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RESEARCH NOTE

A FAST FORM APPROACH TO MEASURING TECHNOLOGY ACCEPTANCE AND OTHER CONSTRUCTS[1]

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Abstract

Nearly all prior studies on the technology acceptance model (TAM) have used Likert scales to measure the model's constructs, but the use of only this type of scale has two shortcomings. One is that such use prevents us from exposing the model's constructs to a robust test of their measure and relationships to each other, termed their nomological validity. The other is that such use leaves us unsure about whether or not we have selected an efficient way, in terms of survey completion time, to assess these constructs. Past researchers have used short form scales to address the issue of efficiency, but there are problems that may result from such efforts. In this study, we address both shortcomings by exploring the use of a semantic differential scale, which we refer to as a fast form, to assess the constructs of TAM. In this regard, we do three things. First, we describe how fast form as a scale may be developed. Second, we conduct a psychometric evaluation of the constructs that are measured by the fast form and examine their relationships. Third, we assess the efficiency of the fast form by comparing the time required to complete a survey with it to that which is required to complete a survey with Likert scales. Our results confirm that the constructs that are measured by the fast form are psychometrically equivalent to those that are measured by the Likert scales. The relationship among these constructs was unchanged, providing strong evidence for nomological validity. The fast form also yielded a 40 percent reduction in the survey completion time, proving its superior efficiency. We conclude with a description of the implications of these results for research and practice.

Keywords: Technology acceptance, semantic differential, scale development, item decomposition, nomological validity

Introduction

Likert scales have been used in information systems research studies for just over 20 years now, dating back to work done by, for example, Srinvisan (1985). These scales are made up

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of a number of response options (using the terms *agree* and *disagree*) to a given statement (Flamer 1983). They have perhaps more often been used in studies on the technology acceptance model (TAM) than other studies in the IS discipline. In fact, nearly all prior studies on TAM have used Likert scales. This is not surprising because Likert scales are often used as attitude scales and for situations where agreed-upon criteria for prediction do not exist (Flamer 1983; Likert 1932). Although these scales are valuable to research, our use of ***only*** these scales has a couple of shortcomings.

First, using only these scales prevents us from exposing our constructs to a more robust test of nomological validity (Boudreau et al. 2001; Straub et al. 2004). In the absence of tests incorporating alternative instruments, we miss out on the opportunity to provide more evidence for nomological validity (Straub et al. 2004). Second, we cannot be sure that we have selected what is necessarily the most efficient way (i.e., survey completion time) to measure the constructs in models that are examined with a single scale (Churchill and Peter 1984). One way researchers have set out to achieve greater efficiency is to use what are called short forms of scales (Baroudi and Orlikowski 1988; Peter 1979), but when doing so, researchers tend to lose the validity of the parent scale because of the methods they used to develop these short forms (Smith et al. 2000).

One approach to address the shortcomings just described is to explore the use of other scales in place of Likert scales with already established research models (Flamer 1983; Friborg et al. 2006; Peter 1979). This research note does just that with three related purposes. The first purpose is to describe how the traditional Likert scales for constructs in TAM are converted to a semantic differential scale, which we term a *fast form*. The second purpose is to conduct a psychometric evaluation of this fast form in a test of TAM, given this model's popularity in information systems (Lee et al. 2003). The third purpose is to assess the efficiency of the fast form by comparing the time required to complete a survey with it to that which is required to complete a survey with Likert scales, also for TAM's constructs.

There are several contributions that our work makes to theory and practice. In terms of theoretical contributions, there is much to gain from our examination of the use of a semantic differential scale as a fast form with TAM. If our work shows that with the fast form scale all the links among the constructs of TAM are significant, then it provides further evidence for the nomological validity of the model. In general, nomological validity is about the explicit investigation of constructs and measures in terms of formal hypotheses derived from theory (Peter and Churchill 1986). The fast form scale can provide new tool for construct validation; the relationships between constructs are expected to be the same based on theory. If these relationships are confirmed using the new scale variant, then there is further evidence for nomological validity (Byrne 1989; Peter and Churchill 1986; Straub et al. 2004). This idea is described as follows.

> A good example of this would be Straub et al. [1995] who use a variant of Davis' TAM instrument for self-reported measures of perceived usefulness, perceived ease of use, and perceived systems usage. In spite of using variants of Davis' instrument items, the strength of the theoretical links in this study were similar to those of other works in this stream. The inference that can be made from this similarity of findings is that, in testing the robustness of the instrumentation, the new study helps to further establish the nomological validity of the constructs (Straub et al. 2004, p. 395).

In contrast, if our work shows that any or all of the links between TAM constructs are not significant, then it will reveal areas of TAM where the meaning of constructs needs further investigation or where common methods biases exist or trait method effects occur (Byrne 1989; Straub and Burton-Jones 2007).

The use of a second method with TAM will also contribute much to our understanding of the method itself and of TAM in terms of a new method of inquiry. Indeed, we think our research can be the starting point for breaking the TAM logjam to which Straub and Burton-Jones (2007) refer. As we continue to test theory driven models, like TAM, nomological validity is one type of validity to which we might strive for in all our research. The use of second scale provides such a basis.

By considering two types of scales in this study, we can also gain some insight into how well they tap into psychometric properties, but with efficiency. In this regard, we are concerned about efficiency in terms of the time it takes for people to respond to questions on the scales. Likert and semantic differential scales have different measurement characteristics, such as their type of labels and extent of scale point descriptors (Albaum et al. 1977; Churchill and Peter 1984; Holmes 1974). As a result of these characteristics, surveys that use these scales tend to differ in length. The length of a survey is an important factor that can affect response rate, which, in turn, can threaten the validity of research findings. Longer surveys can lead to lower response rates because these surveys tend to require more time and effort to be completed (Steele et al. 1992; Yammarino et al. 1991). Longer surveys may also lead to differentially less reliable responses for items that are later in these surveys than for ones that are earlier as fatigue increases over the time it takes to complete them. Researchers can certainly reduce the number of items on a survey and make the survey shorter (Baroudi and Orlikowski 1988; Peter 1979; Smith et al. 2000), but they must balance their effort to do so against their effort to preserve the psychometric properties of the constructs that they seek to measure. Our work reveals to what extent is this balancing act attainable.

Finally, our work also provides guidelines that can be used in practice for converting from one scale to another for other constructs. Once validated, scales that are converted can be used in surveys with the added benefit of efficiency, while showing nomological validity, and revealing where common methods biases might exist.

Our work proceeds as follows. First, we describe both Likert and semantic differential scales, with a focus on their main features. Then, we give a brief description of TAM, our theoretical model of interest. Next we provide a detailed description of what we call our fast form as it relates to TAM. We then describe our test of the validity and reliability of the fast form. We conclude our paper with a discussion of our results and some implications for future research.

Likert Scale

A Likert scale is standard of measurement that is frequently used in survey questionnaires. This scale was developed for the measurement of a person's attitudes (Likert 1932). It consists of declarative statements to which people are required to say the extent to which they agree with these statements (Flamer 1983; Holmes 1974; Peterson 1994). For example, respondents are given a statement of the type "Overall, I found X information system easy to use" and are asked to rate it within the range "1 = Strongly Agree to 7 = Strongly Disagree" (Davis 1989; Venkatesh and Davis 2000). A statement and its rating are said to constitute a single item of the scale. The statement for the scale might be worded in a positive or negative manner. Sometimes the number of rating options is more or less. In its most basic form, for example, the scale consists of statements with a dichotomous rating (agree/disagree) option (Flamer 1983). The scale might also consist of bivalent labels that are symmetric and range from strongly agree to strongly disagree. Most times these options are numbered, consecutively, from one to a maximum of nine (Flamer 1983). Still, there are studies that have numbered this scale up to 11 (Russell and Bobko 1992), but the rating options numbered 1 to 5 and 1 to 7 are the most common types (Beal and Dawson 2007; Holmes 1974; Peterson 1994). It is these numbers that are used to provide a quantifiable measure for the statistical analyses of the scale.

For many years, Likert scales have been used in research studies (Flamer 1983). In recent years, however, studies have found that in measuring positive constructs these scales can introduce an acquiescence bias (Podsakoff et al. 2003). This bias can be reduced by using instead a semantic differential scale (Friborg et al. 2006).

Semantic Differential Scale

A semantic differential scale is also a standard of measurement that is used with surveys, but it was developed to measure the meaning suggested by a word, concept or thing, referred to as the *connotative meaning* (Albaum et al. 1977; Osgood et al. 1957). This scale consists of evaluative statements to which respondents are required to say what their position is (Mueller 1986, pp. 52-53). The rating options for respondents to state their positions are in the form of bipolar labels (Holmes 1974; Osgood et al. 1957). Whereas the rating options for Likert scales are about the extent to which respondents agree, those for semantic differential scales are more varied. As such, these scales give researchers the flexibility to choose their own rating options or types of labels. For example, the options include bipolar labels such as good/bad, weak/strong, and efficient/inefficient.

The labels for semantic differential scales are numbered in the same way that they are for Likert scales, and statistical analyses can also be performed on these scales in just the way that they can be done for Likert scales (Holmes 1974). A semantic differential scale can, therefore, be an alternative to a Likert scale (Friborg et al. 2006). However, there is a potential drawback to the use of the semantic differential scale. It may increase cognitive demands and random errors in measurement, but it has been shown to provide a better SEM fit for research models than using an equivalent Likert scale (Friborg et al. 2006). Before we describe our use of the semantic differential scale as a fast form, we give a brief description of the technology acceptance model to which we apply it.

Technology Acceptance Model

The TAM, originally presented by Davis (1989), adapted from the theory of reasoned bction (Ajzen and Fishbein 1980), argues that acceptance of a new system is predicted by understanding the users' perceptions of the ease of use and usefulness of the new system. The original 12-item Likert-scaled instrument has been used extensively in many studies. A recent review of the use of TAM through a search in the Social Science Citation Index showed that there were 698 citations of TAM by 2003 (Lee et al. 2003). There have been doubts expressed about the original instrument, but these were later removed as the instrument was found to be valid and reliable (Adams et al. 1992; Hendrickson et al. 1993). The predictions of the model were also found to be consistent across different populations and software choices (Lee et al. 2003). Given the extensive use of the TAM,[2] it seems that a more efficient or rapid alternative for collecting this data could aid both practitioners and researchers attempting to diagnose potential problems with a new system and design appropriate response mechanisms to increase the potential of acceptance.

Fast Form TAM Instrument

In creating the fast form, we take advantage of inherent flexibility in being able to choose the types of labels for the semantic differential scale. This flexibility allows us to measure a person's attitude not just in terms of how much their view is the same as that expressed by the statement for the Likert scale but in terms of what the statement is about. An example may help make this point clearer. Let us suppose that the item on a Likert scale is made up of the following: (1) the statement "Using the system enhances my effectiveness" and (2) rating options "strongly disagree to strongly agree" that are numbered 1 to 7. On our fast form, this item would be made up of the following: (1) the statement stem "This system is …" and (2) rating options "ineffective to effective" that are numbered 1 to 7. At this point, we want the reader to notice that the fast form item gives a respondent the opportunity to rate the level of effectiveness that he or she thinks the system provides. By contrast, the Likert scale gives the respondent the opportunity to say how effective the system is only to the extent described in the statement that goes with the rating options. Thus, given the flexibility to have a wide range of rating options and to provide respondents with the means to state the degree of their perceptions, the fast form may be at least as useful as the Likert scale for measuring attitudes.

Another observation we would like to make is that the items of the fast form scale consist of fewer words than those of the Likert scale. We would expect respondents to be able to complete the fast form much quicker than its Likert scale equivalent survey because respondents would have fewer words to read, especially for scales with a larger number of items. However, fewer words alone do not necessarily guarantee the outcome we expect with the fast form. Each set of adjective pairs can reflect different dimensions of interpretation (e.g., good and bad versus harmful and beneficial). As such, even though fewer words are used, there can be an increase in cognitive demand due to interpretation of the dimension implied by each pair of words (Friborg et al. 2006). Higher cognitive demand might, in turn, increase the time needed to complete each item. However, the closer in similarity the evaluative dimensions are for the fast form to the Likert scale items, the more likely it is that cognitive demand for both will be the same. As such, we would expect respondents to be able to complete the fast form quicker than the Likert scale.

Our starting point for creating the fast form instrument is the original 12-item questionnaire with Likert scales that were used by Davis (1989). While researchers have taken the 12 items and used a subset of these measures when studying acceptance, in this study, we use the first instance of the scale as the basis for developing the fast form.[3] These 12 items ask respondents to indicate the extent to which they agree with a series of statements regarding the usefulness and ease of use of a system.

In order to create the fast form to test TAM, we needed to convert all of the items to semantic differential scale format from their Likert scale format. The procedure we used to do this is described in details in Appendix A. This procedure is similar to that which is used in facet theory[4] in the creation of what is known as a Guttman scale. But while facet theory follows a much more global perspective and process for the development of a Guttman scale (Shye et al. 1994), the approach adopted in this study is more restrictive with a less ambitious goal: simply to use a mapping strategy for streamlining the TAM Likert items.

The first step in the adaptation of the measures to this study is to break the original items into their appropriate compo-

[2] A review of TAM by Lee et al. (2003) showed that "the publication of TAM studies has increased steadily" (p. 19) over the years, with TAM studies occupying "10% of the total publications" in the IS field as of the time of the review (p. 20).

[3] While some researchers have utilized the scales in Davis et al. (1989), we have selected the first instance of the scales, which was in Davis (1989).

[4] Facet theory explains how one set of items that describe a phenomenon can be converted to another set of items using a mapping procedure based on meanings (Borg and Shye 1995).

nents. The items for perceived usefulness are decomposed into four elements: a behavioral action, a behavioral action context, a causal verb linkage, and a consequence. To ensure that these elements were appropriately captured for this study, this decomposition is used as the basis for the creation of the fast form items. We find that not all of the four elements exist for some constructs. For those that do exist, however, the underlying dimension of each item is considered and opposing anchor points are created that capture the essence of the item. This is summarized in Table 1.

The items for perceived ease of use were decomposed into three elements: the end objective, the success measure associated with the objective, and the underlying idea being measured. In contrast to perceived usefulness items, Davis did not include the fourth element of a consequence into ease of use. Otherwise, similar to perceived usefulness, this decomposition becomes the basis for the creation of the items in the context of this study. Utilizing this decomposition, the underlying dimension of each item is considered and opposing anchor points are created that capture the essence of the item. This is summarized in Table 2.

Appendix B is a description of the set of constructs and corresponding items that we used. While the original instrument items used a seven-point Likert scale anchored at each end with descriptors "strongly disagree" and "strongly agree," all fast form items used a nine-point scale, with the two-anchor points and the scales ranging from –4 to +4. To demonstrate that our two-fold objective for this new instrument was achieved (i.e., efficiency and psychometrically equivalent), data was collected online in order to analyze the validity and the reliability of the fast form *vis-à-vis* the original instrument.

Validity and Reliability of the Fast Form Instrument

Data Collection Methodology

In order to assess the validity and reliability of the fast form, we asked undergraduate students of a midwestern university to respond to its questions in the form of a survey. These students were enrolled in an introduction to computer course. They were told that the survey was being used to get an understanding of their perceptions about an application designed for database programming. In their regular class section, these students were taught four Microsoft Office products: Microsoft Word (for word processing), Microsoft Excel (for spreadsheets), Microsoft PowerPoint (for presentations), and Microsoft Access (for relational databases). For the purpose of this investigation, the use of Microsoft Access for programming relational databases was chosen. The instrument was administered following the section of the course during which Access was taught, ensuring that all students had equal access to the platform, including personal experience and teaching of the system within the classroom.

Students were offered the opportunity to participate in the research study during in-class announcements in six sections of the class, being taught by four different instructors. The students were directed to an online URL where the survey was located. The survey was conducted on-line for two reasons: (1) the instrument required all answers to be filled out before submission and (2) the activity of the user was tracked, thus allowing a check to determine the amount of time that the students took to complete the survey.

The use of online surveys is clearly on the rise within the academic measurement community. Using an informal search of Yahoo, Kaye and Johnson (1999) identified over 2,000 web-based surveys in 59 areas. Furthermore, Kraut (1999), in studying 20 large companies that regularly conduct surveys among their employees, found that 77 percent use traditional paper/pencil surveys, 83 percent use electronic surveys, and a majority use both. Given our need to assess the efficiency of our proposed approach, we selected an online mechanism for delivery of the survey. Students who successfully completed the survey were entered into a drawing for four prizes, which were randomly distributed across six class sections. To ensure that only students who were enrolled in the section completed the survey, two identifying pieces of information were collected at the beginning of the administration of the instrument: (1) the last four digits of their social security number; and (2) the last three numbers of their phone number. This information was randomly cross-checked with class rosters to ensure that only the students enrolled in the class completed the survey.

A total of 283 students successfully completed the survey. Of the 283 students, 129 (50.4 percent male, 49.6 percent female, average age of 21.5) completed a rotation of the survey with the original instrument first, while 154 students (41.6 percent male, 58.4 percent female, average age of 20.8) completed a version with the fast form first. Both sections of students self-reported to have spent around 30 minutes per week on Microsoft Access during the time that it was being taught in class.

Table 1. Decomposition of Perceived Usefulness

Perceived Usefulness: "The degree to which a person believes that using a particular system would enhance his or her job performance." This follows from the definition of useful: "capable of being used advantageously." (Davis 1989)

	Davis Decomposition				Adapted Decomposition				
Original Davis (1989) Item	**Behavioral Action**	**Behavioral Action Context**	**Causal Verb Linkage**	**Consequence**	**Behavioral Action**	**Behavioral Action Context**	**Causal Verb Linkage**	**Consequence**	**Fast Form Davis Item**
Using CHART-MASTER in my job would enable me to accomplish tasks more quickly.	Using (system)	In my job	Would enable me to	Accomplish tasks more quickly	Using Microsoft Access	As a develop-ment platform	Enables me to	Complete relational databases more quickly	Efficient Inefficient
Using CHART-MASTER would improve my job performance.	Using (system)	None stated	Would improve my	Job performance	Using Microsoft Access		Improves my	Relational database development performance	Performance enhancing Performance degrading
Using CHART-MASTER in my job would increase my productivity.	Using (system)	In my job	Would increase my	Productivity	Using Microsoft Visual Access	As a development platform	Increases my	Productivity	Productivity increasing Productivity decreasing
Using CHART-MASTER would enhance my effectiveness on the job.	Using (system)	None stated	Would enhance my	Effectiveness on the job	Using Microsoft Access		Enhance my	Effectiveness in relational database development	Effective Ineffective
Using CHART-MASTER would make it easier to do my job.	Using (system)	None stated	Would make it easier	To do my job	Using Microsoft Access		Makes it easier	To do my relational database development	Helpful Unhelpful
I would find CHART-MASTER useful in my job.	I	None stated	Would find (system)	Useful in my job	I		Find Microsoft Access	Useful in my relational database development	Quite useful Quite useless

Table 2. Decomposition of Perceived Ease of Use

Perceived Ease of Use: "The degree to which a person believes that using a particular system would be free of effort." This follows from the definition of ease: freedom from difficulty or great effort. (Davis 1989)

Original Davis (1989) Item	Objective	Success Measure	Idea Being Measured	Adapted Measure	Fast Form
Learning to operate CHART-MASTER would be easy for me.	Learning to operate (system)	Easy for me	Ease of learning	Learning to operate the development platform portions of Microsoft Access is easy for me.	Easy to Learn Difficult to Learn
I would find it easy to get CHART-MASTER to do what I want it to do.	I would find it easy to get (system)	To do what I want it to do	Ease of manipulation	I find it easy to get the development platform portions of Microsoft Access to do what I want it to do.	Easy to manipulate Difficult to manipulate
My interaction with CHART-MASTER would be clear and understandable.	My interaction with (system)	Clear and understandable	Ease of overall interaction	My interaction with the development platform portions of Microsoft Access has been clear and understandable.	Clear to interact with Obscure to interact with
I would find CHART-MASTER to be flexible to interact with.	I would find (system)	Flexible to interact with	Ease of flexibility	I find the development platform portions of Microsoft Access to be flexible to interact with.	Flexible to interact with Rigid to interact with
It would be easy for me to become skillful at using CHART-MASTER.	It would be easy for me	To become skillful at using (system)	Ease of skill mastery	It is easy for me to become skillful at using the development platform portions of Microsoft Access	Easy to master Difficult to master
I would find CHART-MASTER easy to use.	I would find (system)	Easy to use	Ease of end-use	I find the development platform portions of Microsoft Access easy to use.	Very Usable Very Cumbersome

Table 3. Efficiency Analysis

	Original-Fast	Fast-Original	Average
Original Instrument (16 clicks minimum)			
Average number of clicks	18.29	17.28	17.79
Average time of completion	03:17	03:09	3:13
Fast Form (16 clicks minimum)			
Average number of clicks	18.03	17.77	17.90
Average time of completion	01:37	02:16	1:56

Data Analysis

Efficiency of Measures

As noted, one of our goals is to create a fast form alternative to the Likert-based TAM scale that is more usable/economical in terms of speed of response. To determine if the new instrument met this objective, user activity was tracked during completion of the survey. Scripts were created that tracked the time that the subjects spent on each page of the survey. Then, every time a user clicked (or registered a response to an item), the time and date were noted. By analyzing the time responses and the number of clicks used to complete the survey, it can be determined if the fast form of TAM was indeed faster and more economical than the original instrument.

Table 3 shows our results. While both instruments were similar in the number of clicks used to complete the survey, there was a significant difference in time between the original and the fast forms ($p < 0.01$). This was confirmed by a t-test. Regardless of the order presented (meaning there was no difference if the user filled out the original instrument or the fast instrument first), the 12 item fast form took over a minute less to complete. In total, 84 percent of respondents took less time to complete the fast form than the original instrument, resulting in a (approximately) 40 percent reduction in the amount of time required. Thus, our expectation that respondents would complete the fast form faster than the original scale is confirmed. Our next step is to assess the psychometric properties of the fast form.

Comparing Instruments

To compare the instruments, the structural equation modeling tool AMOS 7.0 was used to analyze the data and build two separate models—one to test the original version of the instrument and the other the fast form. To ensure comparability, the same dependent variable (predicted use) was used for both models. The measurement model is first examined, followed by the structural model.

Measurement Model

The measurement model analyzes the relationships between the latent constructs and their associated items. The first analysis is to examine the adequacy of the measures, determined by examining the individual item reliabilities, represented by the loadings to their respective construct (summarized in Appendix B). As Chin (1998, p. 325) states, "standardized loadings should be greater than 0.707….But it should also be noted that this rule of thumb should not be as rigid at early stages of scale development. Loading of .5 or .6 may still be acceptable if there are additional indicators in the block for comparison basis." All of the items met the 0.707 criteria for their relevant construct. Also worth noting is the fact that half the fast form items were more reliable (i.e., had higher loadings) than the corresponding original TAM items and vice versa with the TAM items being slightly higher than the corresponding fast form items, suggesting equivalency of the two sets.

While the first analysis demonstrated that the fast form items loaded appropriately on their respective construct, this does not indicate the reliability of the items as a whole. Using the loadings from the constructs, composite reliabilities and Cronbach's alpha were calculated for the ease of use and usefulness fast form and original instruments (see Table 4). The composite reliabilities were included as a contrast to alpha since it does not assume tau equivalency among the measures (Werts et al. 1974). The results are all above the minimum 0.80, ranging from 0.93 to 0.95. This result implies that the increased efficiency of the fast form scale did not come about at the expense of loss in scale reliability. In fact, for usefulness, the composite reliability using the fast form items is slightly higher, but lower for ease of use. This implies that there is no differential advantage between the two sets. This is also consistent with Peterson's meta-analytic conclusion that alpha does not depend on the scale type or format (1994, p. 389). The means, standard deviation, and range for the scales (also provided in Table 4) are also quite similar. T-tests reveal no significant differences ($p < 0.01$) for

Table 4. Scale Reliability Comparison

	Original Instrument						Fast Form					
	Composite Reliability	Cronbach's Alpha	Mean	Std Dev	Min	Max	Composite Reliability	Cronbach's Alpha	Mean	Std Dev	Min	Max
Usefulness	0.922	0.921	5.53	1.13	1	7	0.928	0.926	7.25	1.45	1	9
Ease of use	0.949	0.950	4.91	1.38	1	7	0.940	0.937	6.31	1.91	1	9
Predicted usage	0.952	0.949	5.28	1.41	1	7	0.975	0.974	6.95	1.75	1	9

the means and standard deviation of the two scales (also provided in Table 4).[5]

Structural Model

With the analysis of the measurement model completed, we move on to the structural model. The structural model analyzes the relationships between the various latent variables. Two separate models were run: one using the original instrument and one using the fast form. Figure 1 displays the structural model comparison for the original instrument versus the fast form. Multigroup invariance tests on the impact of the structural paths indicate that both the original and the fast form ease of use had the same effect. And while the path impact for usefulness differed statistically,[6] the influence of the construct on the predicted usage was not substantively different (i.e., a 0.13 difference for the two scales represents at best a 0.01 difference in R^2).

The goodness-of-fit indexes for both models are shown in Table 5.[7] These indexes are above the recommended levels (Kline 2005), but a close look at them might cause the reader to be concerned about how these fit indexes compare to each other. Such a comparison might be misleading because of the nature of these indexes. Let us elaborate on this idea with respect to each index in Table 5.

Although the χ^2 goodness-of-fit statistic can be used to evaluate model fit, psychometricians tend not to consider it a reliable guide for model adequacy (e.g. Curran et al. 1996; Hu and Bentler 1999). That is because the actual size of the test statistic depends not only on model adequacy but also on which one among several χ^2 tests actually is used, as well as other conditions (Bentler and Dudgeon 1996; Curran et al. 1996; Hu and Bentler 1999). This statistic also has no upper limit and as such its value is not interpretable in a standardized way (Kline 2005). Therefore, it is recommended that readers avoid making any judgment about the adequacy of our model based on the χ^2 statistic. We reported this statistic mainly due to tradition, as it is a standard output of most analyses like ours.

RMSEA, CFI, and TLI are alternative measures of fit. For these measures goodness of fit is based on various cutoff criteria (Bynre 2001; Hu and Bentler 1999; MacCallum et al. 1996). It is important to be aware that there is no distinction made in terms of degree of fit for differences in fit indexes beyond the cutoff points. One can think of this as a kind of grading scheme, where say an "A" is given for any score above 93 percent and, in terms of a grade, scores above this cutoff value are indistinguishable from each such that they will all be a grade of "A." For RMSEA, values less than 0.05 indicate a good fit (Byrne 2001, p. 85), and higher values, up to 0.10 can indicate average fit (Browne and Cudeck 1993; Chen et al. 2008; MacCallum et al. 1996). But above a value of 0.10, the fit is said to be poor (Bryne 2001, p. 89). Therefore, on the basis of our measures of RMSEA, both the original scale and the fast form result in average fit.

CFI ranges from zero to one (Bryne 2001). The cutoff value that is said to indicate a superior fit is 0.95 (Bryne 2001; Hu and Bentler 1999). As with the RMSEA, there is no distinction made in terms of degree of fit for CFI values over this cutoff value. The TLI also ranges from zero to one (Byrne 2001), but can also fall outside this range (Kline 1998). For TLI, a cutoff value close to 0.95 is said to indicate a good fit (Byrne 2001; Hu and Bentler 1995). On the basis of these statistics, both the original scale and the fast form result in acceptable fit with no apparent reason for differences in these two to be judged.

[5]Fast form items were rescaled to a seven-point scale for comparison purposes. Original means and standard deviations were 7.25 (1.45) and 6.31 (1.91) for usefulness and ease of use respectively.

[6]This is based on χ^2 difference tests of the two sets of measures constraining paths to be equal.

[7]The covariance matrices for the full and fast form instrument necessary to replicate our results are in Appendix C and D, respectively.

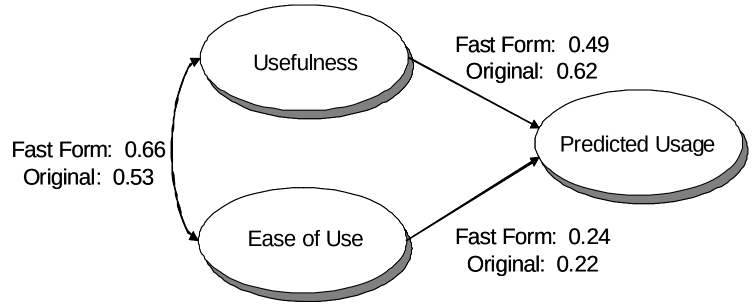

Figure 1. Structural Model Results

Table 5. Goodness of Fit

	Original Instrument	Fast Form
Degrees of Freedom	101	101
Chi-square	182.25	315.44
RMSEA	0.053	0.087
CFI	0.981	0.950
TLI	0.977	0.940

On the matter of the use of cutoff criteria, we wish to make a few important points here. In general, these criteria have limited generalizeability to mildly mis-specified models (Marsh Hau and Wen 2004). Researchers are cautioned not to take them too seriously (Hayduk and Glaser 2000). Although they are useful, it is always difficult to designate a specific one for fit indexes because they do not work equally well (Hu and Bentler 1999). For example, if a researcher uses a cutoff value of say 0.95 for CFI with an average sample size (N < 500), then he or she would end up rejecting anywhere from 29.8 to 71.5 percent of mis-specified models (Hu and Bentler 1999). CFI and TLI are also particularly susceptible to the influence of estimation methods (Sugawara and MacCallum 1993) and confidence intervals cannot be reliably constructed for them (Chen et al. 2008). Thus one can only use point estimates in judgments with these two indexes.

In contrast, one can use both the point estimate and confidence intervals for the RMSEA index to assess model fit. However, recent research shows that there is no universal cutoff value to evaluate model fit with RMSEA (Chen et al. 2008). That is because it is difficult to justify such a value in that the relationship between it and the degree of mis-specification depends on the structure and the size of the model in complex ways that are confounded by sample size effects (Chen et al. 2008). At best, for now, we can only use fit indexes cautiously, and attend to diagnostics for sources of model misfit (Bentler 2007; Hayduk et al. 2007).

Discussion

This study follows the prescript that there is great value in developing alternative instruments to well known constructs. Straub et al. (2004) highly recommended the creation of such "newly validated instruments." In fact, they said,

> Researchers who are able to engage in the extra effort to create and validate instrumentation for established theoretical constructs (nomological validity) are testing the robustness of the constructs and theoretical links to method/measurement change (see Boudreau et al. [2001], for more detailed argumentation). This practice, thus, represents a major contribution to scientific practice in the field (p. 414).

Using the same Likert items in different settings may be evidence of generalizability, but such evidence does not avoid the question as to whether the relationships found among the constructs are in part due to the particular form of measurement. Only through the creation and use of new measures (i.e., alternate variants of the constructs in question) can one provide a robust test of the nomological network.

Although our results are in line with our expectations, it is possible that they could have been different. For example, we could have found that the theoretical relationships for TAM that are based on constructs measured by Likert scaled items are weaker or even nonexistent based on the fast form items. Such a result would raise the question as to whether it is the fast form items or the Likert items that are problematic. This in turn would raise questions about method effect. Since these issues have no implications for our results, we are left with a strong test of TAM. Indeed, from Popper's (1959) viewpoint what we have done by using an alternate scale is to perform a stronger test of the theoretical model since our results could have been quite different.

Notwithstanding the aforementioned encouragement by Straub et al. (2004) on the development of alternative methods for measuring established constructs, the process can be difficult. As a result, for a particular phenomenon such as IT acceptance, we are not necessarily surprised that there are not that many alternative instruments developed to date. Still there is much value in making the effort to develop such instruments. Boudreau et al. (2001, p. 12) describe that value as follows:

> Nevertheless, some researchers will elect to devote the time and effort to create new scale items rather than use previously validated scales. By so doing, they will, in fact, be exposing the constructs to a more robust test of construct validity (Cook and Campbell 1979; Sussmann and Robertson 1986). In other words, if theoretical linkages hold using alternative methods of measuring the constructs, then this would be sufficient evidence for the nomological (construct) validity of both scales. Validation always works in both directions; it is "symmetrical and egalitarian" (Campbell 1960, p. 548). Creating new instruments from scratch for even well established constructs is not an efficient practice, but it should never be discouraged.

Beyond establishing the robustness of the TAM constructs, we also showed how much more efficient is the fast form than Likert scale items. While at an absolute level, the amount of time saved may not appear to be large, it does point toward substantial savings when additional constructs for more complex models are examined. Benbasat and Barki (2007), in a recent commentary on TAM, argued that the model's constructs have largely been treated as a black box that very few have attempted to open. They also noted that researchers' intense focus on a narrow set of behaviors for TAM has caused them to ignore other possible behaviors such as learning and reinvention as well as critical antecedents dealing with IT artifact design and evaluation. If researchers set out to investigate additional behaviors and antecedents (e.g., Schwarz and Chin 2007; Sundaram et al. 2007) then they will necessarily have more complex TAM models to assess. Clearly, a more efficient way to measure the larger set of constructs of such a model would be quite valuable to all researchers.

Whether or not researchers start to look at other behaviors that might be a part of TAM, there are still opportunities for further inquiry into the current model. As our work has shown, additional inquiry could also be focused on reassessing the TAM's constructs. Benbasat and Barki (2007), focusing mainly on theoretical issues of TAM, suggest that "we reached a saturation point in TAM work after which few surprises were evident" (p. 213). We might argue, however, that the model's predictions have not been adequately tested against a broader set of empirical data. So what might seem like a saturation point may in fact reflect that we have simply measured the model's constructs by the same method for far too long.

Apart from providing an additional scope for research on TAM, the fast form may have another measurement benefit. It can enable a researcher to avoid a bias that is inherent with Likert scales. Likert scales can introduce what is called an *acquiescence bias* (DeVellis 1991; Nunnally 1978). This bias comes from respondents' tendency to respond to items positively without much regard for its true content (Friborg et al. 2006). To reduce this bias, items might be transformed to a negation of the concept under examination by the researcher (Podsakoff et al. 2003). But using the negation of a concept can also result in other problems. For example, it can result in method effects (Motl and DiStefano 2002). It can also introduce errors as negations of positive constructs may appear contra-intuitive (Friborg et al. 2006).

Marsh (1996) also discussed this issue in conjunction with his analysis of a global self-esteem scale, which researchers have typically treated as a unidimensional scale, although factor analyses often show separate factors associated with positively and negatively worded items. However, as Marsh notes, the real issue is "whether the distinction is substantively meaningful or an artifact of the response styles associated with the positively and negatively worded items" (p. 810). Marsh further suggests that the only way to evaluate the psychometric properties of the responses to rating scales with both positively and negatively worded Likert items would be to use CFA/SEM methods. However, the inclusion of negative items in an analysis generally requires much more sophisticated SEM modeling and the proportion of such positive and negative items should be relatively constant for each scale. Scores created from these items also need to be differentially weighted. Finally, method effects associated with negative items can bias correlations between measures of the same construct administered on two different occasions. By providing the means for a more varied scale without requiring the introduction of a negation of the concept, semantic scales such as the fast form may avoid the bias that is inherent in Likert scales (Friborg et al. 2006).

Future Research and Conclusion

There are a number of future research directions implied by the limitations and results of this study. One is that the fast form scale can be combined with the original TAM scale for those interested in designing a multitrait/multimethod study to assess and factor out one type of common method bias (i.e., scale bias). Of course, this does not necessarily eliminate other forms of bias such as common rater effects (Podsakoff et al. 2003; Straub and Burton-Jones 2007).

There are also two areas for future research that have to do with cognition: (1) the need to develop an understanding of the cognitive complexity of instruments and (2) the need to develop alternative forms of currently accepted items, with the objective of reducing cognitive load (e.g., Schwarz 1996). Since our study did not explicitly measure all aspects of cognitive complexity, future studies need to explicitly disentangle cognitive demand not only in terms of words read, but also interpretation of the adjective pairs used in the semantic scale.

Finally, researchers may also consider running a more extensive nomological test than the one that we have done in this study. Specifically, the fast form items presented here can be situated in a more elaborate network than the original TAM model. For example, a fast form could also be developed for other constructs such as subjective norm, self efficacy, and perceived behavioral control.

Yet, it should also be noted that not all Likert scales can be easily converted to fast form equivalents. In this study, the original scale items followed a theoretical definition that led to a common element sentence structure containing a similar underlying behavioral action or objective. However, scales that have items with varying domains of consideration would make such an endeavor prohibitive.

In closing, we believe that the creation of fast form instruments is a worthwhile avenue for researchers to pursue. Indeed, difficulties often encountered in cross cultural studies that require translating complex instruments might also be lessened by shifting scales from Likert to semantic differential items, as this would require fewer words to be translated. Furthermore, shifting to a fast form appears to be more efficient, a move which could possibly reduce survey abandonment due to respondent fatigue. Furthermore, switching might not be necessary at all because a fast form instrument can also complement longer surveys in a different way. Multiple modes for survey delivery have also been shown to produce higher response rates (Yun and Trumbo 2000). Of course, these are only suggestive of the value of developing fast form scales, but we hope that more studies will delve further into the notion of cognitive load on survey response rate.

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Appendix A

Item Decomposition

The decomposition was completed in terms of what we call the ACTS approach: **A**ction, **C**ontext, **T**arget behavior, and **S**ubsequent outcome. We examined each scale using these four elements.

First is the **A**ction — What behavioral action are we attempting to understand? In the case of the Davis scales, the behavioral action that we are studying is usage, so the term "Using CHART-MASTER" is the action.

Next is the **C**ontext — What is the context in which the action is taking place? In the case of the Davis scales, the context is "in my job."

Third is the **T**arget behavior — What is the action facilitating (behaviorally)? In the case of the Davis scales, the target behavior is "would enable me"—in other words, the focus is on enablement.

Last is the **S**ubsequent outcome — What is the consequence of the action and behavior? In the case of the Davis scales, the outcome is "accomplish tasks more quickly."

We then adapted this decomposition within the case of Microsoft Access, following the ACTS principles. This resulted in items such as "Using Microsoft Access (action) as a development platform (context) enables me to (target behavior) complete relational databases more quickly (subsequent outcome)." Following the decomposition, the target behavior and subsequent outcome were content analyzed to determine the abstracted meaning that was being asked by the Likert scales. In the case of our first perceived usefulness item, the target behavior was "would enable me to" and the outcome was "accomplish tasks more quickly." Our analysis of this phrase was that it was testing efficiency. Semantic differential scales were created with two anchors to measure the abstracted concept of efficiency.

Our decomposition approach for each item was described in detail in Tables 1 and 2. A comparison of the two scales finds that the perceived ease of use items does not contextualize the behavior similar to perceived usefulness; however, the principles can still be applied. While we are not arguing that this is a comprehensive approach, the ACTS principles can be applied in other contexts. Consider task technology fit, specifically the dimension of quality: the first item is "I can't get data that is current enough to meet my business needs." If we decompose this item, we find

Action: I can't get data
Context: None stated
Target behavior: That is
Subsequent outcome: Current enough to meet my business needs

Appendix B

Scale Items Used

Construct	Original TAM Instrument Wording	Loading	Fast Form Wording	Loading
Usefulness	For the following questions, please indicate the extent to which you agree with the following statements		To aid me in my (accomplishment of tasks), overall, I feel (system) as a (technology type) is:	
	Using (system) as a (technology type) enables me to (accomplish tasks) more quickly	0.77	Efficient/inefficient	0.79
	Using (system) improves my (ability to accomplish task)	0.81	Performance enhancing/performance degrading	0.82
	Using (system) as a (technology type) increases my productivity	0.82	Productivity increasing/productivity decreasing	0.79
	Using (system) enhances my effectiveness in (accomplishing task)	0.84	Effective/ineffective	0.90
	Using (system) makes it easier to do my (task)	0.79	Helpful/unhelpful	0.86
	I find (system) useful in my (task completion)	0.86	Quite useful/quite useless	0.79
EOU	For the following questions, please indicate the extent to which you agree with the following statements		To aid me in my (accomplishment of tasks), overall, I feel (system) as a (technology type) is:	
	Learning to operate the (task-related) platform portions of (system) is easy for me.	0.87	Easy to Learn/Difficult to Learn	0.87
	I find it easy to get the (task-related) portions of (system) to do what I want it to do.	0.89	Easy to manipulate/Difficult to manipulate	0.90
	My interaction with the (task-related) portions of (system) has been clear and understandable.	0.91	Clear to interact with/Obscure to interact with	0.90
	I find the (task-related) portions of (system) to be flexible to interact with.	0.80	Flexible to interact with/Rigid to interact with	0.80
	It is easy for me to become skillful at using the (task-related) portions of (system)	0.87	Easy to master/Difficult to master	0.86
	I find the (task-related) portions of (system) easy to use.	0.91	Very Usable/Very cumbersome	0.77

Construct	Full Instrument Wording	Loading
Predicted Usage	For the following questions, please indicate the extent to which you agree with the following statements	
	If the choice of a (technology type) platform were up to me, it would likely be (system)	0.89
	If I need to (accomplish task) and the choice was up to me, I would expect to use (system) as a (task-related) platform	0.91
	If asked, I would likely recommend (system) as a (task-related) platform	0.91
	For future (task-oriented) tasks that are totally within my control, I would probably use (system) as a (task-oriented) platform	0.92

Appendix C

Covariance Matrix Full Version

	LU4	LU3	LU2	LU1	EOU1	EOU2	EOU3	EOU4	EOU5	EOU6	Use6	Use5	Use4	Use3	Use2	Use1
LU4	2.111															
LU3	1.694	1.903														
LU2	1.662	1.551	1.875													
LU1	1.675	1.570	1.581	1.985												
EOU1	0.880	0.798	0.851	0.757	2.137											
EOU2	0.929	0.877	0.800	0.765	1.619	1.846										
EOU3	0.938	0.895	0.853	0.815	1.541	1.437	1.760									
EOU4	0.920	0.864	0.850	0.794	1.199	1.248	1.251	1.648								
EOU5	0.922	0.864	0.889	0.850	1.535	1.428	1.443	1.258	1.964							
EOU6	0.912	0.873	0.806	0.838	1.620	1.543	1.579	1.346	1.640	2.032						
Use6	1.007	0.939	0.925	0.985	0.644	0.743	0.679	0.676	0.703	0.708	1.436					
Use5	1.026	0.896	0.893	0.883	0.669	0.661	0.666	0.694	0.739	0.693	1.086	1.503				
Use4	0.895	0.864	0.836	0.842	0.564	0.587	0.583	0.641	0.554	0.538	0.956	0.897	1.212			
Use3	0.934	0.945	0.804	0.902	0.526	0.615	0.568	0.602	0.554	0.574	0.978	0.844	0.874	1.311		
Use2	0.831	0.815	0.811	0.856	0.497	0.537	0.576	0.559	0.551	0.528	0.857	0.781	0.778	0.800	1.106	
Use1	0.734	0.740	0.677	0.771	0.505	0.535	0.555	0.528	0.531	0.498	0.748	0.705	0.731	0.773	0.714	1.015

Appendix D

Covariance Matrix Fast Form Version

	LU4	LU3	LU2	LU1	EOU1	EOU2	EOU3	EOU4	EOU5	EOU6	Use6	Use5	Use4	Use3	Use2	Use1
LU4	2.111															
LU3	1.694	1.903														
LU2	1.662	1.551	1.875													
LU1	1.675	1.570	1.581	1.985												
EOU1	1.227	1.072	1.154	1.098	4.202											
EOU2	1.180	1.051	1.061	1.079	2.994	3.299										
EOU3	1.254	1.137	1.123	1.115	2.795	2.584	3.033									
EOU4	1.256	1.224	1.150	1.204	2.157	2.182	2.158	2.897								
EOU5	1.224	1.072	1.097	1.020	3.344	2.958	2.688	2.349	4.247							
EOU6	1.424	1.326	1.224	1.277	2.530	2.232	2.205	2.081	2.433	3.506						
Use6	1.189	1.220	1.079	1.098	1.419	1.303	1.448	1.548	1.265	1.865	2.735					
Use5	0.989	0.999	0.887	0.993	1.275	1.378	1.464	1.414	1.303	1.553	1.818	2.214				
Use4	1.068	1.050	0.952	1.025	1.191	1.272	1.415	1.359	1.243	1.521	1.800	1.807	2.198			
Use3	1.064	0.979	0.862	0.947	1.224	1.286	1.327	1.269	1.214	1.467	1.452	1.330	1.507	2.072		
Use2	1.042	0.938	0.842	0.956	1.105	1.117	1.155	1.056	0.974	1.276	1.270	1.318	1.382	1.396	1.694	
Use1	1.022	0.997	0.910	1.003	1.117	1.020	1.163	1.154	1.109	1.342	1.180	1.207	1.360	1.159	1.183	1.618