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Patrick Y.K. Chau

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PATRICK Y.K. CHAU

PATRICK Y.K. CHAU is an Assistant Professor of Information and Systems Management at the Hong Kong University of Science and Technology. He received his Ph.D. in business administration from the Western Business School, University of Western Ontario. His research interests include decision support systems, visual interactive simulation, and IS/IT adoption and implementation. He has published papers in *Journal of the Operational Research Society, European Journal of Information Systems, Information and Management, INFOR, Journal of Decision Systems, International Transactions in Operational Research, Information and Decision Technologies, Journal of Information Science,* and other journals.

ABSTRACT: The technology acceptance model (TAM) is one of the most influential research models in studies of the determinants of information systems/information technology (IS/IT) acceptance. In TAM, perceived usefulness and perceived ease of use are hypothesized and empirically supported as fundamental determinants of user acceptance of a given IS/IT. A review of the IS and psychology literature, however, suggests that perceived usefulness can be of two distinct types: near-term usefulness and long-term usefulness. This paper reviews the concept of perceived usefulness and modifies TAM to include the two types of perceived usefulness. Data collected from nearly 285 administrative/clerical staff in a large organization were tested against the modified model using the structural equation modeling approach. The results of the study showed that, even though perceived near-term usefulness had the most significant influence on the behavioral intention to use a technology, perceived long-term usefulness also exerted a positive, though lesser, impact. No significant, direct relationship was found between ease of use and behavioral intention to use a technology. Implications of the findings and future research areas are discussed.

KEY WORDS AND PHRASES: perceived ease of information systems use, perceived usefulness of information systems, structural equation modeling, technology acceptance model.

AS ORGANIZATIONS CONTINUE TO INVEST HEAVILY IN INFORMATION TECHNOLOGY (IT), the usage behavior of end users has become an important topic in research on IS/IT implementation. Under a general assumption of a positive relationship between IS/IT utilization and performance, numerous individual, organizational, and technological variables have been investigated in efforts to identify key factors affecting IS/IT usage behavior. Saga and Zmud [41] identified twenty empirical studies aimed

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at investigating the nature and determining factors of IT acceptance. User acceptance of IT has generally been used as a dependent variable, with "system use" as a surrogate measure. Among the twenty studies, Davis's [13] technology acceptance model (TAM) is one of the most influential. Quite a few followup studies have been conducted to test the validity of the model in an empirical setting.

The primary objective of this research is to examine a modified TAM based on integration of findings obtained in these followup studies. The results from empirical tests of the modified model provide valuable insights into the factors affecting IT usage behavior. First, TAM and the concept of perceived usefulness are reviewed. Based on this review, a modified TAM is proposed and described. Details of the empirical tests of the proposed model are presented, followed by a discussion of the results. Finally, implications and limitations of the study are discussed.

Theory

A FEW THEORETICAL FRAMEWORKS OR MODELS HAVE BEEN PROPOSED and tested to explain the nature and determinants of IS/IT acceptance. TAM is one such model that has been empirically proven to have high validity. This section first describes the model and related empirical studies. Then, drawing from other IS studies and studies in the psychology field, the rationale of splitting one of two key constructs in TAM, perceived usefulness, into two distinct factors, near-term usefulness and long-term usefulness, is presented. The discussion lays the theoretical foundation for the modified TAM described in the following section.

TAM and Related Empirical Studies

TAM was developed by Davis [13] to explain computer-usage behavior. The theoretical grounding for the model was Fishbein and Ajzen's [18] theory of reasoned action (TRA). According to the TRA, beliefs influence attitudes, which in turn lead to intentions, which then generate behaviors. TAM adapted this belief–attitude–intention–behavior relationship to model user acceptance of IT. The goal of TAM was "to provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behavior across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified" [15, p. 985].

Davis included two constructs in TAM: *perceived usefulness* and *perceived ease of use.* He defined the former as "the degree to which a person believes that using a particular system would enhance his or her job performance" and the latter as "the degree to which a person believes that using a particular system would be free of effort" [14, p. 320]. With support from various theories and models, such as expectancy theory, self-efficacy theory, cost–benefit research, innovation research, and the channel disposition model, TAM postulated that computer usage was determined by a behavioral intention to use a system, which was jointly determined by a person's attitude toward using the system and its perceived usefulness (figure 1). This attitude

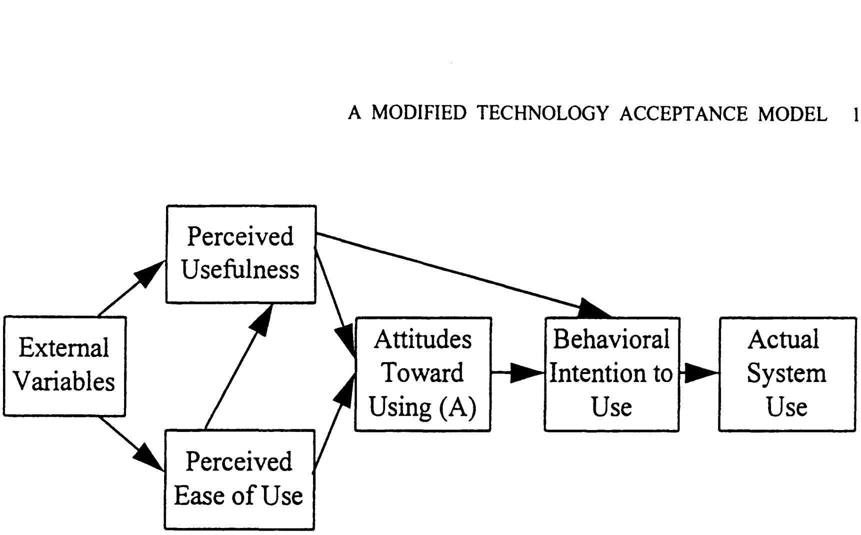

Figure 1. Technology Acceptance Model (from [15])

was also jointly determined by perceived usefulness and perceived ease of use. Finally, perceived usefulness was influenced by perceived ease of use and external variables, which could be system features, training, documentation, and user support. The model was empirically tested in a longitudinal study of 107 users' intentions to use a specific system [15]. The results of the study supported TAM; specifically, perceived usefulness was found to have a strong influence on people's intentions, while perceived ease of use had a smaller but still significant effect that subsided over time.

The validity of TAM was tested again in Mathieson [32], who compared TAM with another model based on the theory of planned behavior (TPB) which predicted an individual's intention to use an IS. Following the guidelines suggested by Cooper and Richardson [12] for ensuring a fair comparison, and using 262 students in an introductory management course as the subjects, the study found that both TAM and TPB predicted intention to use an IS quite well, with TAM having a slight empirical advantage. Also, the authors commented that TAM was easier to apply in practice, with it only supplied very general information about users' opinions of a system, while TPB provided more specific information that could better guide development.

The validity of the measurement scales of the two constructs (i.e., perceived usefulness and perceived ease of use) in Davis's model was reexamined in a number of other studies. Adams, Nelson, and Todd [1] replicated Davis's [14] study with a focus on evaluating the psychometric properties of the two scales, while they examined the relationship among ease of use, usefulness, and system usage. Two studies were conducted and the results generally demonstrated the reliability and validity of the two scales. However, a factor analysis in the second study showed that two of the usefulness items were loaded with both the ease-of-use scale and the usefulness scale. Although the authors explained this result (i.e., the respondents' limited experience with Harvard Graphics), it also revealed the complexity of the construct.

Another test of the reliability of the perceived usefulness and perceived ease-of-use scales was reported by Hendrickson et al. [22]. Using two software packages, the authors demonstrated that Davis's [14] instrument exhibited a high degree of test–retest reliability.

A third study of the reliability and validity of the two scales is Segars and Grover

[42]. Instead of using *classical* approaches (their term for Campbell and Fiske's [10] MTMM technique and common factor analysis) to establish construct validity, the authors adopted a *contemporary* approach that included a variety of confirmatory factor models utilizing maximum likelihood estimation. Using LISREL, a program designed to do structural equation modeling and confirmatory factor analysis, the correlation matrix observed by Adams et al. [1] in their study was used as input for data analysis. The results of the analysis suggested a poor fit between the hypothesized model and the observed correlations in both samples of the study. After respecifying the model according to the guidelines suggested by MacCallum [31], they generated a revised model fit that was acceptable according to several measures of model fit. However, the scale for perceived usefulness had to be split into two constructs in one sample. The authors called them "usefulness" and "effectiveness." This finding was consistent with Barki and Hartwick's [5] assertion that Davis's construct of perceived usefulness was measured with items assessing perceived usefulness, as well as perceived increase in productivity, effectiveness, and performance. These additional dimensions suggest the presence of distinct constructs within the construct.

Moore and Benbasat [33] discussed the similarities between the perceived usefulness construct in TAM and the *relative advantage* construct in Rogers's classic diffusion of innovations model [40]. Rogers defined relative advantage as the degree to which an innovation was perceived as being better than its precursor [33, p. 195]. Davis [14] operationalized perceived usefulness by six items that were basically the advantages of using a particular technology, such as perceived increases in productivity, effectiveness, and performance. The six items included (1) "using *A* [a technology] in my job would enable me to accomplish tasks more quickly"; (2) "using *A* would improve my job performance"; (3) "using *A* in my job would increase my productivity"; (4) "using *A* would enhance my effectiveness on the job"; (5) "using *A* would make it easier to do my job"; and (6) "I would find *A* useful in my job." While Tornatzky and Klein [49] criticized the relative advantage construct for being poorly explicated and poorly measured, Moore and Benbasat [33] criticized the perceived usefulness construct as suffering from the same problem, that is, that it was rather broadly based.

The term "perceived usefulness" was also used by Larcker and Lessig [29] in their study on the evaluation of information reports. These authors identified two distinct factors, *perceived importance* and *perceived usableness*, that influenced the use of information reports; they referred to these two dimensions collectively as *perceived usefulness*. Moore and Benbasat [33] commented that the two dimensions, though closely related, were distinct and that Davis's perceived usefulness might be confounded with this approach.

It is clear, thus, that a better understanding of the concept of perceived usefulness is needed and that the development of a better measure of the construct is important.

Perceived Usefulness

As reviewed in Davis [14], one of the theoretical grounds of the importance of perceived usefulness in user behavior is based on expectancy theory, which models the role of beliefs in decision making [18]. Proposed by Vroom [52] and developed further by Porter and Lawler [36], this theory asserts that the perceived relative attractiveness of various options is related to people's beliefs about the consequences to which each option will lead and their beliefs about the desirability of these consequences. In other words, individuals evaluate the consequences of their behavior in terms of perceived usefulness and base their choice of behavior on the desirability of the usefulness. Based on this theory, Robey [39] theorized that "a system that does not help people perform their jobs is not likely to be received favorably in spite of careful implementation efforts" (p. 537). As empirical support for his assertion, Robey further suggested that future research on attitudes should be done within the context of the expectancy theory of behavior. Additional empirical support for the use of expectancy theory has been found in subsequent studies (e.g., [9, 17, 45]).

In the field of psychology, Triandis [50, 51] proposed a theory of user acceptance that incorporated many of the concepts used in expectancy theory but differed in some conceptual aspects. Triandis's theory distinguished between beliefs that linked emotions to an act (occurring at the *moment of action*) and beliefs that linked the act to *future consequences* [47]. Therefore, an important factor influencing behavior is the expected consequences of the behavior. Triandis [51] named it "perceived consequences." In the context of user acceptance, the concept of perceived usefulness can be expanded. The usefulness perceived can be near term, such as improving job performance or enhancing job satisfaction, or it can be long term, such as improving one's career prospects or social status (future consequences). Thus, perceived usefulness can include two closely related but different concepts: near-term usefulness and long-term usefulness.

The idea of long-term usefulness was also included in several studies. Rogers [40] included *image* as an aspect of relative advantage and argued that "undoubtedly one of the most important motivations for almost any individual to adopt an innovation is the desire to gain social status" [40, p. 215]. Tornatzky and Klein [49] identified *social approval* as one of the ten characteristics addressed most frequently in over 100 innovation studies. Both image and social approval can be treated as more long-term consequences of adopting an information system/information technology and can be considered different enough from relative advantage to be treated as a separate factor [24]. Moore and Benbasat [33] included the image construct as a four-item subscale of their *perceptions of IT adoption* scale. It was found to be different from relative advantage based on the results of factor analysis.

In a study of how users and prospective users of computer-aided software engineering (CASE) technology perceived CASE as an innovation in their work [37], Ramiller hypothesized five important factors affecting perceptions of CASE. Of these five constructs, two, *efficiency of the technology* and *experience of work*, embraced the concept of usefulness. These two constructs had seven and six items, respectively. A closer examination of these items revealed that some could be considered aspects of perceived (near-term or long-term) usefulness of adopting the technology. For example, items in the efficiency of the technology scale such as "CASE will help me deliver my work on schedule" and "CASE will help me deliver my work within budget" could be examples of items for near-term usefulness. Also, some items in the experience of work scale included benefits that could be treated as longer term. Examples included "knowing CASE will put me at the 'cutting edge' in my field" and "knowledge of CASE will enhance my prestige among my professional peers." Although the author did not use the specifications for the two constructs cited above, he did report the Cronbach's alpha coefficients (0.8481 for efficiency of the technology; 0.7339 for experience of work), which express the two different types of usefulness.

Thompson, Higgins, and Howell [47] adopted this near-term/long-term usefulness concept to test a conceptual model of utilization of personal computers. The model proposed that two variables, *near-term job fit* and *long-term consequences of use* have an influence on personal-computer utilization. Job fit was defined as "the extent to which an individual believes that using a personal computer can enhance his job performance," while long-term consequences of use was defined as "outcomes that have a pay-off in the future" [47, p. 129]. Both variables were statistically significant in affecting the extent of personal computer utilization.

The similarities between the two constructs used in Thompson et al.'s study and the near-term/long-term usefulness constructs discussed above are clear. The Thompson et al. study provided empirical evidence for differentiating perceived usefulness into two constructs. It should, therefore, be possible to modify TAM to include the long-term usefulness construct and evaluate the modified model in an empirical setting.

Research Model

THE PROPOSED MODIFIED TAM CONSISTS OF ONLY FOUR CONSTRUCTS. As depicted in figure 2, there are two main differences between the original TAM and the modified version. First, in the original TAM, the two "perceived" constructs affect attitudes toward using a technology, which in turn affect behavioral intention, and then actual use. In the modified model, like many other studies of TAM (e.g., [1, 30]), the "attitudes" factor is taken out to simplify the model. Second, a link between perceived ease of use and behavioral intention to use is included in the modified model although it is not present in the original TAM. This was done because many empirical studies of TAM have included this link and found a significant relationship between the two factors [1, 30, 33]. The main objective is to test the relationship in the proposed modified model empirically.

This study, however, did not follow Adams et al.'s [1] study, which used actual use of the technology as the dependent variable. Instead, this study used behavioral intention of use, primarily for two reasons: First, TAM postulates behavioral intention, rather than actual use, as the major determinant of usage behavior [14]. Second, Adams et al. obtained data for usage based on two self-report measures, a technique that has been criticized for subjectivity [48].

The perceived long-term usefulness construct is added to the original TAM and is hypothesized to have a positive effect on intention to use the technology. In this study, perceived long-term usefulness is defined as the long-term job-related benefits of

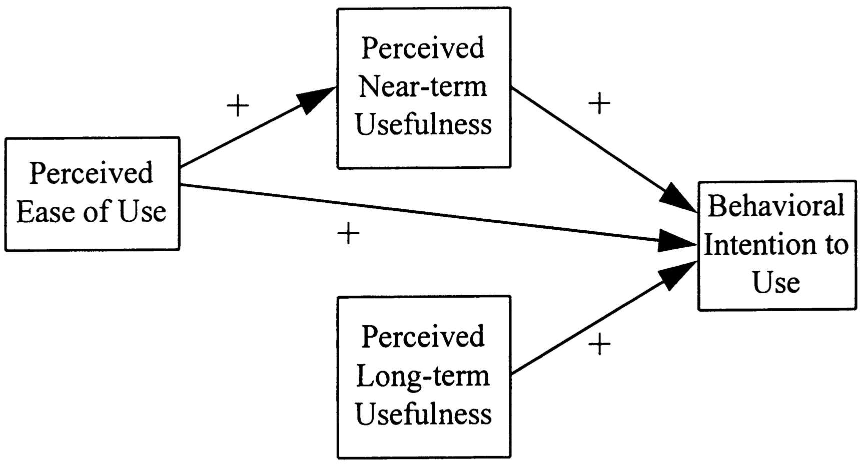

Figure 2. Modified TAM

having knowledge of a particular technology, such as flexibility of changing jobs and opportunity for preferred future job assignments. The relationship between perceived near-term usefulness and perceived long-term usefulness (i.e., whether or not perceived near-term usefulness affects perceived long-term usefulness and vice versa) is not hypothesized. Instead, the relationship was explored empirically on the basis of the model assessment. The main rationale for this was the exploratory nature of the modified model.

Research Design and Method

Model Validation

THE VALIDITY OF THE MODIFIED TAM WAS TESTED AGAINST DATA obtained from the administrative/clerical staff of a large not-for-profit organization. The scales used and the model proposed in the study were tested with structural equation modeling (LISREL), as suggested in Segars [42] and Segars and Grover [43].

As in the Adams et al. [1] study, two software packages, Microsoft Word and Excel, were selected as the software technologies to be examined. These packages could be accessed via the organization's computer network. In general, all administrative/clerical staff in the organization were provided with individual personal computers for their work. An alternative for each package was available on the network: WordPerfect for Word and Lotus for Excel. It was understood that usage of a specific package was generally not required for a particular job or task, and each staff member could choose the package that would enable him or her to work most effectively and/or efficiently. Therefore, captive use was not likely to be an important issue [1]. From a methodological perspective, comparison of these packages using the same measurement scales can provide a strong test of the discriminant validity of the scales [1, 4].

Measures of the Constructs

As Davis [14] pointed out, psychometricians emphasize that the validity of a measurement scale is built from the outset. To ensure the content validity of the scales, the items selected must represent the concept about which generalizations are to be made [7]. Therefore, items selected for the constructs were mainly adapted from prior studies to ensure content validity.

Statements used to operationalize the perceived ease-of-use construct were basically adapted from Davis's [14] study. With minor changes in wording to fit the specific technologies studied, the scale consisted of six items. Items for the perceived near-term usefulness construct were also adapted from Davis's original six-item scale of perceived usefulness, with changes in wording to fit the specific technologies. The four items for the perceived long-term usefulness construct were adapted from Thompson et al.'s [47] long-term consequences-of-use construct. Finally, intention to use was measured by two statements specifically developed for this study. The appendix lists the items used in this study.

Instrument Administration

A questionnaire was designed and sent to all administrative/clerical staff of the organization chosen for the study. A cover letter explained the purpose of the study and guaranteed confidentiality. The questionnaire consisted of three major parts. The first and second parts asked questions related to the two software packages while the last part asked for personal information about the respondent. Each of the first two parts consisted of four questions. The first question asked the frequency of use of the software package. The second question was about the ease of use of the package, with statements basically adapted from Davis's [14] study. The third question dealt with the two perceived usefulness constructs. Items for these two constructs were mixed together to minimize biases due to response consistency [16]. The last question measured the intention to use. In questions two through four, the respondent was asked to express his or her agreement with the statements, based on a seven-point Likert-type scale with anchors ranging from "strongly agree" to "strongly disagree." Of the 330 questionnaires distributed, 285 were returned, for an overall response rate of 86 percent. Of these 285 respondents, 192 used Microsoft Word and 176 used Microsoft Excel in their daily work. In other words, about one-third of the respondents did not use either Microsoft Word or Excel. They might have used Lotus–123 or WordPerfect instead. As a result, the analysis reported below is for a sample of 192 Microsoft Word users and 176 Microsoft Excel users.

Eighty-seven percent of the 285 respondents were female and the majority (87 percent) were between twenty and forty years of age. Most (88 percent) had completed high school, while the rest (12 percent) had obtained college degrees. Of the Microsoft Word users, about half used Word at least once a day and nearly a third used the software occasionally, that is, not more than once a week. The usage for Excel was less. About a third of Excel users used it at least once a day, and another third did not use it more than once a week. This difference in usage was expected since administrative/clerical staff generally make use of word processors more often than spreadsheets.

Analytical Procedures

The data were analyzed using LISREL, a second-generation multivariate technique based on the structural equation modeling approach [6, 19] which has gained popularity in quite a few recently published MIS studies. Examples include Adams et al. [1], Barki and Hartwick [5], Hartwick and Barki [21], Henry and Stone [23], Igbaria, Parasuraman, and Badawy [26], Rasch and Tosi [38], Scott [44], and Thompson et al. [47, 48].

According to procedures recommended by Segars and Grover [43], to avoid the possible interaction between measurement and structural equation models, the measurement model should first be assessed and then "fixed" before the structural equation model is examined. After the model is modified to create the "best" measurement model, the structural equation model is analyzed. As suggested in Barki and Hartwick [5] and Hartwick and Barki [21], hypothesized paths in the model can then be tested, and possible relationships between the model constructs can be explored. Additional models are then assessed to find the model that fits the study data "best."

Various researchers have recommended minimum sample size for reliable analysis using LISREL, ranging from 100 [6] to 200 or more [8]. Anderson and Gerbing [2] recommend a minimum sample size of 150 to generate parameter estimates with standard errors small enough to be of practical usefulness [35]. The two data sets used in this study had a sample size of 192 (Word users) and 176 (Excel users). Given the relatively simple model under investigation, the sample sizes were considered adequate. The analysis was performed twice, once for each software technology: First, for data collected from users of Microsoft Word, the measurement model and the structural equation model were assessed and, if necessary, modified to search for the "best-fitting" model for Microsoft Word. Once the assessment and modifications were completed, this "best-fitting" model was tested using data collected from users of Microsoft Excel. The purpose of this was to test the model's consistency in determining the acceptance of different software packages.

Results

Analysis of the Measurement Model

FIRST, THE MEASUREMENT MODEL FOR THE FOUR LATENT CONSTRUCTS was assessed (figure 3). The data set involved responses from users of Microsoft Word. Chi-square/degrees of freedom, goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), normed fit index (NFI), non-normed fit index (NNFI), comparative fit index (CFI), and root mean square residual (RMSR) were used as measures for

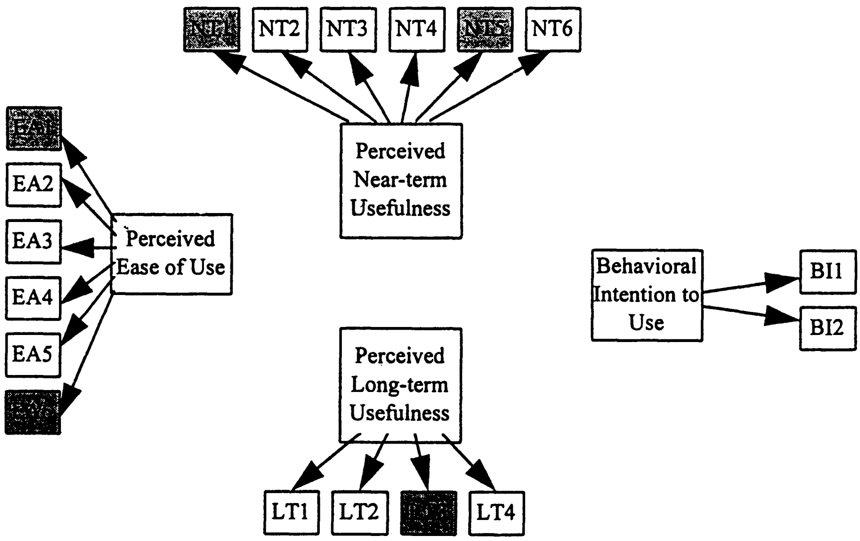

Figure 3. Initial and Final Measurement Models
(Shaded items are not included in the final model.)

goodness of fit. The chi-square statistic was not used because of its weak sensitivity to sample size, as pointed out in Hartwick and Barki [21]. The literature suggests that, for a good model fit, chi-square/degrees of freedom should be less than 3.0, GFI, NFI, NNFI, and CFI should be greater than 0.90, AGFI should be greater than 0.80, and RMSR should be less than 0.10 [23, 44]. These benchmarks were used here to assess the model.

The indices for the measurement model indicate a poor fit. GFI (0.84) and AGFI (0.78) were below their acceptable levels. The LISREL output indicated that several items in the model had large residuals and/or weak correlations with other items, notably, the first and sixth items of perceived ease of use, the fifth item of perceived near-term usefulness, and the third item of perceived long-term usefulness. These results suggested that fit could be improved by respecifying the measurement model without these items. Following suggestions by Segars and Grover [42], each of these items was discarded one by one and the model was reevaluated. The first item of perceived near-term usefulness was also discarded owing to large covariance residuals. Similar modifications were carried out to derive a "good" measurement model. Figure 3 also shows the final measurement model.

Psychometric Properties of the "Best-fitting" Measurement Model

Further analysis was conducted to assess the psychometric properties of the measurement model.

The convergent validity can be assessed by three measures: item reliability, construct (composite) reliability, and average variance extracted [20]. Item reliability indicates the amount of variance in an item due to the underlying construct rather than to error and can be obtained by squaring the factor loading. An item reliability of at least 0.50 and/or a significant t-value for each item is considered evidence of convergent validity. Construct reliability can be calculated as follows: (square of summation of factor loadings)/[(square of summation of factor loadings) + (summation of error variances)] [20]. Nunnally [34] suggested a minimum of 0.80 for evidence of convergent validity. Finally, the average variance extracted measures the amount of variance captured by the construct in relation to the amount of variance due to measurement error and can be calculated using the following formula: (summation of squared factor loadings)/[(summation of squared factor loadings) + (summation of error variances)] [20]. If the average variance extracted is less than 0.50, the variance due to measurement error is greater than the variance due to the construct itself. In this case, the convergent validity of the construct is questionable.

Table 1 presents the results of three tests of convergent validity. Both Word and Excel data were used for assessment. One of the twenty item reliabilities was lower than the 0.50 cutoff value, but all paths had significant t-values. For all constructs in both data sets, reliability was higher than 0.80 and average variance extracted was greater than 50. Thus, the instrument had a relatively clean pass in the three tests, which suggests strong convergent validity for the research variables.

Discriminant validity can be assessed by fixing the correlation between various constructs at 1.0 and then reestimating the modified model [43]. Significant differences in the chi-square statistics of the constrained and unconstrained models suggest high discriminant validity. Table 2 reports the results of twelve pairwise tests among the four constructs (six tests for each data set). The results provide positive support for the discriminant validity.

Analysis of the Structural Equation Model

The structural equation model (i.e., the modified TAM model as shown in figure 2 with the modified measurement model) was examined to test the relationships among constructs. Goodness-of-fit indices for this model were chi-square/degrees of freedom = 3.15, GFI = 0.88, AGFI = 0.82, NFI = 0.92, NNFI = 0.92, CFI = 0.94, and RMSR = 0.21. Chi-square/degrees of freedom, GFI, and RMSR were outside the acceptable levels, indicating a poor model fit. The modification indices (part of the LISREL output) suggested that a path from perceived near-term usefulness to long-term usefulness should be added. The model was modified accordingly.

The modified model was examined. All goodness-of-fit indices surpassed the acceptable levels (chi-square/degrees of freedom = 1.44, GFI = 0.94, AGFI = 0.90, NFI = 0.96, NNFI = 0.98, CFI = 0.99, and RMSR = 0.05). Figure 4 depicts the final full model for Microsoft Word. Of the five paths hypothesized in the model, only influence of perceived ease of use on behavioral intention to use was nonsignificant. All other paths were significant at $p < 0.05$. Thus, a reasonably good fit was obtained for the modified model.

Table 1. Test Results of Convergent Validity

Test 1: Item reliability

Item	Reliability—Word	Reliability—Excel
EA2	0.68	0.78
EA3	0.72	0.86
EA4	0.79	0.77
EA5	0.69	0.73
NT2	0.65	0.82
NT3	0.84	0.76
NT4	0.78	0.74
NT6	0.79	0.71
LT1	0.67	0.77
LT2	0.84	0.71
LT4	0.48	0.56
BI1	0.87	0.75
BI2	0.89	0.89

Test 2: Construct reliability

Construct	Reliability—Word	Reliability—Excel
PEOU	0.93	0.94
PNTU	0.93	0.92
PLTU	0.85	0.86
BITU	0.82	0.88

Test 3: Average variance extracted

Construct	Word	Excel
PEOU	0.76	0.79
PNTU	0.77	0.74
PLTU	0.65	0.67
BITU	0.83	0.78

Second Assessment of the "Best-Fitting" Model

The "best-fitting" model was tested again using data collected from users of Microsoft Excel. Like those for Microsoft Word, all goodness-of-fit indices for Microsoft Excel were above the acceptable levels. The same four significant paths were once again significant and the nonsignificant path remained nonsignificant (figure 5). This indicated the model's consistency across the two software packages.

Discussion

THIS STUDY MODIFIED TAM TO INCLUDE THE ADDITIONAL CONSTRUCT perceived long-term usefulness. Perceived long-term usefulness, operationalized as the long-term job-related benefits of having knowledge of a particular technology, was examined together with perceived ease of use and perceived near-term usefulness to see whether or not they had any influence on the behavioral intention of using the technology.

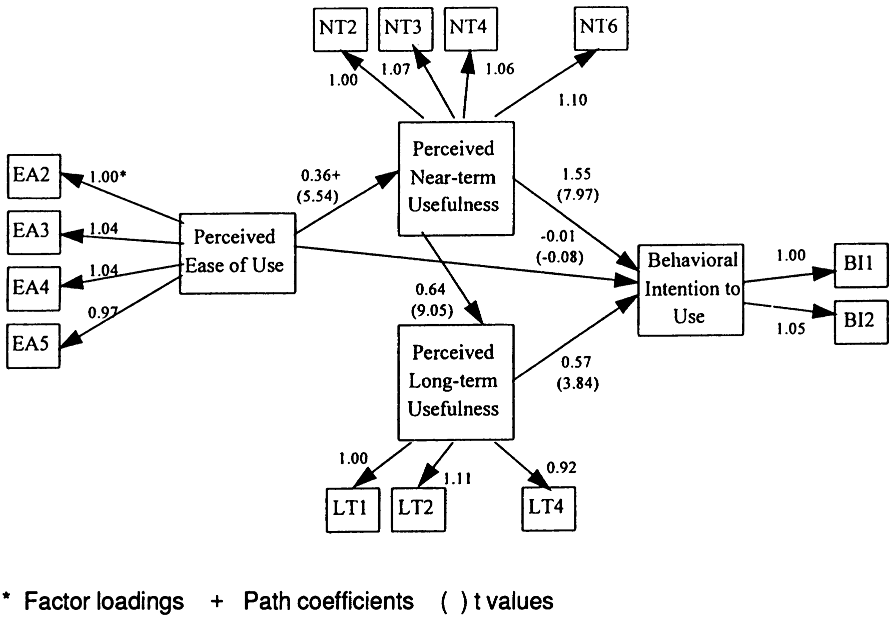

Figure 4. Full Model (Microsoft Word)

Influence of Ease of Use

Previous empirical studies of TAM have found that ease of use influences both near-term usefulness and attitudes toward using the technology, behavioral intention, and actual use. These were not the findings in this study. Ease of use was found to be a significant factor affecting perceived near-term usefulness, but it had no statistically significant influence on intention to use. The first part of the results concurred with most prior studies (e.g., [25, 30]) and was easy to explain. For voluntary use of a technology, since individuals usually explore a number of basic features first, the technology's ease of use plays an important role in this exploratory stage [30]. The individuals' assessment of the usefulness of the technology, thus, is influenced by the technology's ease of use.

The second part of the results suggests that there is no significant, direct relationship between perceived ease of use of the technology and intention to use. In other words, whether or not the technology is easy to use influences the user's intention to use only indirectly via the perception of near-term usefulness. The user's intention to use a technology depends on both types of perceived usefulness, not on how easy the technology is to use. This finding concurs with that of the original TAM but contradicts the results obtained in many previous studies (e.g., [30, 33]) where ease of use was a significant determinant of intention to use a computer technology. A plausible reason for this is that as the technology (Microsoft Word and Excel in our study) becomes more user-friendly, learning to use it becomes much easier than in the past (when users were required to remember dozens of commands/keys). Davis [14] also reported that, while perceived ease of use was found to be significantly correlated with usage, when

Table 2. Test Results of Discriminant Validity

	Chi-square statistic		
	Constrained	Unconstrained	Difference
Microsoft Word			
PEOU with			
PNTU	42.18	31.57	10.61**
PLTU	43.23	25.51	17.62**
BITU	26.14	19.33	6.81**
PNTU with			
PLTU	20.06	15.88	4.18*
BITU	13.99	9.98	4.01*
PLTU with			
BITU	11.10	6.37	4.73*
Microsoft Excel			
PEOU with			
PNTU	41.82	37.72	4.10*
PLTU	51.68	43.76	7.92**
BITU	20.53	16.31	4.22*
PNTU with			
PLTU	42.74	38.07	4.67*
BITU	31.32	27.21	4.11*
PLTU with			
BITU	20.09	15.67	4.42*

* Significant at the 5% level; ** significant at the 1% level.

controlling for usefulness, the effects of ease of use on usage were nonsignificant. He further suggested that "perceived ease of use may actually be a causal antecedent to perceived usefulness, as opposed to a parallel, direct determinant of system usage" (p. 319).

This finding has both practical and research implications. From a practical point of view, it may imply that users are relatively "pragmatic." They use a certain technology mainly because they think it is or will be useful to them, either in the near term or the long term. Users tend to focus on the usefulness of the technology itself. From a research point of view, the difference between the findings of prior studies (significant influence of ease of use on behavioral intention) and this study (insignificant influence) may be due to the nature of the sample. IT end users today are generally more computer-literate than their counterparts five to ten years ago. Hence, ease of use may have been less of an issue for this sample than it would have been for the samples used in prior studies. Owing to this general improvement of computer literacy among IT end-users, the relationships found to be valid in prior work may need to be re-examined.

Influence of Perceived Near-Term Usefulness

Perceived near-term usefulness was found to be the most significant factor affecting intention to use for both Microsoft Word and Excel. This is consistent with most prior

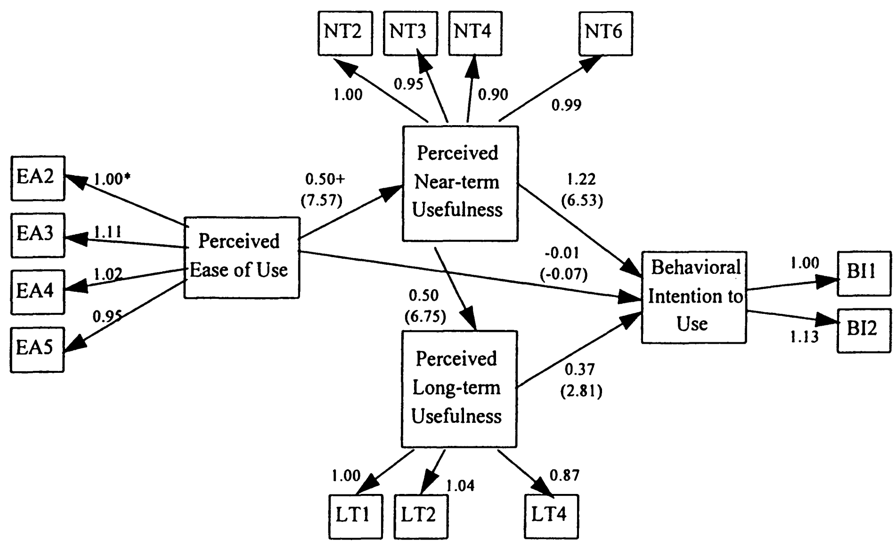

Figure 5. Full Model (Microsoft Excel)

studies. In determining use, usefulness is more important than ease of use. Adams et al. [1] commented on this point and suggested that "a heavy emphasis on ease of use, particularly at the cost of functionality, is not advisable" (p. 237). Keil, Beranek, and Konsynski [28] criticized the fact that, although many previous studies found usefulness more important than ease of use, many developers continue to place a disproportionate emphasis on ease of use, for example, in developing a good user interface. They warned that "no amount of EOU [ease of use] will compensate for low usefulness" [28, p. 89]. The current study supported their statement.

Perceived long-term usefulness of a technology was also found to be significantly influenced by a user's perception of the near-term usefulness of the technology. In both cases (Microsoft Word and Excel), perceived near-term usefulness had a significant and positive impact on perceived long-term usefulness. This can be interpreted as follows: a user who finds a technology useful in accomplishing current tasks is predisposed to believe it will help him or her in his future career.

Influence of Perceived Long-Term Usefulness

The direct influence of perceived long-term usefulness on intention to use was statistically significant in both data sets (Microsoft Word and Excel). As expected, a user who perceived a strong usefulness for familiarity with a particular technology in the long term had a stronger intention to use the technology. This finding is very important since it implies that, during the implementation phase of a new technology, users may focus not only on the perceived near-term usefulness of the technology but also on the perceived long-term benefits of mastering the use of that technology. Creating this kind of perception (letting the user understand the benefits) may help in the overall implementation of the technology. From a research perspective, this finding provides empirical support for modifying TAM to include perceived long-term usefulness.

This study found no significant, direct relationship between perceived ease of use and perceived long-term usefulness. It is conceivable, as argued above, that ease of use mainly has direct effects on perceived near-term usefulness. The ease of use of the technology allows users to explore the usefulness related to their current jobs/tasks, which may in turn affect intention to use and perception of the long-term benefits of the technology to the user.

Conclusions

THIS STUDY SOUGHT EMPIRICAL SUPPORT FOR A RESEARCH MODEL that modified the well-known technology acceptance model, or TAM. Toward that end, the study was succesful. Data collected from administrative and clerical staff in a large organization for two software packages (Microsoft Word and Excel) generally supported the overall validity of the modified TAM. After model modification according to guidelines suggested by Segars and Grover [43], the model was statistically valid in both data sets. With slight differences in the magnitudes, the parameter estimates in both models (for Microsoft Word and Excel) are basically the same, in terms of the order, direction, and relative strength of each factor. The results showed that, even though perceived near-term usefulness had the most significant influence on the behavioral intention to use a technology, perceived long-term usefulness also exerted a positive, though lesser, impact. Also, no significant, direct relationship was found between ease of use and behavioral intention to use a technology.

This research has several limitations. First, even though the research model was a modified model of TAM, it did not exactly match TAM. Behavioral intention, instead of attitudes toward using a technology, was used as the dependent variable. Although, as in TAM, attitudes toward using a technology were modeled as having a direct influence on behavioral intention, this relationship should be further investigated.

Second, the dependent variable, behavioral intention, used in this study was measured by self-reporting. Although this method has been adopted in many studies and was used as the dependent variable in this study, some researchers have suggested that some more behavior-oriented measure such as choice behavior should be used instead [46]. Thompson et al. [48] further suggested that both objective and subjective measures should be employed and that the correspondence (or lack thereof) between them should be examined regardless of which factor is used as the dependent variable.

A third limitation is the relatively small size of the samples in both data sets. While the sample sizes were considered large enough in this study, from a statistical point of view, larger samples would have given more reliable results [48].

This study's findings have implications for both IS practitioners and researchers. For practitioners, the results highlight an additional factor for implementation success.

While perceived near-term usefulness of knowing/using a technology is important, positive perception of the long-term usefulness by the users also plays a significant role. Training users in a technology, thus, should not only focus on how the technology can be of benefit in daily work but also emphasize the delivery of this "long-term" message. Second, the findings suggest that user interface improvements (representing a technology's ease of use) alone may not have much of an impact on intentions to use the technology. As users gain familiarity with a technology over time, the direct effect of ease of use diminishes.

For IS researchers, Adams et al. [1] concluded that "the relationship of the constructs [usefulness and ease of use] to usage is perhaps more complex than is typically postulated" (p. 245). This study has shown a possible modification of TAM. Many other studies could use this study as a basis for future modifications. Of course, the research model used here can also be reexamined in a variety of contexts. As suggested in Chin and Todd [11], because of the methodological limitations of the structural equation modeling approach, results of work based on this approach should be interpreted with care. More research should be done to further confirm the validity of the modified model examined here. Davis et al. [15] have argued that the ease-of-use factor may have a greater impact on intentions in dealing with more complex and difficult systems. This claim should be examined further despite the fact that IT end users are increasingly computer-literate, as argued above. Finally, as Adams et al. [1] commented, a variety of factors, such as user experience and characteristics, type or sophistication of system use, and other task characteristics, may mediate the relationship among ease of use, usefulness, behavioral intentions, and usage. Future research should address these issues.

REFERENCES

1. Adams, D.A.; Nelson, R.R.; and Todd, P.A. Perceived usefulness, ease of use, and usage of information technology: a replication. *MIS Quarterly*, *16*, 2 (1992), 227–247.

2. Anderson, J.C., and Gerbing, D.W. Structural equation modeling in practice: a review and recommended two-step approach. *Psychological Bulletin*, *103*, 3 (1988), 411–423.

3. Bagozzi, R.P. *Causal Models in Marketing*. New York: John Wiley, 1980.

4. Bagozzi, R.P., and Warshaw, P.R. Trying to consume. *Journal of Consumer Research*, *17*, 2 (1990), 127–140.

5. Barki, H., and Hartwick, J. User participation, conflict, and conflict resolution: the mediating roles of influence. *Information Systems Research*, *5*, 4 (1994), 422–438.

6. Bollen, K.A. *Structural Equations with Latent Variables*. New York: Wiley-Interscience, 1989.

7. Bohmstedt, G.W. Reliability and validity assessment in attitude measurement. In G.F. Summers (ed.), *Attitude Measurement*. Chicago: Rand-McNally, 1970, pp. 80–99.

8. Boomsma, A. The robustness of LISREL against small sample sizes in factor analysis models. In K.G. Joreskog and H. Wold (eds.), *Systems under Indirect Observation: Causality, Structure, Prediction*. Amsterdam: North Holland, 1982, pp. 149–173.

9. Burton, F.G.; Chen, Y.N.; Grover, V.; and Stewart, K.A. An application of expectancy theory for assessing user motivation to utilize an expert system. *Journal of Management Information Systems*, *9*, 3 (1993), 183–198.

10. Campbell, D.T., and Fiske, D.W. Convergent and discriminant validation by the multi-trait multimethod matrix. *Psychology Bulletin*, *56*, 1 (1959), 81–105.

11. Chin, W.W., and Todd, P.A. On the use, usefulness, and ease of use of structural equation

modeling in MIS research: a note of caution. *MIS Quarterly*, *19*, 2 (1995), 237–246.

12. Cooper, W.H., and Richarson, A.J. Unfair comparisons. *Journal of Applied Psychology*, *71*, 1 (1986), 179–184.

13. Davis, F.D. A technology acceptance model for empirically testing new end-user information systems: theory and results. Doctoral dissertation. Sloan School of Management, MIT, 1986.

14. Davis, F. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly,* 13, 3 (September 1989), 319–340.

15. Davis, F.; Bagozzi, R.; and Warshaw, P. User acceptance of computer technology: a comparison of two theoretical models. *Management Science, 35*, 8 (August 1989), 982–1003.

16. Davis, F., and Venkatesh, V. Measuring user acceptance of emerging information technologies: an assessment of possible method biases. *Proceedings of the Twenty-Eighth Annual Hawaii International Conference on System Sciences*, vol. 4, 1995, pp. 729–736.

17. DeSanctis, G. Expectancy theory as explanation of voluntary use of a decision support system. *Psychological Reports*, *52* (February 1983), 247–60.

18. Fishbein, M., and Azjen, I. *Belief, Attitude, Intention and Behavior*, Reading, MA: Addison-Wesley, 1975.

19. Fornell, C. *A Second Generation of Multivariate Analysis*, vol. 1, *Methods*. New York: Praeger, 1982.

20. Fornell, C., and Larcker, D.F. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18* (1981), 39–50.

21. Hartwick, J., and Barki, H. Explaining the role of user participation in information systems use. *Management Science, 40*, 4 (April 1994), 440–465.

22. Hendrickson, A.R.; Glorfeld, K.; and Cronan, T.P. On the repeated test-retest reliability of the end-user computing satisfaction instrument: a comment. *Decision Sciences*, *25*, 4 (1994), 655–667.

23. Henry, J.W., and Stone, R.W. A structural equation model of end-user satisfaction with a computer-based medical information system. *Information Resources Management Journal*, *7*, 3 (1994), 21–33.

24. Holloway, R.E. Perceptions of an innovation: Syracuse University project advance. Doctoral dissertation, Syracuse University, 1977.

25. Hubona, G.S. Evaluating user interface design with belief constructs. *Proceedings of the Twenty-Eighth Annual Hawaii International Conference on System Sciences*, vol. 4, 1995, pp. 700–709.

26. Igbaria, M.; Parasuraman, S.; and Badawy, M.K. Work experiences, job involvement, and quality of work life among information systems personnel. *MIS Quarterly*, *18*, 2 (1994), 175–201.

27. Joreskog, K.G., and Sorborm, D. *LISREL: Analysis of Linear Structural Relationships by Maximum Likelihood and Least Squares Methods*. Chicago: National Educational Resources, 1981.

28. Keil, M.; Beranek, P. M.; and Konsynski, B.R. Usefulness and ease of use: field study evidence regarding task considerations. *Decision Support Systems*, *13*, 1 (1995), 75–91.

29. Larcker, D.F., and Lessig, V.P. Perceived usefulness of information: a psychometric examination. *Decision Sciences*, *11*, 1 (1980), 121–134.

30. Lu, H.P., and Gustafson, D.H. An empirical study of perceived usefulness and perceived ease of use on computerized support system use over time. *International Journal of Information Management*, *14*, 5 (1994), 317–329.

31. MacCallum, R. Specification searches in covariance structure modelling. *Psychological Bulletin*, *100*, 1 (1986), 107–120.

32. Mathieson, K. Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior. *Information Systems Research*, *2*, 3 (1991), 173–191.

33. Moore, G.C., and Benbasat, I. Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, *2*, 3 (1991), 192–222.

34. Nunnally, J.C. *Psychometric Theory*, 2d ed. New York: McGraw-Hill, 1978.

35. Pelton, L.E.; Strutton, D.; Barnes, J.H., Jr.; and True, S.L. The relationship among referents, opportunity, rewards, and punishments in consumer attitudes toward recycling: a

structural equations approach. *Journal of Macromarketing, 13,* 1 (1993), 60–74.

36. Porter, L., and Lawler, E. *Managerial Attitudes and Performance.* Homewood, IL: Irwin-Dorsey, 1968.

37. Ramiller, N. Computer-aided software engineering: perceptions of technology, work, and management among IS personnel. *Proceedings of the 1993 ACM SIGCPR Conference,* St. Louis, Missouri, April 1993, pp. 436–449.

38. Rasch, R.H., and Tosi, H.L. Factors affecting software developers' performance: an integrated approach. *MIS Quarterly, 16,* 3 (1992), 395–413.

39. Robey, D. User attitudes and management information system use. *Academy of Management Journal, 22,* 3 (September 1979), 527–538.

40. Rogers, E.M. *Diffusion of Innovations,* 3d ed. New York: Free Press, 1983.

41. Saga, V., and Zmud, R. The nature and determinants of IT acceptance, routinization, and infusion. *IFIP Transactions A (Computer Science and Technology), A–45* (1994), 67–86.

42. Segars, A.H. Scale development in information systems research: a paradigm incorporating unidimensionality and its assessment. *Proceedings of the Fifteenth International Conference on Information Systems,* Vancouver, British Columbia, December 1994, pp. 1–12.

43. Segars, A.H., and Grover, V. Re-examining perceived ease of use and usefulness: a confirmatory factor analysis. *MIS Quarterly, 17,* 4 (1993), 517–525.

44. Scott, J.E. The measurement of information systems effectiveness: evaluating a measuring instrument. *Proceedings of the Fifteenth International Conference on Information Systems,* Vancouver, British Columbia, December 1994, pp. 111–128.

45. Snead, K.C., Jr., and Harrell, A. M. An application of expectancy theory to explain a manager's intention to use a decision support system. *Decision Sciences, 25,* 4 (1994), 499–513.

46. Szajna, B. Software evaluation and choice: predictive validation of the technology acceptance instrument. *MIS Quarterly, 18,* 4 (1994), 319–324.

47. Thompson, R.; Higgins, C.; and Howell, J. Personal computing: toward a conceptual model of utilization. *MIS Quarterly, 15,* 1 (March 1991), 125–143.

48. Thompson, R.; Higgins, C.; and Howell, J. Influence of experience on personal computer utilization: testing a conceptual model. *Journal of Management Information Systems, 11,* 1 (Summer 1994), 167–187.

49. Tornatzky, L., and Klein, K. Innovation characteristics and innovation adoption implementation: a meta-analysis of findings. *IEEE Transactions on Engineering Management, 29,* 1 (February 1982), 28–45.

50. Triandis, H. *Attitude and Attitude Change.* New York: John Wiley, 1971.

51. Triandis, H. Values, attitudes, and interpersonal behavior. *Nebraska Symposium on Motivation, 1979: Beliefs, Attitudes, and Values.* Lincoln: University of Nebraska Press, 1980, pp. 195–259.

52. Vroom, V. *Work and Motivation.* New York: Wiley, 1964.

APPENDIX: Items used in the Study

Variable/item	Description
Perceived ease of use (PEOU)	
EA1	Learning to operate (A) is easy for me.
EA2	I find it easy to get (A) to do what I want it to do.
EA3	My interaction with (A) is clear and understandable.
EA4	I find (A) to be flexible to interact with.
EA5	It is easy for me to become skillful at using (A)
EA6	I find (A) easy to use.
Perceived near-term usefulness (PNTU)	
NT1	Using (A) can enable me to accomplish tasks more quickly.
NT2	Using (A) can improve my job performance.

NT3	Using (A) can make it easier to do my job.
NT4	Using (A) in my job can increase my productivity.
NT5	Using (A) can enhance my effectiveness on the job.
NT6	I find (A) useful in my job.

Perceived long-term usefulness (PLTU)

LT1	Knowledge of (A) can increase my flexibility of changing jobs.
LT2	Knowledge of (A) can increase the opportunity for more meaningful work.
LT3	Knowledge of (A) can increase the opportunity for preferred future job assignments.
LT4	Knowledge of (A) can increase the opportunity to gain job security.

Behavioral intention to use (BITU)

BI1	I always try to use (A) to do a task whenever it has a feature to help me perform it.
BI2	I always try to use (A) in as many cases/occasions as possible.