ease of use		.22**		.03		.05
	Subjective norm		.02		.06		.06
MM	Extrinsic motivation	.37	.50***	.36	.47***	.37	.49***
	Intrinsic motivation		.22**		.22**		.24***
TPB/ DTPB	Attitude toward using tech.	.37	.52***	.25	.50***	.21	.44***
	Subjective norm		.05		.04		.05
	Perceived behavioral control		.24***		.03		.02
C-TAM-TPB	Perceived usefulness	.39	.56***	.36	.60***	.39	.63***
	Attitude toward using tech.		.04		.03		.05
	Subjective norm		.06		.04		.03
	Perceived behavioral control		.25***		.02		.03
MPCU	Job-fit	.37	.54***	.36	.60***	.38	.62***
	Complexity (reversed)		.23***		.04		.04
	Long-term consequences		.06		.04		.07
	Affect toward use		.05		.05		.04
	Social factors		.04		.07		.06
	Facilitating conditions		.05		.06		.04
IDT	Relative advantage	.38	.54***	.37	.61***	.39	.63***
	Ease of use		.26**		.02		.07
	Result demonstrability		.03		.04		.06
	Trialability		.04		.09		.08
	Visibility		.06		.03		.06
	Image		.06		.05		.07
	Compatibility		.05		.02		.04
	Voluntariness		.03		.04		.03
SCT	Outcome expectations	.37	.47***	.36	.60***	.36	.60***
	Self-efficacy		.20***		.03		.01
	Affect		.05		.03		.04
	Anxiety		-.17*		.04		.06

Notes: 1. *p < .05; **p < .01; ***p < .001.
2. When the data were analyzed separately for studies 2a and 2b, the pattern of results was very similar.

Table 6. Study 2: Predicting Intention in Mandatory Settings							
		Time 1 (N = 96)		Time 2 (N = 96)		Time 3 (N = 96)	
Models	**Independent variables**	R^2	**Beta**	R^2	**Beta**	R^2	**Beta**
TRA	Attitude toward using tech.	.26	.27***	.26	.28***	.17	.40***
	Subjective norm		.20**		.21**		.05
TAM/ TAM2	Perceived usefulness	.39	.42***	.41	.50***	.36	.60***
	Perceived ease of use		.21*		.23**		.03
	Subjective norm		.20*		.03		.04
MM	Extrinsic motivation	.38	.47***	.40	.49***	.35	.44***
	Intrinsic motivation		.21**		.24**		.19**
TPB/ DTPB	Attitude toward using tech.	.34	.22*	.28	.36***	.18	.43***
	Subjective norm		.25***		.26**		.05
	Perceived behavioral control		.19*		.03		.08
C-TAM-TPB	Perceived usefulness	.36	.42***	.35	.51***	.35	.60***
	Attitude toward using tech.		.07		.08		.04
	Subjective norm		.20*		.23**		.03
	Perceived behavioral control		.19*		.11		.09
MPCU	Job-fit	.37	.42***	.40	.50***	.37	.61***
	Complexity (reversed)		.20*		.02		.04
	Long-term consequences		.07		.07		.07
	Affect toward use		.01		.05		.04
	Social factors		.18*		.23**		.02
	Facilitating conditions		.05		.07		.07
IDT	Relative advantage	.38	.47***	.42	.52***	.37	.61***
	Ease of use		.20*		.04		.04
	Result demonstrability		.03		.07		.04
	Trialability		.05		.04		.04
	Visibility		.04		.04		.01
	Image		.18*		.27**		.05
	Compatibility		.06		.02		.04
	Voluntariness		.02		.06		.03
SCT	Outcome expectations	.38	.46***	.39	.44***	.36	.60***
	Self-efficacy		.19**		.21***		.03
	Affect		.06		.04		.05
	Anxiety		-.18*		-.16*		.02

Notes: 1. *p < .05; **p < .01; ***p < .001.
2. When the data were analyzed separately for studies 2a and 2b, the pattern of results was very similar.

Table 7. Predicting Intention—Model Comparison Including Moderators: Data Pooled Across Studies (N = 645)

Model	Version	Independent Variables	R^2	Beta	Explanation
TRA	1	Attitude (A)	.36	.41***	Direct effect
		Subjective norm (SN)		.11	
		Experience (EXP)		.09	
		Voluntariness (VOL)		.04	
		A × EXP		.03	
		SN × EXP		-.17*	Effect decreases with increasing experience
		SN × VOL		.17*	Effect present only in mandatory settings
TAM	2a TAM2	Perceived usefulness (U)	.53	.48***	Direct effect
		Perceived ease of use (EOU)		.11	
		Subjective norm (SN)		.09	
		Experience (EXP)		.06	
		Voluntariness (VOL)		.10	
		EOU × EXP		-.20**	Effect decreases with increasing experience
		SN × EXP		-.15	
		SN × VOL		-.16*	Cannot be interpreted due to presence of higher-order term
		EXP × VOL		.07	
		SN × EXP × VOL		-.18**	Effect exists only in mandatory settings but decreases with increasing experience
	2b TAM incl. gender	Perceived usefulness (U)	.52	.14*	Cannot be interpreted due to presence of interaction term
		Percd. ease of use (EOU)		.08	
		Subjective norm (SN)		.02	
		Gender (GDR)		.11	
		Experience (EXP)		.07	
		U × GDR		.31***	Effect is greater for men
		EOU × GDR		-.20**	Effect is greater for women
		SN × GDR		.11	
		SN × EXP		.02	
		EXP × GDR		.09	
		SN × GDR × EXP		.17**	Effect is greater for women but decreases with increasing experience

Table 7. Predicting Intention—Model Comparison Including Moderators: Data Pooled Across Studies (N = 645) (Continued)

Model	Version	Independent Variables	R^2	Beta	Explanation
MM	3	Extrinsic motivation	.38	.50***	Direct effect
		Intrinsic motivation		.20***	Direct effect
TPB/ DTPB	4a TPB incl. vol	Attitude (A)	.36	.40***	Direct effect
		Subjective norm (SN)		.09	
		Percd. behrl. control (PBC)		.13	
		Experience (EXP)		.10	
		Voluntariness (VOL)		.05	
		SN × EXP		-.17**	Effect decreases with increasing experience
		SN × VOL		.17**	Effect present only in mandatory settings
	4b TPB incl. gender	Attitude (A)	.46	.17***	Cannot be interpreted due to presence of interaction term
		Subjective norm (SN)		.02	
		Percd. behrl. control (PBC)		.10	
		Gender (GDR)		.01	
		Experience (EXP)		.02	
		A × GDR		.22***	Effect is greater for men
		SN × EXP		-.12	
		SN × GDR		.10	
		PBC × GDR		.07	
		PBC × EXP		.04	
		GDR × EXP		.15*	Term included to test higher-order interactions below
		SN × GDR × EXP		-.18**	Both SN and PBC effects are higher for women, but the effects decrease with increasing experience
		PBC × GDR × EXP		-.16*	
	4c TPB incl. age	Attitude (A)	.47	.17***	Cannot be interpreted due to presence of interaction term
		Subjective norm (SN)		.02	
		Percd. behrl. control (PBC)		.10	
		Age (AGE)		.01	
		Experience (EXP)		.02	
		A × AGE		-.26***	Effect is greater for younger workers
		SN × EXP		-.03	
		SN × AGE		.11	
		PBC × AGE		.21**	Effect is greater for older workers

Table 7. Predicting Intention—Model Comparison Including Moderators: Data Pooled Across Studies (N = 645) (Continued)

Model	Version	Independent Variables	R^2	Beta	Explanation
		AGE × EXP		.15*	Term included to test higher-order interaction below
		SN × AGE × EXP		-.18**	Effect is greater for older workers, but the effect decreases with increasing experience
C-TAM-TPB	5	Perceived usefulness (U)	.39	.40***	Direct effect
		Attitude (A)		.09	
		Subjective norm (SN)		.08	
		Perceived beholder control (PBC)		.16*	Cannot be interpreted due to presence of interaction term
		Experience (EXP)		.11	
		U × EXP		.01	
		A × EXP		.08	
		SN × EXP		-.17*	Effect decreases with increasing experience
		PBC × EXP		-.19**	Effect decreases with increasing experience
MPCU	6	Job-fit (JF)	.47	.40***	Direct effect
		Complexity (CO) (reversed)		.07	
		Long-term consequences (LTC)		.02	
		Affect toward use (ATU)		.05	
		Social factors (SF)		.10	
		Facilitating condns. (FC)		.07	
		Experience (EXP)		.08	
		CO × EXP (CO—reversed)		-.17*	Effect decreases with increasing experience
		LTC × EXP		.02	
		ATU × EXP		.01	
		SF × EXP		-.20**	Effect decreases with increasing experience
		FC × EXP		.05	
IDT	7	Relative advantage (RA)	.40	.49***	Direct effect
		Ease of use (EU)		.05	
		Result demonstrability (RD)		.02	
		Trialability (T)		.04	
		Visibility (V)		.03	
		Image (I)		.01	
		Compatibility (COMPAT)		.06	
		Voluntariness of use (VOL)		.11	

Table 7. Predicting Intention—Model Comparison Including Moderators: Data Pooled Across Studies (N = 645) (Continued)

Model	Version	Independent Variables	R^2	Beta	Explanation
		Experience (EXP)		.03	
		EU × EXP		-.16*	Effect decreases with increasing experience
		RD × EXP		.03	
		V × EXP		-.14*	Effect decreases with increasing experience
		I × EXP		-.14*	Effect decreases with increasing experience
		Voluntariness of use (VOL)		.05	
SCT	8	Outcome expectations	.36	.44***	Direct effect
		Self-efficacy		.18*	Direct effect
		Affect		.01	
		Anxiety		-.15*	Direct effect

Notes: 1. *p < .05; **p < .01; ***p < .001.
2. The significance of the interaction terms was also verified using Chow's test.

same individuals, resulting in measurement errors that are potentially correlated across time. However, cross-sectional analysis using Chow's (1960) test of beta differences (p < .05) from each time period (not shown here) confirmed the pattern of results shown in Table 7. Those beta differences with a significance of p < .05 or better (when using Chow's test) are discussed in the "Explanation" column in Table 7. The interaction terms were modeled as suggested by Chin et al. (1996) by creating interaction terms that were at the level of the indicators. For example, if latent variable A is measured by four indicators (A1, A2, A3, and A4) and latent variable B is measured by three indicators (B1, B2, and B3), the interaction term A × B is specified by 12 indicators, each one a product term—i.e., A1 × B1, A1 × B2, A1 × B3, A2 × B1, etc.

With the exception of MM and SCT, the predictive validity of the models increased after including the moderating variables. For instance, the variance explained by TAM2 increased to 53 percent and TAM including gender increased to 52 percent when compared to approximately 35 percent in cross-sectional tests of TAM (without moderators). The explained variance of TRA, TPB/DTPB, MPCU, and IDT also improved. For each model, we have only included moderators previously tested in the literature. For example, in the case of TAM and its variations, the extensive prior empirical work has suggested a larger number of moderators when compared to moderators suggested for other models. This in turn may have unintentionally biased the results and contributed to the high variance explained in TAM-related models when compared to the other models. Regardless, it is clear that the extensions to the various models identified in previous research mostly enhance the predictive validity of the various models beyond the original specifications.

In looking at technology use as the dependent variable, in addition to intention as a key predictor, TPB and DTPB employ perceived behavioral control as an additional predictor. MPCU employs facilitating conditions, a construct similar to perceived behavioral control, to predict behavior. Thus, intention and perceived behavioral control were used to predict behavior in the subsequent

Table 8. Predicting Usage Behavior

		Use_{12}		Use_{23}		Use_{34}	
	Independent Variables	R^2	**Beta**	R^2	**Beta**	R^2	**Beta**
Studies 1a and 1b (voluntary) (N=119)	Behavioral intention to use (BI)	.37	.61***	.36	.60***	.39	.58***
	Perceived behavioral control (PBC)		.04		.06		.17*
Studies 2a and 2b (mandatory) (N = 96)	Behavioral intention to use (BI)	.35	.58***	.37	.61***	.39	.56***
	Perceived behavioral control (PBC)		.07		.07		.20*

Notes: 1. BI, PBC measured at T1 were used to predict usage between time periods 1 and 2 (denoted Use_{12}); BI, PBC measured at T2 were used to predict usage between time periods 2 and 3 (Use_{23}); BI, PBC measured at T3 were used to predict usage between time periods 3 and 4 (Use_{34}).
2. *p < .05; **p < .01; ***p < .001.

time period: intention from T1 was used to predict usage behavior measured between T1 and T2 and so on (see Table 8). Since intention was used to predict actual behavior, concerns associated with the employment of subjective measures of usage do not apply here (see Straub et al. 1995). In addition to intention being a predictor of use, perceived behavioral control became a significant direct determinant of use over and above intention with increasing experience (at T3) indicating that continued use could be directly hindered or fostered by resources and opportunities. A nearly identical pattern of results was found when the data were analyzed using facilitating conditions (from MPCU) in place of perceived behavioral control (the specific results are not shown here).

Having reviewed and empirically compared the eight competing models, we now formulate a unified theory of acceptance and use of technology (UTAUT). Toward this end, we examine commonalities across models as a first step. Tables 5, 6, 7, and 8 presented cross-sectional tests of the baseline models and their extensions. Several consistent findings emerged. First, for every model, there was at least one construct that was significant in all time periods and that construct also had the strongest influence—e.g., attitude in TRA and TPB/DTPB, perceived usefulness in TAM/TAM2 and C-TAM-TPB, extrinsic motivation in MM, job-fit in MPCU, relative advantage in IDT, and outcome expectations in SCT. Second, several other constructs were initially significant, but then became nonsignificant over time, including perceived behavioral control in TPB/DTPB and C-TAM-TPB, perceived ease of use in TAM/TAM2, complexity in MPCU, ease of use in IDT, and self-efficacy and anxiety in SCT. Finally, the voluntary vs. mandatory context *did* have an influence on the significance of constructs related to social influence: subjective norm (TPB/DTPB, C-TAM-TPB and TAM2), social factors (MPCU), and image (IDT) were only significant in mandatory implementations.

Formulation of the Unified Theory of Acceptance and Use of Technology (UTAUT)

Seven constructs appeared to be significant direct determinants of intention or usage in one or more of the individual models (Tables 5 and 6). Of these, we theorize that four constructs will play a

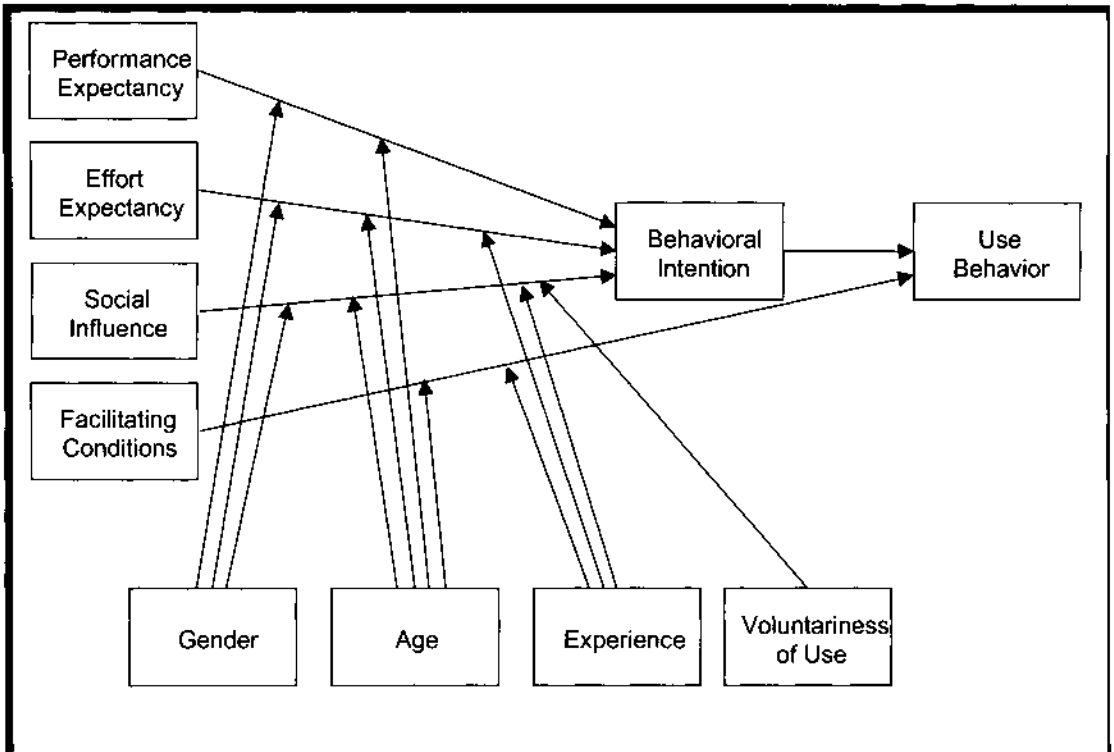

Figure 3. Research Model

significant role as direct determinants of user acceptance and usage behavior: *performance expectancy*, *effort expectancy*, *social influence*, and *facilitating conditions*. As will be explained below, *attitude toward using technology*, *self-efficacy*, and *anxiety* are theorized *not* to be direct determinants of intention. The labels used for the constructs describe the essence of the construct and are meant to be independent of any particular theoretical perspective. In the remainder of this section, we define each of the determinants, specify the role of key moderators (gender, age, voluntariness, and experience), and provide the theoretical justification for the hypotheses. Figure 3 presents the research model.

Performance Expectancy

Performance expectancy is defined as the degree to which an individual believes that using the system will help him or her to attain gains in job performance. The five constructs from the different models that pertain to performance expectancy are perceived usefulness (TAM/TAM2 and C-TAM-TPB), extrinsic motivation (MM), job-fit (MPCU), relative advantage (IDT), and outcome expectations (SCT). Even as these constructs evolved in the literature, some authors acknowledged their similarities: usefulness and extrinsic motivation (Davis et al. 1989, 1992), usefulness and job-fit (Thompson et al. 1991), usefulness and relative advantage (Davis et al. 1989; Moore and Benbasat 1991; Plouffe et al. 2001), usefulness and outcome expectations (Compeau and Higgins 1995b; Davis et al. 1989), and job-fit and outcome expectations (Compeau and Higgins 1995b).

The performance expectancy construct within each individual model (Table 9) is the strongest predictor of intention and remains significant at all points of measurement in both voluntary and mandatory settings (Tables 5, 6, and 7), consistent with previous model tests (Agarwal and Prasad

Table 9. Performance Expectancy: Root Constructs, Definitions, and Scales		
Construct	**Definition**	**Items**
Perceived Usefulness (Davis 1989; Davis et al. 1989)	The degree to which a person believes that using a particular system would enhance his or her job performance.	1. Using the system in my job would enable me to accomplish tasks more quickly. 2. Using the system would improve my job performance. 3. Using the system in my job would increase my productivity. 4. Using the system would enhance my effectiveness on the job. 5. Using the system would make it easier to do my job. 6. I would find the system useful in my job.
Extrinsic Motivation (Davis et al. 1992)	The perception that users will want to perform an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions	Extrinsic motivation is operationalized using the same items as perceived usefulness from TAM (items 1 through 6 above).
Job-fit (Thompson et al. 1991)	How the capabilities of a system enhance an individual's job performance.	1. Use of the system will have no effect on the performance of my job (reverse scored). 2. Use of the system can decrease the time needed for my important job responsibilities. 3. Use of the system can significantly increase the quality of output on my job. 4. Use of the system can increase the effectiveness of performing job tasks. 5. Use can increase the quantity of output for the same amount of effort. 6. Considering all tasks, the general extent to which use of the system could assist on the job. (different scale used for this item).

Table 9. Performance Expectancy: Root Constructs, Definitions, and Scales (Continued)

Construct	Definition	Items
Relative Advantage (Moore and Benbasat 1991)	The degree to which using an innovation is perceived as being better than using its precursor.	1. Using the system enables me to accomplish tasks more quickly. 2. Using the system improves the quality of the work I do. 3. Using the system makes it easier to do my job. 4. Using the system enhances my effectiveness on the job. 5. Using the system increases my productivity.
Outcome Expectations (Compeau and Higgins 1995b; Compeau et al. 1999)	Outcome expectations relate to the consequences of the behavior. Based on empirical evidence, they were separated into performance expectations (job-related) and personal expectations (individual goals). For pragmatic reasons, four of the highest loading items from the performance expectations and three of the highest loading items from the personal expectations were chosen from Compeau and Higgins (1995b) and Compeau et al. (1999) for inclusion in the current research. However, our factor analysis showed the two dimensions to load on a single factor.	If I use the system... 1. I will increase my effectiveness on the job. 2. I will spend less time on routine job tasks. 3. I will increase the quality of output of my job. 4. I will increase the quantity of output for the same amount of effort. 5. My coworkers will perceive me as competent. 6. I will increase my chances of obtaining a promotion. 7. I will increase my chances of getting a raise.

1998; Compeau and Higgins 1995b; Davis et al. 1992; Taylor and Todd 1995a; Thompson et al. 1991; Venkatesh and Davis 2000). However, from a theoretical point of view, there is reason to expect that the relationship between performance expectancy and intention will be moderated by *gender* and *age*. Research on gender differences indicates that men tend to be highly task-oriented (Minton and Schneider 1980) and, therefore, performance expectancies, which focus on task accomplishment, are likely to be especially salient to men. Gender schema theory suggests that such differences stem from gender roles and socialization processes reinforced from birth rather than biological gender per se (Bem 1981; Bem and Allen 1974; Kirchmeyer 1997; Lubinski et al. 1983; Lynott and McCandless 2000; Motowidlo 1982). Recent empirical studies outside the

IT context (e.g., Kirchmeyer 2002; Twenge 1997) have shown that gender roles have a strong psychological basis and are relatively enduring, yet open to change over time (see also Ashmore 1990; Eichinger et al. 1991; Feldman and Aschenbrenner 1983; Helson and Moane 1987).

Similar to gender, age is theorized to play a moderating role. Research on job-related attitudes (e.g., Hall and Mansfield 1975; Porter 1963) suggests that younger workers may place more importance on extrinsic rewards. Gender and age differences have been shown to exist in technology adoption contexts also (Morris and Venkatesh 2000; Venkatesh and Morris 2000). In looking at gender and age effects, it is interesting to note that Levy (1988) suggests that studies of gender differences can be misleading without reference to age. For example, given traditional societal gender roles, the importance of job-related factors may change significantly (e.g., become supplanted by family-oriented responsibilities) for working women between the time that they enter the labor force and the time they reach child-rearing years (e.g., Barnett and Marshall 1991). Thus, we expect that the influence of performance expectancy will be moderated by both *gender* and *age*.

> *H1: The influence of performance expectancy on behavioral intention will be moderated by* ***gender*** *and* ***age****, such that the effect will be stronger for men and particularly for younger men.*

Effort Expectancy

Effort expectancy is defined as the degree of ease associated with the use of the system. Three constructs from the existing models capture the concept of effort expectancy: perceived ease of use (TAM/TAM2), complexity (MPCU), and ease of use (IDT). As can be seen in Table 10, there is substantial similarity among the construct definitions and measurement scales. The similarities among these constructs have been noted in prior research (Davis et al. 1989; Moore and Benbasat 1991; Plouffe et al. 2001; Thompson et al. 1991).

The effort expectancy construct within each model (Table 10) is significant in both voluntary and mandatory usage contexts; however, each one is significant only during the first time period (post-training, T1), becoming nonsignificant over periods of extended and sustained usage (see Tables 5, 6, and 7), consistent with previous research (e.g., Agarwal and Prasad 1997, 1998; Davis et al. 1989; Thompson et al. 1991, 1994). Effort-oriented constructs are expected to be be more salient in the early stages of a new behavior, when process issues represent hurdles to be overcome, and later become overshadowed by instrumentality concerns (Davis et al. 1989; Szajna 1996; Venkatesh 1999).

Venkatesh and Morris (2000), drawing upon other research (e.g., Bem and Allen 1974; Bozionelos 1996), suggest that effort expectancy is more salient for *women* than for *men*. As noted earlier, the gender differences predicted here could be driven by cognitions related to gender roles (e.g., Lynott and McCandless 2000; Motowidlo 1982; Wong et al. 1985). Increased *age* has been shown to be associated with difficulty in processing complex stimuli and allocating attention to information on the job (Plude and Hoyer 1985), both of which may be necessary when using software systems. Prior research supports the notion that constructs related to effort expectancy will be stronger determinants of individuals' intention for women (Venkatesh and Morris 2000; Venkatesh et al. 2000) and for older workers (Morris and Venkatesh 2000). Drawing from the arguments made in the context of performance expectancy, we expect gender, age, and experience to work in concert (see Levy 1988). Thus, we propose that effort expectancy will be most salient for *women*, particularly those who are *older* and with relatively little *experience with the system*.

> *H2: The influence of effort expectancy on behavioral intention will be moderated by* ***gender****,* ***age****, and* ***experience****, such that the effect will be stronger for women, particularly younger women, and particularly at early stages of experience.*

Table 10. Effort Expectancy: Root Constructs, Definitions, and Scales

Construct	Definition	Items
Perceived Ease of Use (Davis 1989; Davis et al. 1989)	The degree to which a person believes that using a system would be free of effort.	1. Learning to operate the system would be easy for me. 2. I would find it easy to get the system to do what I want it to do. 3. My interaction with the system would be clear and understandable. 4. I would find the system to be flexible to interact with. 5. It would be easy for me to become skillful at using the system. 6. I would find the system easy to use.
Complexity (Thompson et al. 1991)	The degree to which a system is perceived as relatively difficult to understand and use.	1. Using the system takes too much time from my normal duties. 2. Working with the system is so complicated, it is difficult to understand what is going on. 3. Using the system involves too much time doing mechanical operations (e.g., data input). 4. It takes too long to learn how to use the system to make it worth the effort.
Ease of Use (Moore and Benbasat 1991)	The degree to which using an innovation is perceived as being difficult to use.	1. My interaction with the system is clear and understandable. 2. I believe that it is easy to get the system to do what I want it to do. 3. Overall, I believe that the system is easy to use. 4. Learning to operate the system is easy for me.

Social Influence

Social influence is defined as the degree to which an individual perceives that important others believe he or she should use the new system. Social influence as a direct determinant of behavioral intention is represented as subjective norm in TRA, TAM2, TPB/DTPB and C-TAM-TPB, social factors in MPCU, and image in IDT. Thompson et al. (1991) used the term *social norms* in defining their construct, and acknowledge its similarity to subjective norm within TRA. While they have different labels, each of these constructs contains the explicit or implicit notion that the individual's behavior is influenced by the way in which they believe others will view them as a result of having used the technology. Table 11 presents the three constructs related to social influence: subjective norm (TRA, TAM2, TPB/ DTPB, and C-TAM-TPB), social factors (MPCU), and image (IDT).

The current model comparison (Tables 5, 6, and 7) found that the social influence constructs listed above behave similarly. None of the social influence constructs are significant in voluntary contexts; however, each becomes significant when

Table 11. Social Influence: Root Constructs, Definitions, and Scales

Construct	Definition	Items
Subjective Norm (Ajzen 1991; Davis et al. 1989; Fishbein and Azjen 1975; Mathieson 1991; Taylor and Todd 1995a, 1995b)	The person's perception that most people who are important to him think he should or should not perform the behavior in question.	1. People who influence my behavior think that I should use the system. 2. People who are important to me think that I should use the system.
Social Factors (Thompson et al. 1991)	The individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations.	1. I use the system because of the proportion of coworkers who use the system. 2. The senior management of this business has been helpful in the use of the system. 3. My supervisor is very supportive of the use of the system for my job. 4. In general, the organization has supported the use of the system.
Image (Moore and Benbasat 1991)	The degree to which use of an innovation is perceived to enhance one's image or status in one's social system.	1. People in my organization who use the system have more prestige than those who do not. 2. People in my organization who use the system have a high profile. 3. Having the system is a status symbol in my organization.

use is mandated. Venkatesh and Davis (2000) suggested that such effects could be attributed to compliance in mandatory contexts that causes social influences to have a direct effect on intention; in contrast, social influence in voluntary contexts operates by influencing perceptions about the technology—the mechanisms at play here are internalization and identification. In mandatory settings, social influence appears to be important only in the early stages of individual experience with the technology, with its role eroding over time and eventually becoming nonsignificant with sustained usage (T3), a pattern consistent with the observations of Venkatesh and Davis (2000).

The role of social influence in technology acceptance decisions is complex and subject to a wide range of contingent influences. Social influence has an impact on individual behavior through three mechanisms: compliance, internalization, and identification (see Venkatesh and Davis 2000; Warshaw 1980). While the latter two relate to altering an individual's belief structure and/or causing an individual to respond to potential social status gains, the compliance mechanism causes an individual to simply alter his or her intention in response to the social pressure—i.e., the individual intends to comply with the social influence. Prior research suggests that individuals are more likely to comply with others' expectations when those referent others have the ability to reward the desired behavior or punish nonbehavior (e.g., French and Raven 1959; Warshaw 1980). This view of compliance is consistent with results in the technology acceptance literature indicating that reliance on others' opinions is significant only in *mandatory* settings (Hartwick and Barki 1994), particularly in the early stages of experience, when an individual's opinions are relatively ill-informed (Agarwal and Prasad 1997; Hartwick and Barki 1994; Karahanna et al. 1999; Taylor and Todd 1995a; Thompson et al. 1994; Venkatesh and Davis 2000). This normative pressure will attenuate over time as increasing *experience* provides a more instrumental (rather than social) basis for individual intention to use the system.

Theory suggests that *women* tend to be more sensitive to others' opinions and therefore find social influence to be more salient when forming an intention to use new technology (Miller 1976; Venkatesh et al. 2000), with the effect declining with experience (Venkatesh and Morris 2000). As in the case of performance and effort expectancies, gender effects may be driven by psychological phenomena embodied within socially-constructed gender roles (e.g., Lubinski et al. 1983). Rhodes' (1983) meta-analytic review of age effects concluded that affiliation needs increase with **age**, suggesting that older workers are more likely to place increased salience on social influences, with the effect declining with experience (Morris and Venkatesh 2000). Therefore, we expect a complex interaction with these moderating variables simultaneously influencing the social influence-intention relationship.

> *H3: The influence of social influence on behavioral intention will be moderated by* ***gender***, ***age***, ***voluntariness***, *and* ***experience***, *such that the effect will be stronger for women, particularly older women, particularly in mandatory settings in the early stages of experience.*

Facilitating Conditions

Facilitating conditions are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system. This definition captures concepts embodied by three different constructs: perceived behavioral control (TPB/DTPB, C-TAM-TPB), facilitating conditions (MPCU), and compatibility (IDT). Each of these constructs is operationalized to include aspects of the technological and/or organizational environment that are designed to remove barriers to use (see Table 12). Taylor and Todd (1995b) acknowledged the theoretical overlap by modeling facilitating conditions as a core component of perceived behavioral control in TPB/DTPB. The compatibility construct from IDT incorporates items that tap the fit between the individual's work style and the use of the system in the organization.

The empirical evidence presented in Tables 5, 6, 7, and 8 suggests that the relationships between each of the constructs (perceived behavioral control, facilitating conditions, and compatibility) and intention are similar. Specifically, one can see that perceived behavioral control is significant in both voluntary and mandatory settings immediately following training (T1), but that the construct's influence on intention disappears by T2. It has been demonstrated that issues related to the support infrastructure—a core concept within the facilitating conditions construct—are largely captured within the effort expectancy construct which taps the ease with which that tool can be applied (e.g., Venkatesh 2000). Venkatesh (2000) found support for full mediation of the effect of facilitating conditions on intention by effort expectancy. Obviously, if effort expectancy is not present in the model (as is the case with TPB/DTPB), then one would expect facilitating conditions to become predictive of intention. Our empirical results are consistent with these arguments. For example, in TPB/DTPB, the construct is significant in predicting intention; however, in other cases (MPCU and IDT), it is nonsignificant in predicting intention. In short,

Table 12. Facilitating Conditions: Root Constructs, Definitions, and Scales

Construct	Definition	Items
Perceived Behavioral Control (Ajzen 1991; Taylor and Todd 1995a, 1995b)	Reflects perceptions of internal and external constraints on behavior and encompasses self-efficacy, resource facilitating conditions, and technology facilitating conditions.	1. I have control over using the system. 2. I have the resources necessary to use the system. 3. I have the knowledge necessary to use the system. 4. Given the resources, opportunities and knowledge it takes to use the system, it would be easy for me to use the system. 5. The system is not compatible with other systems I use.
Facilitating Conditions (Thompson et al. 1991)	Objective factors in the environment that observers agree make an act easy to do, including the provision of computer support.	1. Guidance was available to me in the selection of the system. 2. Specialized instruction concerning the system was available to me. 3. A specific person (or group) is available for assistance with system difficulties.
Compatibility (Moore and Benbasat 1991)	The degree to which an innovation is perceived as being consistent with existing values, needs, and experiences of potential adopters.	1. Using the system is compatible with all aspects of my work. 2. I think that using the system fits well with the way I like to work. 3. Using the system fits into my work style.

when both performance expectancy constructs and effort expectancy constructs are present, facilitating conditions becomes nonsignificant in predicting intention.

> *H4a: Facilitating conditions will* ***not*** *have a significant influence on behavioral intention.*[5]

The empirical results also indicate that facilitating conditions do have a direct influence on usage beyond that explained by behavioral intentions alone (see Table 8). Consistent with TPB/DTPB, facilitating conditions are also modeled as a direct antecedent of usage (i.e., not fully mediated by intention). In fact, the effect is expected to increase with experience as users of technology find multiple avenues for help and support throughout the organization, thereby removing impediments to sustained usage (Bergeron et al. 1990). Organizational psychologists have noted that older workers attach more importance to receiving help and assistance on the job (e.g., Hall and Mansfield 1975). This is further underscored in the context of complex IT use given the increasing cognitive and physical limitations associated with age. These arguments are in line with empirical evidence from Morris and Venkatesh (2000). Thus, when moderated by *experience* and *age*, facilitating conditions will have a significant influence on usage behavior.

> *H4b: The influence of facilitating conditions on usage will be mode-*

[5]To test the nonsignificant relationship, we perform a power analysis in the results section.

rated by ***age*** *and* ***experience****, such that the effect will be stronger for older workers, particularly with increasing experience.*

Constructs Theorized Not to Be Direct Determinants of Intention

Although *self-efficacy* and *anxiety* appeared to be significant direct determinants of intention in SCT (see Tables 5 and 6), UTAUT does *not* include them as direct determinants. Previous research (Venkatesh 2000) has shown self-efficacy and anxiety to be conceptually and empirically distinct from effort expectancy (perceived ease of use). Self-efficacy and anxiety have been modeled as indirect determinants of intention fully mediated by perceived ease of use (Venkatesh 2000). Consistent with this, we found that self-efficacy and anxiety appear to be significant determinants of intention in SCT—i.e., without controlling for the effect of effort expectancy. We therefore expect *self-efficacy* and *anxiety* to behave similarly, that is, to be distinct from effort expectancy and to have no direct effect on intention above and beyond effort expectancy.

H5a: *Computer self-efficacy will* ***not*** *have a significant influence on behavioral intention.*[6]

H5b: *Compute anxiety will* ***not*** *have a significant influence on behavioral intention.*[7]

Attitude toward using technology is defined as an individual's overall affective reaction to using a system. Four constructs from the existing models align closely with this definition: attitude toward behavior (TRA, TPB/DTPB, C-TAM-TPB), intrinsic motivation[8] (MM), affect toward use (MPCU), and affect (SCT). Table 13 presents the definitions and associated scale items for each construct. Each construct has a component associated with generalized feeling/affect associated with a given behavior (in this case, using technology). In examining these four constructs, it is evident that they all tap into an individual's liking, enjoyment, joy, and pleasure associated with technology use.

Empirically, the attitude constructs present an interesting case (see Tables 5, 6, and 7). In some cases (e.g., TRA, TPB/DTPB, and MM), the attitude construct is significant across all three time periods and is also the strongest predictor of behavioral intention. However, in other cases (C-TAM-TPB, MPCU, and SCT), the construct was not significant. Upon closer examination, the attitudinal constructs are significant only when specific cognitions—in this case, constructs related to performance *and* effort expectancies—are *not* included in the model. There is empirical evidence to suggest that affective reactions (e.g., intrinsic motivation) may operate through effort expectancy (see Venkatesh 2000). Therefore, we consider any observed relationship between attitude and intention to be spurious and resulting from the omission of the other key predictors (specifically, performance and effort expectancies). This spurious relationship likely stems from the effect of performance and effort expectancies on attitude (see Davis et al. 1989). The non-significance of attitude in the presence of such other constructs has been reported in previous model tests (e.g., Taylor and Todd 1995a; Thompson et al. 1991), despite the fact that this finding is counter to what is theorized in TRA and TPB/DTPB. Given that we expect strong relationships in UTAUT between performance expectancy and intention, and between effort expectancy and intention, we believe that, consistent with the logic developed here, attitude toward using technology

[6] To test the nonsignificant relationship, we perform a power analysis in the results section.

[7] To test the nonsignificant relationship, we perform a power analysis in the results section.

[8] Some perspectives differ on the role of intrinsic motivation. For example, Venkatesh (2000) models it as a determinant of perceived ease of use (effort expectancy). However, in the motivational model, it is shown as a direct effect on intention and is shown as such here.

Table 13. Attitude Toward Using Technology: Root Constructs, Definitions, and Scales

Construct	Definition	Items
Attitude Toward Behavior (Davis et al. 1989; Fishbein and Ajzen 1975; Taylor and Todd 1995a, 1995b)	An individual's positive or negative feelings about performing the target behavior.	1. Using the system is a bad/good idea. 2. Using the system is a foolish/wise idea. 3. I dislike/like the idea of using the system. 4. Using the system is unpleasant/ pleasant.
Intrinsic Motivation (Davis et al. 1992)	The perception that users will want to perform an activity for no apparent reinforcement other than the process of performing the activity per se.	1. I find using the system to be enjoyable 2. The actual process of using the system is pleasant. 3. I have fun using the system.
Affect Toward Use (Thompson et al. 1991)	Feelings of joy, elation, or pleasure; or depression, disgust, displeasure, or hate associated by an individual with a particular act.	1. The system makes work more interesting. 2. Working with the system is fun. 3. The system is okay for some jobs, but not the kind of job I want. (R)
Affect (Compeau and Higgins 1995b; Compeau et al. 1999)	An individual's liking of the behavior.	1. I like working with the system. 2. I look forward to those aspects of my job that require me to use the system. 3. Using the system is frustrating for me. (R) 4. Once I start working on the system, I find it hard to stop. 5. I get bored quickly when using the system. (R)

will *not* have a direct or interactive influence on intention.

> *H5c: Attitude toward using technology will* **not** *have a significant influence on behavioral intention.*[9]

Behavioral Intention

Consistent with the underlying theory for all of the intention models[10] discussed in this paper, we expect that behavioral intention will have a significant positive influence on technology usage.

> *H6: Behavioral intention will have a significant positive influence on usage.*

[9] To test the absence of a relationship, we perform a power analysis in the results section.

[10] For example, see Sheppard et al. (1988) for an extended review of the intention-behavior relationship.

Empirical Validation of UTAUT

Preliminary Test of UTAUT

Using the post-training data (T1) pooled across studies (N = 215), a measurement model of the seven direct determinants of intention (using all items that related to each of the constructs) was estimated. All constructs, with the exception of use, were modeled using reflective indicators. All internal consistency reliabilities (ICRs) were greater than .70. The square roots of the shared variance between the constructs and their measures were higher than the correlations across constructs, supporting convergent and discriminant validity—see Table 14(a). The reverse-coded affect items of Compeau and Higgins (1995b) had loadings lower than .60 and were dropped and the model was reestimated. With the exception of eight loadings, all others were greater than .70, the level that is generally considered acceptable (Fornell and Larcker 1981; see also Compeau and Higgins 1995a, 1995b; Compeau et al. 1999)—see Table 15. Inter-item correlation matrices (details not shown here due to space constraints) confirmed that intra-construct item correlations were very high while inter-construct item correlations were low. Results of similar analyses from subsequent time periods (T2 and T3) also indicated an identical pattern and are shown in Tables 14(b) and 14(c).

Although the structural model was tested on all the items, the sample size poses a limitation here because of the number of latent variables and associated items. Therefore, we reanalyzed the data using only four of the highest loading items from the measurement model for each of the determinants; intention only employs three items and use is measured via a single indicator. UTAUT was estimated using data pooled across studies at each time period (N = 215). As with the model comparison tests, the bootstrapping method was used here to test the PLS models. An examination of the measurement model from the analysis using the reduced set of items was similar to that reported in Tables 14 and 15 in terms of reliability, convergent validity, discriminant validity, means, standard deviations, and correlations. The results from the measurement model estimations (with reduced items) are not shown here in the interest of space.

An examination of these highest loading items suggested that they adequately represented the conceptual underpinnings of the constructs—this preliminary content validity notwithstanding, we will return to this issue later in our discussion of the limitations of this work. Selection based on item loadings or corrected item-total correlations are often recommended in the psychometric literature (e.g., Nunnally and Bernstein 1994). This approach favors building a homogenous instrument with high internal consistency, but could sacrifice content validity by narrowing domain coverage.[11] The items selected for further analysis are indicated via an asterisk in Table 15, and the actual items are shown in Table 16.

Tables 17(a) and 17(b) show the detailed model test results at each time period for intention and usage, respectively, including all lower-level interaction terms. Tables 17(a) and 17(b) also show the model with direct effects only so the reader can compare that to a model that includes the moderating influences. The variance explained at various points in time by a direct effects-only model and the full model including interaction terms are shown in Tables 17(a) and 17(b) for intention and usage behavior, respectively.[12] We pooled the data across the different

[11]Bagozzi and Edwards (1998) discuss promising new alternatives to this approach for coping with the inherent tension between sample size requirements and the number of items, such as full or partial aggregation of items.

[12]Since PLS does not produce adjusted R^2, we used an alternative procedure to estimate an adjusted R^2. PLS estimates a measurement model that in turn is used to generate latent variable observations based on the loadings; these latent variable observations are used to estimate the structural model using OLS. Therefore, in order to estimate the adjusted R^2, we used the latent variable observations generated from PLS and analyzed the data using hierarchical regressions in SPSS. We report the R^2 and adjusted R^2 from the hierarchical regressions. This allows for a direct comparison of variance explained from PLS with variance explained (both R^2 and adjusted R^2) from traditional OLS regressions and allows the reader to evaluate the variance explained-parsimony trade-off.

Table 14. Measurement Model Estimation for the Preliminary Test of UTAUT

(a) T1 Results (N = 215)

	ICR	Mean	S Dev	PE	EE	ATUT	SI	FC	SE	ANX	BI
PE	.92	5.12	1.13	.94							
EE	.91	4.56	1.40	.31***	.91						
ATUT	.84	4.82	1.16	.29***	.21**	.86					
SI	.88	4.40	1.04	.30***	-.16*	.21**	.88				
FC	.87	4.17	1.02	.18*	.31***	.17*	.21**	.89			
SE	.89	5.01	1.08	.14	.33***	.16*	.18**	.33***	.87		
ANX	.83	3.11	1.14	-.10	-.38***	-.40***	-.20**	-.18**	-.36***	.84	
BI	.92	4.07	1.44	.38***	.34***	.25***	.35***	.19**	.16*	-.23**	.84

(b) T2 Results (N = 215)

	ICR	Mean	S Dev	PE	EE	ATUT	SI	FC	SE	ANX	BI
PE	.91	4.71	1.11	.92							
EE	.90	5.72	0.77	.30***	.90						
ATUT	.77	5.01	1.42	.25**	.20**	.86					
SI	.94	3.88	1.08	.27***	-.19*	.21**	.88				
FC	.83	3.79	1.17	.19*	.31***	.18*	.20**	.86			
SE	.89	5.07	1.14	.24**	.35***	.19**	.21**	.33***	.75		
ANX	.79	3.07	1.45	-.07	-.32***	-.35***	-.21**	-.17*	-.35***	.82	
BI	.90	4.19	0.98	.41***	.27***	.23**	.21**	.16*	.16*	-.17*	.87

(c) T3 Results (N = 215)

	ICR	Mean	S Dev	PE	EE	ATUT	SI	FC	SE	ANX	BI
PE	.91	4.88	1.17	.94							
EE	.94	5.88	0.62	.34***	.91						
ATUT	.81	5.17	1.08	.21**	.24**	.79					
SI	.92	3.86	1.60	.27***	-.15	.20**	.93				
FC	.85	3.50	1.12	.19*	.28***	.18*	.22**	.84			
SE	.90	5.19	1.07	.14*	.30***	.22**	.20**	.33***	.77		
ANX	.82	2.99	1.03	-.11	-.30***	-.30***	-.20**	-.24**	-.32***	.82	
BI	.90	4.24	1.07	.44***	.24**	.20**	.16*	.16*	.16*	-.14	.89

Notes:
1. ICR: Internal consistency reliability.
2. Diagonal elements are the square root of the shared variance between the constructs and their measures; off-diagonal elements are correlations between constructs.
3. PE: Performance expectancy; EE: Effort expectancy; ATUT: Attitude toward using technology; SI: Social influence; FC: Facilitating conditions; SE: Self-efficacy; ANX: Anxiety; BI: Behavioral intention to use the system.

Table 15. Item Loadings from PLS (N = 215 at Each Time Period)

	Items	T1	T2	T3
Performance Expectancy (PE)	U1	.82	.81	.80
	U2	.84	.80	.81
	U3	.81	.84	.84
	U4	.80	.80	.84
	U5	.81	.78	.84
	*U6	.88	.88	.90
	*RA1	.87	.90	.90
	RA2	.73	.70	.79
	RA3	.70	.69	.83
	RA4	.71	.74	.74
	*RA5	.86	.88	.94
	JF1	.70	.71	.69
	JF2	.67	.73	.64
	JF3	.74	.70	.79
	JF4	.73	.79	.71
	JF5	.77	.71	.73
	JF6	.81	.78	.81
	OE1	.72	.80	.75
	OE2	.71	.68	.77
	OE3	.75	.70	.70
	OE4	.70	.72	.67
	OE5	.72	.72	.70
	OE6	.69	.79	.74
	*OE7	.86	.87	.90
Effort Expectancy (EE)	EOU1	.90	.89	.83
	EOU2	.90	.89	.88
	*EOU3	.94	.96	.91
	EOU4	.81	.84	.88
	*EOU5	.91	.90	.90
	*EOU6	.92	.92	.93
	EU1	.84	.80	.84
	EU2	.83	.88	.85
	EU3	.89	.84	.80
	*EU4	.91	.91	.92
	CO1	.83	.82	.81
	CO2	.83	.78	.80
	CO3	.81	.84	.80
	CO4	.75	.73	.78
Attitude Toward Using Technology (ATUT)	*A1	.80	.83	.85
	A2	.67	.64	.65
	A3	.64	.64	.71
	A4	.72	.71	.64
	IM1	.70	.78	.72
	IM2	.72	.72	.78
	IM3	.73	.75	.81
	*AF1	.79	.77	.84
	*AF2	.84	.83	.84
	AF3	.71	.70	.69
	*Affect1	.82	.85	.82
	Affect2	.67	.70	.70
	Affect3	.62	.68	.64

	Items	TI	T2	T3
Social Influence (SI)	*SN1	.82	.85	.90
	*SN2	.83	.85	.84
	SF1	.71	.69	.76
	*SF2	.84	.80	.90
	SF3	.72	.74	.77
	*SF4	.80	.82	.84
	I1	.69	.72	.72
	I2	.65	.75	.70
	I3	.71	.72	.69
Facilitating Conditions (FC)	PBC1	.72	.66	.62
	*PBC2	.84	.81	.80
	*PBC3	.81	.81	.82
	PBC4	.71	.69	.70
	*PBC5	.80	.82	.80
	FC1	.74	.73	.69
	FC2	.78	.77	.64
	*FC3	.80	.80	.82
	C1	.72	.72	.70
	C2	.71	.74	.74
	C3	.78	.77	.70
Self-Efficacy (SE)	*SE1	.80	.83	.84
	SE2	.78	.80	.80
	SE3	.72	.79	.74
	*SE4	.80	.84	.84
	SE5	.77	.74	.69
	*SE6	.81	.82	.82
	*SE7	.87	.85	.86
	SE8	.70	.69	.72
Anxiety (ANX)	*ANX1	.78	.74	.69
	*ANX2	.71	.70	.72
	*ANX3	.72	.69	.73
	*ANX4	.74	.72	.77
Intention (BI)	*BI1	.88	.84	.88
	*BI2	.82	.86	.88
	*BI3	.84	.88	.87

Notes:
1. The loadings at T1, T2, and T3 respectively are from *separate* measurement model tests and relate to Tables 14(a), 14(b), and 14(c) respectively.
2. Extrinsic motivation (EM) was measured using the same scale as perceived usefulness (U).
3. Items denoted with an asterisk are those that were selected for inclusion in the test of UTAUT.

Table 16. Items Used in Estimating UTAUT

Performance expectancy

- U6: I would find the system useful in my job.
- RA1: Using the system enables me to accomplish tasks more quickly.
- RA5: Using the system increases my productivity.
- OE7: If I use the system, I will increase my chances of getting a raise.

Effort expectancy

- EOU3: My interaction with the system would be clear and understandable.
- EOU5: It would be easy for me to become skillful at using the system.
- EOU6: I would find the system easy to use.
- EU4: Learning to operate the system is easy for me.

Attitude toward using technology

- A1: Using the system is a bad/good idea.
- AF1: The system makes work more interesting.
- AF2: Working with the system is fun.
- Affect1: I like working with the system.

Social influence

- SN1: People who influence my behavior think that I should use the system.
- SN2: People who are important to me think that I should use the system.
- SF2: The senior management of this business has been helpful in the use of the system.
- SF4: In general, the organization has supported the use of the system.

Facilitating conditions

- PBC2: I have the resources necessary to use the system.
- PBC3: I have the knowledge necessary to use the system.
- PBC5: The system is not compatible with other systems I use.
- FC3: A specific person (or group) is available for assistance with system difficulties.

Self-efficacy

I could complete a job or task using the system…

- SE1: If there was no one around to tell me what to do as I go.
- SE4: If I could call someone for help if I got stuck.
- SE6: If I had a lot of time to complete the job for which the software was provided.
- SE7: If I had just the built-in help facility for assistance.

Anxiety

- ANX1: I feel apprehensive about using the system.
- ANX2: It scares me to think that I could lose a lot of information using the system by hitting the wrong key.
- ANX3: I hesitate to use the system for fear of making mistakes I cannot correct.
- ANX4: The system is somewhat intimidating to me.

Behavioral intention to use the system

- BI1: I intend to use the system in the next <n> months.
- BI2: I predict I would use the system in the next <n> months.
- BI3: I plan to use the system in the next <n> months.

points of measurement by converting time period (experience) into a moderator. The column titled "Pooled Analysis" reports the results of this analysis. Caution is necessary when conducting such analyses and the reader is referred to Appendix A for a discussion of the potential constraints of pooling. Also reported in Appendix A are the statistical tests that we conducted prior to pooling the data for the analysis in Table 17.

As expected, the effect of performance expectancy was in the form of a three-way interaction—the effect was moderated by gender and age such that it was more salient to younger workers, particularly men, thus supporting H1. Note that a direct effect for performance expectancy on intention was observed; however, these main effects are not interpretable due to the presence of interaction terms (e.g., Aiken and West 1991). The effect of effort expectancy was via a three-way interaction—the effect was moderated by gender and age (more salient to women and more so to older women). Based on Chow's test of beta differences ($p < .05$), effort expectancy was more significant with limited exposure to the technology (effect decreasing with experience), thus supporting H2. The effect of social influence was via a four-way interaction—with its role being more important in the context of mandatory use, more so among women, and even more so among older women. The Chow's test of beta differences ($p < .05$) indicated that social influence was even more significant in the early stages of individual experience with the technology, thus supporting H3. Facilitating conditions was nonsignificant as a determinant of intention, thus supporting H4a.[13] As expected self-efficacy, anxiety, and attitude did not have any direct effect on intention, thus supporting H5a, H5b, and H5c. Three of the four nonsignificant determinants (i.e., self-efficacy, anxiety, and attitude) were dropped from the model and the model was reestimated; facilitating conditions was not dropped from the model because of its role in predicting use.[14] The reestimated model results are shown in Table 17.

In predicting usage behavior (Table 17b), both behavioral intention (H6) and facilitating conditions were significant, with the latter's effect being moderated by age (the effect being more important to older workers); and, based on Chow's test of the beta differences ($p < .05$), the effect was stronger with increasing experience with the technology (H4b). Since H4a, H5a, H5b, and H5c are hypothesized such that the predictor is *not* expected to have an effect on the dependent variable, a power analysis was conducted to examine the potential for type II error. The likelihood of detecting medium effects was over 95 percent for an alpha level of .05 and the likelihood of detecting small effects was under 50 pecent.

Cross-Validation of UTAUT

Data were gathered from two additional organizations to further validate UTAUT and add external validity to the preliminary test. The major details regarding the two participating organizations are provided in Table 18. The data were collected on the same timeline as studies 1 and 2 (see Figure 2). The data analysis procedures were the same as the previous studies. The results were consistent with studies 1 and 2. The items used in the preliminary test of UTAUT (listed in Table 16) were used to estimate the measurement and structural models in the new data. This helped ensure the test of the same model in both the preliminary test and this validation, thus limiting any variation due to the changing of items. UTAUT was then tested separately for each time

[13]Since these two hypotheses were about nonsignificant relationships, the supportive results should be interpreted with caution, bearing in mind the power analysis reported in the text. In this case, the concern about the lack of a relationship is somewhat alleviated as some previous research in this area has found attitude and facilitating conditions to not be predictors of intention in the presence of performance expectancy *and* effort expectancy constructs (see Taylor and Todd 1995b; Venkatesh 2000).

[14]Since these two hypotheses were about nonsignificant relationships, the supportive results should be interpreted with caution after consideration of the power analyses reported in the text. The results are presented here for model completeness and to allow the reader to link the current research with existing theoretical perspectives in this domain.

Table 17. Preliminary Test of UTAUT

(a) Dependent Variable: Intention

	T1 (N = 215)		T2 (N = 215)		T3 (N = 215)		Pooled (N = 645)	
	D ONLY	D + I	D ONLY	D + I	D ONLY	D + I	D ONLY	D + I
R^2 (PLS)	.40	.51	.41	.52	.42	.50	.31	.76
R^2 (hierarchical regrn.)	.39	.51	.41	.51	.42	.50	.31	.77
Adjusted R^2 (hierarchical regrn.)	.35	.46	.38	.46	.36	.45	.27	.69
Performance expectancy (PE)	.46***	.17*	.57***	.15*	.59***	.16*	.53***	.18*
Effort expectancy (EE)	.20*	-.12	.08	.02	.09	.11	.10	.04
Social influence (SI)	.13	.10	.10	.07	.07	.04	.11	.01
Facilitating conditions (FC)	.03	.04	.02	.01	.01	.01	.09	.04
Gender (GDR)	.04	.02	.04	.01	.02	.01	.03	.01
Age (AGE)	.08	.02	.09	.08	.01	-.08	.06	.00
Voluntariness (VOL)	.01	.04	.03	.02	.04	-.04	.02	.00
Experience (EXP)							.04	.00
PE × GDR		.07		.17*		.06		.02
PE × AGE		.13		.04		.10		.01
GDR × AGE		.07		.02		.02		.06
PE × GDR × AGE		.52***		.55***		.57***		.55***
EE × GDR		.17*		.08		.09		.02
EE × AGE		.08		.04		.02		.04
EE × EXP								.02
GDR × AGE (included earlier)		Earlier		Earlier		Earlier		Earlier
GDR × EXP								.02
AGE × EXP								.01
EE × GDR × AGE		.22**		.20***		.18*		.01
EE × GDR × EXP								-.10
EE × AGE × EXP								-.02
GDR × AGE × EXP								-.06
EE × GDR × AGE × EXP								-.27***
SI × GDR		.11		.00		.02		.02
SI × AGE		.01		.06		.01		.02
SI × VOL		.02		.01		.02		.06
SI × EXP								.04
GDR × AGE (included earlier)		Earlier		Earlier		Earlier		Earlier
GDR × VOL		.01		.04		.02		.01
GDR × EXP (included earlier)								Earlier
AGE × VOL		.00		.02		.06		.02
AGE × EXP (included earlier)								Earlier
VOL × EXP								.02
SI × GDR × AGE		-.10		.02		.04		.04
SI × GDR × VOL		-.01		.03		.02		.01
SI × GDR × EXP								.01
SI × AGE × VOL		-.17*		.02		.06		.06
SI × AGE × EXP								.01
SI × VOL × EXP								.00

Table 17. Preliminary Test of UTAUT (Continued)

	T1 (N = 215)		T2 (N = 215)		T3 (N = 215)		Pooled (N = 645)	
	D ONLY	D + I	D ONLY	D + I	D ONLY	D + I	D ONLY	D + I
GDR × AGE × VOL		.02		.02		.01		.00
GDR × AGE × EXP (included earlier)								Earlier
GDR × VOL × EXP								.00
AGE × VOL × EXP								.01
SI × GDR × AGE × VOL		.25**		.23**		.20*		.04
GDR × AGE × VOL × EXP								.02
SI × GDR × AGE × VOL × EXP								-.28***
(b) Dependent Variable: Usage Behavior								
R^2 (PLS)	.37	.43	.36	.43	.39	.44	.38	.53
R^2 (hierarchical regrn.)	.37	.43	.36	.43	.39	.43	.38	.52
Adjusted R^2 (hierarchical regrn.)	.36	.41	.35	.40	.38	.41	.37	.47
Behavioral intention (BI)	.61***	.57***	.60***	.58***	.58***	.59***	.59***	.52***
Facilitating conditions (FC)	.05	.07	.06	.07	.18*	.07	.10	.11
Age (AGE)	.02	.02	.01	.02	.04	.13	.04	.08
Experience (EXP)								.06
FC × AGE		.22*		.24*		.27**		.02
FC × EXP								.00
AGE × EXP								.01
FC × AGE × EXP								.23**

Notes:
1. D ONLY: Direct effects only; D + I: Direct effects and interaction terms.
2. "Included earlier" indicates that the term has been listed earlier in the table, but is included again for completeness as it relates to higher-order interaction terms being computed. Grayed out cells are not applicable for the specific column.

Table 18. Description of Studies

Study	Industry	Functional Area	Sample Size	System Description
Voluntary Use				
3	Financial Services	Research	80	This software application was one of the resources available to analysts to conduct research on financial investment opportunities and IPOs
Mandatory Use				
4	Retail Electronics	Customer Service	53	Application that customer service representatives were required to use to document and manage service contracts

Table 19. Measurement Model Estimation for the Cross-Validation of UTAUT

(a) T1 Results (N = 133)

	ICR	Mean	S Dev	PE	EE	ATUT	SI	FC	SE	ANX	BI
PE	.90	4.87	1.20	.88							
EE	.90	3.17	1.09	.30***	.93						
ATUT	.80	2.67	0.87	.28***	.16*	.80					
SI	.91	4.01	1.07	.34***	-.21*	.20*	.89				
FC	.85	3.12	1.11	.18*	.30***	.15*	.14	.84			
SE	.85	4.12	1.08	.19**	.37***	.17*	.22**	.41***	.82		
ANX	.82	2.87	0.89	-.17*	-.41***	-.41***	-.22**	-.25**	-.35***	.80	
BI	.89	4.02	1.19	.43***	.31***	.23***	.31***	.22*	.24**	-.21**	.85

(b) T2 Results (N=133)

	ICR	Mean	S Dev	PE	EE	ATUT	SI	FC	SE	ANX	BI
PE	.90	4.79	1.22	.91							
EE	.92	4.12	1.17	.34***	.89						
ATUT	.84	3.14	0.79	.32***	.18**	.78					
SI	.92	4.11	1.08	.30***	-.20*	.21**	.91				
FC	.88	3.77	1.08	.19*	.31***	.13	.11	.86			
SE	.87	4.13	1.01	.21**	.38***	.25**	.20**	.35***	.80		
ANX	.83	3.00	0.82	-.17*	-.42***	-.32***	-.24**	-.26*	-.36***	.81	
BI	.88	4.18	0.99	.40***	.24**	.21**	.24**	.20*	.21**	-.22**	.88

(c) T3 Results (N = 133)

	ICR	Mean	S Dev	PE	EE	ATUT	SI	FC	SE	ANX	BI
PE	.94	5.01	1.17	.92							
EE	.92	4.89	0.88	.34***	.90						
ATUT	.83	3.52	1.10	.30***	.19**	.80					
SI	.92	4.02	1.01	.29***	-.21*	.21**	.84				
FC	.88	3.89	1.00	.18*	.31***	.14	.15	.81			
SE	.87	4.17	1.06	.18**	.32***	.21*	.20*	.35***	.84		
ANX	.85	3.02	0.87	-.15*	-.31***	-.28***	-.22*	-.25*	-.38***	.77	
BI	.90	4.07	1.02	.41***	.20**	.21*	.19*	.20*	.20*	-.21**	.84

Notes:
1. ICR: Internal consistency reliability.
2. Diagonal elements are the square root of the shared variance between the constructs and their measures; off-diagonal elements are correlations between constructs.
3. PE: Performance expectancy; EE: Effort expectancy; ATUT: Attitude toward using technology; SI: Social influence; FC: Facilitating conditions; SE: Self-efficacy; ANX: Anxiety; BI: Behavioral intention to use the system.

Table 20. Item Loadings from PLS (N=133 at each time period)

	Items	T1	T2	T3		Items	T1	T2	T3
Performance Expectancy (PE)	U6	.91	.92	.91	Facilitating Conditions (FC)	PBC2	.84	.88	.85
	RA1	.90	.89	.88		PBC3	.88	.89	.88
	RA5	.94	.89	.90		PBC5	.86	.89	.84
	OE7	.89	.90	.91		FC3	.87	.78	.81
Effort Expectancy (EE)	EOU3	.91	.90	.94	Self-Efficacy (SE)	SE1	.90	.84	.88
	EOU5	.92	.91	.90		SE4	.88	.82	.81
	EOU6	.93	.90	.89		SE6	.80	.85	.79
	EU4	.87	.87	.90		SE7	.81	.77	.75
Attitude Toward Using Technology (ATUT)	A1	.84	.80	.86	Anxiety (ANX)	ANX1	.80	.84	.80
	AF1	.82	.83	.77		ANX2	.84	.84	.82
	AF2	.80	.80	.76		ANX3	.83	.80	.83
	Affect1	.87	.84	.76		ANX4	.84	.77	.83
Social Influence (SI)	SN1	.94	.90	.90	Intention (BI)	BI1	.92	.90	.91
	SN2	.90	.93	.88		BI2	.90	.90	.91
	SF2	.89	.92	.94		BI3	.90	.92	.92
	SF4	.92	.81	.79					

Note: The loadings at T1, T2, and T3 respectively are from **separate** measurement model tests and relate to Tables 18(a), 18(b), and 18(c) respectively.

Table 21. Cross-Validation of UTAUT

(a) Dependent Variable: Intention

	T1 (N = 133)		T2 (N = 133)		T3 (N = 133)		Pooled (N = 399)	
	D ONLY	D + I	D ONLY	D + I	D ONLY	D + I	D ONLY	D + I
R^2 (PLS)	.42	.52	.41	.52	.42	.51	.36	.77
R^2 (hierarchical regrn.)	.41	.52	.41	.52	.42	.51	.36	.77
Adjusted R^2 (hierarchical regrn.)	.37	.48	.36	.47	.36	.46	.30	.70
Performance expectancy (PE)	.45***	.15	.59***	.16*	.59***	.15*	.53***	.14
Effort expectancy (EE)	.22**	.02	.06	.06	.04	.01	.10	.02
Social influence (SI)	.02	.04	.04	.04	.02	.01	.02	.02
Facilitating conditions (FC)	.07	.01	.00	.08	.01	.00	.07	.01
Gender (GDR)	.02	.06	.01	.04	.07	.02	.03	.03
Age (AGE)	.01	.00	.07	.02	.02	.01	.07	.01
Voluntariness (VOL)	.00	.00	.01	.06	.02	.04	.00	.01
Experience (EXP)							.08	.00
PE × GDR		.14		.17*		.18*		.01
PE × AGE		.06		.01		.02		-.04
GDR × AGE		.02		.04		.04		-.02
EE × GDR		-.06		.02		.04		-.09
EE × AGE		-.02		.01		.02		-.04
EE × EXP								.01

Table 21. Cross-Validation of UTAUT (Continued)

	T1 (N = 133)		T2 (N = 133)		T3 (N = 133)		Pooled (N = 399)	
	D ONLY	D + I	D ONLY	D + I	D ONLY	D + I	D ONLY	D + I
GDR × AGE (included earlier)		Earlier		Earlier		Earlier		Earlier
GDR × EXP								.02
AGE × EXP								.06
EE × GDR × AGE		.21**		.18*		.16*		.04
EE × GDR × EXP								.00
EE × AGE × EXP								.00
GDR × AGE × EXP								.01
EE × GDR × AGE × EXP								-.25***
SI × GDR		-.06		.00		.02		-.07
SI × AGE		.02		.01		.04		.02
SI × VOL		.01		.04		.00		.00
SI × EXP								.02
GDR × AGE (included earlier)		Earlier		Earlier		Earlier		Earlier
GDR × VOL		.04		.02		-.03		.02
GDR × EXP (included earlier)								Earlier
AGE × VOL		.00		.01		.00		.07
AGE × EXP (included earlier)								Earlier
VOL × EXP								.02
SI × GDR × AGE		-.03		-.01		-.07		.00
SI × GDR × VOL		.04		-.03		.04		.00
SI × GDR × EXP								.00
SI × AGE × VOL		.06		.02		.00		.01
SI × AGE × EXP								.07
SI × VOL × EXP								.02
GDR × AGE × VOL		.01		.06		.01		.04
GDR × AGE × EXP (included earlier)								Earlier
GDR × VOL × EXP								.01
AGE × VOL × EXP								.00
SI × GDR × AGE × VOL		.27***		.21**		.16*		.01
GDR × AGE × VOL × EXP								.00
SI × GDR × AGE × VOL × EXP								-.29***
(b) Dependent Variable: Usage Behavior								
R^2 (PLS)	.37	.44	.36	.41	.36	.44	.38	.52
R^2 (hierarchical regrn.)	.37	.43	.36	.41	.36	.44	.37	.52
Adjusted R^2 (hierarchical regrn.)	.36	.41	.35	.38	.35	.41	.36	.48
Behavioral intention (BI)	.60***	.56***	.59***	.50***	.59***	.56***	.59***	.51***
Facilitating conditions (FC)	.04	.11	.01	.01	.02	.06	.14*	.08
Age (AGE)	.06	.02	.06	-.03	-.03	-.01	.06	.02
Experience (EXP)								.10
FC × AGE		.17*		.21**		.24**		.01
FC × EXP								-.06
AGE × EXP								-.07
FC × AGE × EXP								.22**

Notes:
1. D ONLY: Direct effects only; D + I: Direct effects and interaction terms.
2. "Included earlier" indicates that the term has been listed earlier in the table, but is included again for completeness as it relates to higher-order interaction terms being computed. Grayed out cells are not applicable for the specific column.

period (N = 133 at each time period). The measurement models are shown in Tables 19 and 20. The pattern of results in this validation (Tables 21(a) and 21(b)) mirrors what was found in the preliminary test (Table 17). The last column of Tables 21(a) and 21(b) reports observations from the pooled analysis as before. Appendix B reports the statistical tests we conducted prior to pooling the data for the cross-validation test, consistent with the approach taken in the preliminary test. Insofar as the no-relationship hypotheses were concerned, the power analysis revealed a high likelihood (over 95 percent) of detecting medium effects. The variance explained was quite comparable to that found in the preliminary test of UTAUT.

Discussion

The present research set out to integrate the fragmented theory and research on individual acceptance of information technology into a unified theoretical model that captures the essential elements of eight previously established models. First, we identified and discussed the eight specific models of the determinants of intention and usage of information technology. Second, these models were empirically compared using within-subjects, longitudinal data from four organizations. Third, conceptual and empirical similarities across the eight models were used to formulate the Unified Theory of Acceptance and Use of Technology (UTAUT). Fourth, the UTAUT was empirically tested using the original data from the four organizations and then cross-validated using new data from an additional two organizations. These tests provided strong empirical support for UTAUT, which posits three direct determinants of intention to use (performance expectancy, effort expectancy, and social influence) and two direct determinants of usage behavior (intention and facilitating conditions). Significant moderating influences of experience, voluntariness, gender, and age were confirmed as integral features of UTAUT. UTAUT was able to account for 70 percent of the variance (adjusted R^2) in usage intention—a substantial improvement over any of the original eight models and their extensions. Further, UTAUT was successful in integrating key elements from among the initial set of 32 main effects and four moderators as determinants of intention and behavior collectively posited by eight alternate models into a model that incorporated four main effects and four moderators.

Thus, UTAUT is a definitive model that synthesizes what is known and provides a foundation to guide future research in this area. By encompassing the combined explanatory power of the individual models and key moderating influences, UTAUT advances cumulative theory while retaining a parsimonious structure. Figure 3 presents the model proposed and supported. Table 22 presents a summary of the findings. It should be noted that performance expectancy appears to be a determinant of intention in most situations: the strength of the relationship varies with gender and age such that it is more significant for men and younger workers. The effect of effort expectancy on intention is also moderated by gender and age such that it is more significant for women and older workers, and those effects decrease with experience. The effect of social influence on intention is contingent on all four moderators included here such that we found it to be nonsignificant when the data were analyzed without the inclusion of moderators. Finally, the effect of facilitating conditions on usage was only significant when examined in conjunction with the moderating effects of age and experience—i.e., they only matter for older workers in later stages of experience.

Prior to discussing the implications of this work, it is necessary to recognize some of its limitations. One limitation concerns the scales used to measure the core constructs. For practical analytical reasons, we operationalized each of the core constructs in UTAUT by using the highest-loading items from each of the respective scales. This approach is consistent with recommendations in the psychometric literature (e.g., Nunnally and Bernstein 1994). Such pruning of the instrument was the only way to have the degrees of freedom necessary to model the various interaction terms

Table 22. Summary of Findings

Hypothesis Number	Dependent Variables	Independent Variables	Moderators	Explanation
H1	Behavioral intention	Performance expectancy	Gender, Age	Effect stronger for men and younger workers
H2	Behavioral intention	Effort expectancy	Gender, Age, Experience	Effect stronger for women, older workers, and those with limited experience
H3	Behavioral intention	Social influence	Gender, Age, Voluntariness, Experience	Effect stronger for women, older workers, under conditions of mandatory use, and with limited experience
H4a	Behavioral intention	Facilitating conditions	None	Nonsignificant due to the effect being captured by effort expectancy
H4b	Usage	Facilitating conditions	Age, Experience	Effect stronger for older workers with increasing experience
H5a	Behavioral intention	Computer self-efficacy	None	Nonsignificant due to the effect being captured by effort expectancy
H5b	Behavioral intention	Computer anxiety	None	Nonsignificant due to the effect being captured by effort expectancy
H5c	Behavioral intention	Attitude toward using tech.	None	Nonsignificant to the effect being captured by process expectancy and effort expectancy
H6	Usage	Behavioral intention	None	Direct effect

at the item level as recommended by Chin et al. (1996). However, one danger of this approach is that facets of each construct can be eliminated, thus threatening content validity. Specifically, we found that choosing the highest-loading items resulted in items from some of the models not being represented in some of the core constructs (e.g., items from MPCU were not represented in performance expectancy). Therefore, the measures for UTAUT should be viewed as preliminary and future research should be targeted at more fully developing and validating appropriate scales for each of the constructs with an emphasis on content validity, and then revalidating the model specified herein (or extending it accordingly) with the new measures. Our research employed standard measures of intention, but future research should examine alternative measures of intention and behavior in revalidating or extending the research presented here to other contexts.

From a theoretical perspective, UTAUT provides a refined view of how the determinants of intention and behavior evolve over time. It is important to emphasize that most of the key relationships in the model are moderated. For example, age has received very little attention in the technology acceptance research literature, yet our results indicate that it moderates all of the key relationships in the model. Gender, which has received some recent attention, is also a key moderating influence; however, consistent with findings in the sociology and social psychology literature (e.g., Levy 1988), it appears to work in concert with age, a heretofore unexamined interaction. For example, prior research has suggested that effort expectancy is more salient for women (e.g., Venkatesh and Morris 2000). While this may be true, our findings suggest this is particularly true for the older generation of workers and those with relatively little experience with a system. While existing studies have contributed to our understanding of gender and age influences independently, the present research illuminates the interplay of these two key demographic variables and adds richness to our current understanding of the phenomenon. We interpret our findings to suggest that as the younger cohort of employees in the workforce mature, gender differences in how each perceives information technology may disappear. This is a hopeful sign and suggests that oft-mentioned gender differences in the use of information technology may be transitory, at least as they relate to a younger generation of workers raised and educated in the Digital Age.

The complex nature of the interactions observed, particularly for gender and age, raises several interesting issues to investigate in future research, especially given the interest in today's societal and workplace environments to create equitable settings for women and men of all ages. Future research should focus on identifying the potential "magic number" for age where effects begin to appear (say for effort expectancy) or disappear (say for performance expectancy). While gender and age are the variables that reveal an interesting pattern of results, future research should identify the underlying influential mechanisms—potential candidates here include computer literacy and social or cultural background, among others. Finally, although gender moderates three key relationships, it is imperative to understand the importance of gender roles and the possibility that "psychological gender" is the root cause for the effects observed. Empirical evidence has demonstrated that gender roles can have a profound impact on individual attitudes and behaviors both within and outside the workplace (e.g., Baril et al. 1989; Feldman and Aschenbrenner 1983; Jagacinski 1987; Keys 1985; Roberts 1997; Sachs et al. 1992; Wong et al. 1985). Specifically, gender effects observed here could be a manifestation of effects caused by masculinity, femininity, and androgyny rather than just "biological sex" (e.g., Lubinski et al. 1983). Future work might be directed at more closely examining the importance of gender roles and exploring the socio-psychological basis for gender as a means for better understanding its moderating role.

As is evident from the literature, the role of social influence constructs has been controversial. Some have argued for their inclusion in models of adoption and use (e.g., Taylor and Todd 1995b; Thompson et al. 1991), while others have not included them (e.g., Davis et al. 1989). Previous work has found social influence to be significant only in mandatory settings (see Hartwick and Barki 1994; Venkatesh and Davis 2000). Other work has found social influence to be more significant among women in early stages of experience (e.g., Venkatesh and Morris 2000). Still other research has found social influence to be more significant among older workers (e.g., Morris and Venkatesh 2000). This research is among the first to examine these moderating influences in concert. Our results suggest that social influences do matter; however, they are more likely to be salient to older workers, particularly women, and even then during early stages of experience/adoption. This pattern mirrors that for effort expectancy with the added caveat that social influences are more likely to be important in mandatory usage settings. The contingencies identified here provide some insights into the way in which social influences change over time and may help explain some of the equivocal results reported in the literature. By helping to clarify the contingent nature of social influences, this paper sheds light on when social influence is likely to play an important role in driving behavior and when it is less likely to do so.

UTAUT underscores this point and highlights the importance of contextual analysis in developing strategies for technology implementation within organizations. While each of the existing models in the domain is quite successful in predicting technology usage behavior, it is only when one considers the complex range of potential moderating influences that a more complete picture of the dynamic nature of individual perceptions about technology begins to emerge. Despite the ability of the existing models to predict intention and usage, current theoretical perspectives on individual acceptance are notably weak in providing prescriptive guidance to designers. For example, applying any of the models presented here might inform a designer that some set of individuals might find a new system difficult to use. Future research should focus on integrating UTAUT with research that has identified causal antecedents of the constructs used within the model (e.g., Karahanna and Straub 1999; Venkatesh 2000; Venkatesh and Davis 2000) in order to provide a greater understanding of how the cognitive phenomena that were the focus of this research are formed. Examples of previously examined determinants of the core predictors include system characteristics (Davis et al. 1989) and self-efficacy (Venkatesh 2000). Additional determinants that have not been explicitly tied into this stream but merit consideration in future work include task-technology fit (Goodhue and Thompson 1994) and individual ability constructs such as "g"—general cognitive ability/intelligence (Colquitt et al. 2000).

While the variance explained by UTAUT is quite high for behavioral research, further work should attempt to identify and test additional boundary conditions of the model in an attempt to provide an even richer understanding of technology adoption and usage behavior. This might take the form of additional theoretically motivated moderating influences, different technologies (e.g., collaborative systems, e-commerce applications), different user groups (e.g., individuals in different functional areas), and other organizational contexts (e.g., public or government institutions). Results from such studies will have the important benefit of enhancing the overall generalizability of UTAUT and/or extending the existing work to account for additional variance in behavior. Specifically, given the extensive moderating influences examined here, a research study that examines the generalizability of these findings with significant representation in each cell (total number of cells: 24; two levels of voluntariness, three levels of experience [no, limited, more], two levels of gender, and at least two levels of age [young vs. old]) would be valuable. Such a study would allow a pairwise, inter-cell comparison using the rigorous Chow's test and provide a clear understanding of the nature of effects for each construct in each cell. Related to the predictive validity of this class of models in general and UTAUT in particular is the role of intention as a key criterion in user acceptance research—future research should investigate other potential constructs such as behavioral expectation (Warshaw and Davis 1985) or habit (Venkatesh et al. 2000) in the nomological network. Employing behavioral expectation will help account for anticipated changes in intention (Warshaw and Davis 1985) and thus shed light even in the early stages of the behavior about the *actual likelihood* of behavioral performance since intention only captures internal motivations to perform the behavior. Recent evidence suggests that sustained usage behavior may not be the result of deliberated cognitions and are simply routinized or automatic responses to stimuli (see Venkatesh et al. 2000).

One of the most important directions for future research is to tie this mature stream of research into other established streams of work. For example, little to no research has addressed the link between user acceptance and individual or organizational usage outcomes. Thus, while it is often assumed that usage will result in positive outcomes, this remains to be tested. The unified model presented here might inform further inquiry into the short- and long-term effects of information technology implementation on job-related outcomes such as productivity, job satisfaction, organizational commitment, and other performance-oriented constructs. Future research should study the degree to which systems perceived as *successful* from an IT adoption perspective (i.e., those that are liked and highly used by users) are considered a *success* from an organizational perspective.

Conclusion

Following from the Unified Theory of Acceptance and Use of Technology presented here, future research should focus on identifying constructs that can add to the prediction of intention and behavior *over and above* what is already known and understood. Given that UTAUT explains as much as 70 percent of the variance in intention, it is possible that we may be approaching the practical limits of our ability to explain individual acceptance and usage decisions in organizations. In the study of information technology implementations in organizations, there has been a proliferation of competing explanatory models of individual acceptance of information technology. The present work advances individual acceptance research by unifying the theoretical perspectives common in the literature and incorporating four moderators to account for dynamic influences including organizational context, user experience, and demographic characteristics.

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Appendix A

Cautions Related to Pooling Data and Associated Statistical Tests for Preliminary Test of UTAUT (Studies 1 and 2)

The most critical concern when pooling repeated measures from the same subjects is the possibility of correlated errors. West and Hepworth describe this problem as follows:

> A perusal of the empirical literature over the past 30 years reveals some of the statistical approaches to repeated measures over time that have been used by personality researchers. The first and perhaps most classic approach is to aggregate the observations collected over time on each subject to increase the reliability of measurement (1991, p. 610).

However, in many cases, these observations will often violate the assumption of independence, requiring alternate analyses (see West and Hepworth for an extended discussion of alternate approaches).

When error terms can be shown to be independent, West and Hepworth note that " traditional statistical analyses such as ANOVA or MR [multiple regression] can be performed directly without any adjustment of the data." (pp. 612-613). The best way to determine whether it is appropriate to pool data is to conduct a test for correlated errors. In order for it to be acceptable to pool the data, the error terms should be uncorrelated. A second approach uses bootstrapping to select subsamples to conduct a between-subjects examination of the within-subjects data. In order for it to be acceptable to pool the data, this second test should yield identical results to the test of the model on the complete data set. Below we report the results from the specific findings from the correlated errors test and the pattern of findings from the second test.

Correlated Errors Test

We computed the error terms associated with the prediction of intention at T1, T2, and T3 in studies 1 (voluntary settings) and 2 (mandatory settings). Further, we also calculated the error terms when pooled across both settings—i.e., for cross-sectional tests of the unified model at T1, T2, and T3 respectively. These computations were conducted both for the preliminary test and the cross-validation (reported below). The error term correlations across the intention predictions at various points in time are shown below. *Note that all error correlations are nonsignificant and, therefore, not significantly different from zero in all situations.*

Between-Subjects Test of Within-Subjects Data

While the results above are compelling, as a second check, we pooled the data across different levels of experience (T1, T2, and T3) and used PLS to conduct a between-subjects test using the within-subjects data. We used a DOS version of PLS to conduct the analyses (the reason for not using PLS-Graph as in the primary analyses in the paper was because it did not allow the specification of filtering rules for selecting observations in bootstraps). Specifically for the between-subjects test, we applied a filtering rule that selected any given respondent's observation at only one of the three time periods. This approach en-

Table A1. Correlations Between Error Terms of Intention Construct at Various Time Periods

Study 1 (Voluntary)	T1	T2	T3
T1			
T2	.04		
T3	.11	.09	
Study 2 (Mandatory)	**T1**	**T2**	**T3**
T1			
T2	.07		
T3	.08	.13	
Study 1 and 2 (Pooled)	**T1**	**T2**	**T3**
T1			
T2	.06		
T3	.09	.10	

sured that the data included to examine the interaction terms with experience did *not* include any potential for systematic correlated errors. Using 50 such random subsamples, the model was tested and the results derived supported the pattern observed when the entire data set was pooled across experience.

Taken together, the analyses reported above support the pooling of data (see Table 17) across levels of experience and eliminate the potential statistical concerns noted by West and Hepworth in the analysis of temporal data.

Appendix B

Statistical Tests Prior to Pooling of Data for Cross-Validation of UTAUT (Studies 3 and 4)

As with the test of the preliminary model, prior to pooling the data for the cross-validation studies (studies 3 and 4), we conducted statistical tests to examine the independence of observations (as detailed in Appendix A). The table below presents the error term correlation matrices for intention for studies 3 (voluntary) and 4 (mandatory) as well as pooled across both settings at T1, T2, and T3 respectively.

As in the preliminary test of UTAUT, the error correlation matrices above suggest that there is no constraint to pooling in the cross-validation study of the model. As before, a between-subjects test of the within-subjects data was tested using PLS (as described in Appendix A), and the results of that test corroborated the independence of observations in this sample. In light of both sets of results, we proceeded with the pooled analysis as reported in the body of the paper (see Table 21).

Table B1. Correlations Between Error Terms of Intention Construct at Various Time Periods

Study 3 (Voluntary)	**T1**	**T2**	**T3**
T1			
T2	.01		
T3	.07	.11	
Study 4 (Mandatory)	**T1**	**T2**	**T3**
T1			
T2	.04		
T3	.02	.08	
Study 3 and 4 (Pooled)	**T1**	**T2**	**T3**
T1			
T2	.03		
T3	.05	.10	