MIS Quarterly

RESEARCH NOTE

A META-ANALYSIS OF THE ROLE OF ENVIRONMENT-BASED VOLUNTARINESS IN INFORMATION TECHNOLOGY ACCEPTANCE[1]

By: **Jiming Wu**
Department of Management
College of Business and Economics
California State University, East Bay
25800 Carlos Bee Boulevard
Hayward, CA 94542
U.S.A.
jiming.wu@csueastbay.edu

Albert Lederer
School of Management
Gatton College of Business and Economics
University of Kentucky
Lexington, KY 40506
U.S.A.
lederer@uky.edu

Abstract

The technology acceptance model (TAM) asserts that ease of use and usefulness are two primary determinants of behavioral intention and usage. A parallel research stream emphasizes voluntariness, a key social influence and contextual variable, as a critical factor in information technology (IT) adoption, but pays little attention to its role in TAM. This paper addresses this particular absence by investigating the impact of environment-based voluntariness on the relationships among the four primary TAM constructs. A meta-analysis of 71 empirical studies provides strong support for the hypotheses that environment-based voluntariness moderates the effects of ease of use and usefulness on behavioral intention, but not the effect of ease of use on usefulness. Moreover, inconsistent with our expectations, environment-based voluntariness does not moderate the effects of ease of use and usefulness on usage. By further analyzing the data set, we suggest this may be because of the relatively small sample size, the presence of other factors, or the inappropriate measurement of usage in previous studies. The current study contributes not only to the distinction between user-based and environment-based voluntariness but also to a more complete understanding of user acceptance of IT across system-use environments.

Keywords: Acceptance, behavioral intention, ease of use, meta-analysis, statistical power analysis, publication bias, study artifacts, TAM, system usage, usefulness, voluntariness

Introduction

For the last two decades, a key objective of much IS research has been to investigate the factors that motivate individuals to use information systems. Pursuing this objective, Davis and his colleagues (1989) have developed the technology acceptance model (TAM). The model asserts that the intention to use or actual use of an information system is a function of perceived ease of use and perceived usefulness. In addition, the model proposes that perceived ease of use influences perceived usefulness. From its inception, TAM has been widely applied to a diverse set of information technologies

[1]Detmar Straub was the accepting senior editor for this paper. Moez Limayem served as the associate editor.

Note: The appendices for this paper are located at http://www.misq.org/archivist/appendices/WuLedererAppendices.pdf.

and users, and has received substantial empirical support (e.g., Adams et al. 1992; Agarwal and Karahanna 2000; Gefen et al. 2003b).

Meanwhile, prior research has investigated the importance of a social influence factor and contextual variable, namely, voluntariness. The research has done so via two perspectives: first, its moderating role between behavioral intention and such other variables as subjective norms (Hartwick and Barki 1994; Venkatesh et al. 2003), and second, its direct effect on IT adoption and use (Agarwal and Prasad 1997; Karahanna et al. 1999). However, research has yet to examine the role of voluntariness in the relationships among the four primary TAM constructs of perceived ease of use, perceived usefulness, behavioral intention, and usage. As Brown and her colleagues (2002) point out, examining the role of voluntariness in TAM can help researchers ascertain whether the well-documented TAM relationships differ in voluntary versus nonvoluntary environments. They suggest the need to include voluntariness to capture the possible variation in the model's performance.

This study responds to this research need by conducting a meta-analysis of previous TAM studies and investigating the role of environment-based voluntariness in moderating the relationships among the four constructs. A meta-analysis is quite appropriate for such investigation because the empirical studies included in the data set offer a variety of system-use environments and thus various levels of environment-based voluntariness. Such environments and levels are unlikely to be obtained from a single study. Moreover, a synthesis of previous studies can assist in evaluating TAM findings, robustness, and limitations. Such evaluation can help IS researchers resolve some of the controversy surrounding the methodology of TAM research, identify possible research opportunities, and conduct future studies (Lee et al. 2003). Finally, such a study also responds to Straub and Burton-Jones's (2007) call for meta-analysis examining the main TAM relationships and important moderating factors. As they point out, such a meta-analysis will help researchers achieve the goal of moving TAM research toward parsimony.

Therefore, the objective of this paper is to address the following research questions: (1) Does environment-based voluntariness impact TAM findings about perceived ease of use, perceived usefulness, behavioral intention, and usage? (2) If so, does it impact them differently? To answer these questions, this paper develops a theoretical model that integrates environment-based voluntariness into TAM and tests the model through a combination of meta-analysis and weighted least squares regression procedures.

Theoretical Background

TAM and Other Important Factors

While acknowledging the robustness and power of TAM, researchers continue to attempt to extend the model with other factors critical to IT adoption and use. In a meta-analysis of TAM, Lee and his colleagues (2003) find that more than 20 other factors have been introduced into the model. Among them, the most frequently introduced factors can be categorized into two main groups.

The first includes individual difference factors such as level of education (Agarwal and Prasad 1999; Bostrom et al. 1990), gender (Gefen and Straub 1997; Venkatesh and Morris 2000), computer self-efficacy (Compeau et al. 1999; Fu et al. 2006; Hong et al. 2001), and prior experience (Agarwal and Prasad 1999; Igbaria et al. 1995). The second group includes social influence factors such as voluntariness (Hartwick and Barki 1994; Karahanna et al. 1999), subjective norms (Mathieson 1991; Wu and Liu 2007), image (Plouffe et al. 2001; Venkatesh and Davis 2000), and management support (Igbaria et al. 1997). Both individual difference and social influence factors are critical to our understanding of user acceptance of IT because both play significant roles in influencing how users make their decisions about system adoption and use (Venkatesh and Morris 2000). Moreover, prior studies indicate that some of these factors can be important moderators of key relationships in technology acceptance models (Brown et al. 2002; Hartwick and Barki 1994; Morris and Venkatesh 2000; Srite and Karahanna 2006; Sun and Zhang 2006; Venkatesh and Davis 2000; Venkatesh and Morris 2000; Venkatesh et al. 2003). Next, we will discuss voluntariness, the core social influence factor of this paper, in the context of technology acceptance.

Voluntariness and IT Adoption

Voluntariness is defined as the degree of free will involved in the adoption of an information system. An individual's freedom to choose to adopt an information system is primarily affected by contextual factors. An organizational policy may require the use of a particular information system, and thus deprive the individual of the freedom of choice (Moore and Benbasat 1991). An individual's job description can also include such a requirement. For example, accountants' job descriptions may require them to use an accounting information system to record the flow of corporate funds. A mandate from superiors can also influence technology use in an organization (Agarwal and Prasad 1997). Specifically, superiors who are aware of the advantages of a particular

information system may thus expect or even require their subordinates to use it (Sasidharan et al. 2006). Notwithstanding organizational policy, job description, and superiors' mandates, employees within an organization may still lack freedom to choose to adopt if they are required to use the system to perform their jobs (Brown et al. 2002).

Previous IS research suggests that voluntariness can be based in the environment or in the user. Voluntariness based in the environment refers to a context-dependent freedom in adopting an information system. This voluntariness is nonperceptually based, stems from a physical context, and is independent of personal biases and points of view. Motivation of system use is thus extrinsic. For each context, a corresponding voluntariness degree can be measured by analyzing the environment-related information, such as the extent one's superior requires the use. Studies of environment-based voluntariness focus on how environments differentially influence user adoption behavior (Brown et al. 2002; Venkatesh et al. 2003).

Voluntariness based in the user refers to a perception-dependent freedom in adopting an information system (Moore and Benbasat 1991). Such voluntariness is subjective because it exists inside users' minds; thus, motivation is intrinsic. Individuals who share the same environment can nevertheless differ in their willingness to use an information system. That is, they can have different degrees of user-based voluntariness. Studies of user-based voluntariness focus on how IS adoption behavior is different when users perceive an adoption decision as more or less voluntary (Agarwal and Prasad 1997; Karahanna et al. 1999). We think it is important to distinguish between environment- and user-based voluntariness because such a distinction helps IS researchers better understand the concept of voluntariness, more effectively design and conduct relevant research, and more accurately interpret their findings.

Previous research suggests that voluntariness can be studied as either a continuous or a binary variable. Moore and Benbasat (1991) argue that system-use behavior can be neither completely voluntary nor mandatory, but lies somewhere between the two. Thus, they measure voluntariness on a continuum. Similarly, Karahanna et al. (1999) argue that voluntariness can be widely variable, even when the system is held constant. However, simply viewing system use as either voluntary or mandatory, Hartwick and Barki (1994) and Venkatesh et al. (2003) treat voluntariness as a binary construct.

Moore and Benbasat were among the first researchers to pay attention to the construct of voluntariness. In their study developing an instrument to measure IT adoption perceptions, they argue that when examining the diffusion of IT, research attention must be given to whether individuals are free to make and apply personal adoption or rejection decisions. They also argue, based on their common sense and experience, that there tend to be degrees of voluntariness with respect to behavior in organizations. Finally, to help researchers clarify assumptions about the freedom of choice in IT adoption, they develop a four-item scale to measure voluntariness.

Subsequent research on voluntariness can be categorized into two main streams. The first stream seeks to understand the moderating role of environment-based voluntariness in the context of information system use. In a study examining the relationship between user participation and system use, Hartwick and Barki divide research participants into a mandatory-user group and a voluntary-user group based on their system-use environments. The results of their study indicate that environment-based voluntariness moderates the roles of user participation and involvement in system use behavior. More specifically, they find that for the voluntary group, user participation and involvement are important predictors of attitudes, norms, intentions, and use, while for the mandatory group, user participation does not predict any of these variables, and user involvement also fails to predict attitude and subjective norm. Thus, they argue that depending on whether system-use environment is voluntary, the roles of user participation and involvement can be different.

Similarly, in a research paper focusing on a unified model of IT adoption, Venkatesh et al. (2003) investigate the moderating role of environment-based voluntariness. They use the scale developed by Moore and Benbasat to measure voluntariness level, and divide their four empirical studies into two groups: a voluntary-use group and a mandatory-use group. They find that social influence (measured via three constructs: subjective norm, social factors, and image) has a stronger effect on behavioral intention in the context of mandatory use than in the context of voluntary use. Similar results have also been reported by Venkatesh and Davis (2000).

The second stream seeks to examine the direct impact of user-based voluntariness on IT adoption and use. In a study examining the impact of technology characteristics on the acceptance of that technology, Agarwal and Prasad (1997) find a differential influence of user-based voluntariness on current and future system-use intentions. Specifically, voluntariness has a significant effect on current system use, but not on continued-usage intention. Meanwhile, in a study focusing on the differences in pre- and post-adoption beliefs and attitudes, Karahanna et al. (1999) also examine the relationship

between user-based voluntariness and behavioral intention. The results of their study indicate that user-based voluntariness is a significant determinant of intention for current users, but not for potential adopters.

In summary, prior studies on voluntariness have made three primary assumptions:

1. Voluntariness can be based in the environment and in the user.
2. Voluntariness can be measured as a continuous or a binary variable.
3. Varying levels of voluntariness exist regarding system use in organizations and institutions.

Moreover, previous work collectively confirms the important role of voluntariness in shaping an individual's intention to use or actual use of an information system.

Research Model and Hypotheses

Evidence from Prior Research

A voluntary or willful action differs from a nonvoluntary action in that the voluntary action is internally determined by the individual, whereas the nonvoluntary action is directed or coerced from outside. A nonvoluntary action is thus reactive while a voluntary action is active (Polivanova 2001). In the context of information system use, Doll and Torkzadeh (1998) argue that when usage is nonvoluntary, the actual use of a system may only mean conformance to a superior's requirements or compliance with organizational policies. On the other hand, when usage is voluntary, intention to use and actual usage reflect the individual's perceptions and beliefs regarding the system (Hartwick and Barki 1994).

Although various types of systems are employed for different purposes, user perceptions and beliefs regarding those systems may have the same focus. For example, when a project team member has the free will to use or not use a groupware system (e.g., Lotus Domino Discussion Database), the individual will probably consider whether the system is easy to use and whether the technology is useful to add additional value to project outcome (Lerouge et al. 2004). Similarly, when individuals make their own decisions to adopt or reject an electronic tax-filing system, they may consider whether the system is easy to learn and use, and whether the system is useful to their tax return preparation (Wang 2002). Following this line of thought, we argue that in a voluntary-use environment, perceived ease of use and perceived usefulness are more likely to be the fundamental determinants of intention to use or actual use of an information system.

Prior research suggests some evidence in favor of the above argument by emphasizing that in a voluntary-use environment, factors other than perceived ease of use and perceived usefulness are less likely to significantly impact behavioral intention. For example, Venkatesh et al. (2003) provide empirical evidence that social influence constructs (i.e., subjective norm, social factors, and image) play a relatively insignificant role in predicting behavioral intention in voluntary-use environments. Similarly, Hartwick and Barki (1994) empirically show that subjective norm does not have a significant impact on intention in voluntary settings. The same result is replicated by Venkatesh and Davis (2000) in a study of an extended TAM model. In light of this, we argue that the attenuation or disappearance of the impact of these social influence constructs on intention and usage suggests the possibility that in a voluntary-use environment, some other factors (such as, perhaps, perceived ease of use and perceived usefulness) may play a key role in predicting behavioral intention and usage.

TRA and Related Studies

The theory of reasoned action (TRA) and related studies also support the proposition that perceived ease of use and perceived usefulness will more significantly impact behavioral intention and usage in voluntary-use environments. TRA focuses on examining the determinants of volitional behavior —the behavior under an individual's control (Karahanna et al. 1999). Previous research suggests that voluntary behavior is likely to be the result of the individual's favorable attitude, while mandatory behavior is likely to be the result of organizational coercion (Hartwick and Barki 1994). Moreover, TRA asserts that an individual's attitude toward a behavior is determined by a set of salient beliefs the individual holds about performing the behavior (Ajzen and Fishbein 1980). To date, the two most salient beliefs identified in the IT adoption and use literature are perceived ease of use and perceived usefulness (Davis 1989; Davis et al. 1989). Taken together, it can be reasoned that voluntary behavior of using an information system is more likely influenced by perceived ease of use and perceived usefulness. In other words, in voluntary-use environments, perceived ease of use and perceived usefulness would seem to be the two most important determinants of behavioral intention and usage. Therefore, it is plausible to posit that the more that voluntariness is embedded into system-use environments, the greater is the impact of perceived ease of use and perceived usefulness on behavioral intention and usage.

The Theory of Apparent Mental Causation

The theory of apparent mental causation is proposed to account for the experience of free will (Wegner 2002; Wegner and Wheatley 1999). According to this theory, individuals usually experience "conscious will" (i.e., the power of choosing their own actions) when they interpret their own thought as the cause of their action. Thus, the conscious will can be viewed as a function of the priority, consistency, and exclusivity of the thought about the action; the thought should therefore occur before the action, be consistent with the action, and be unaccompanied by other causes (Wegner 2002). In essence, the theory indicates that individuals experience voluntariness mostly when their thought about an action is the primary cause of the action (Wegner and Erskine 2003).

The relevance of the theory to the study of IT adoption is clear. When individuals voluntarily use an information system, their thoughts about using are very likely the main cause of behavioral intention and usage. According to prior research (Davis 1989; Davis et al. 1989), such thoughts may involve evaluating the ease of use and usefulness of the system. This is because ease of use and usefulness are greatly important to users, the former reducing their efforts and the latter helping them to perform their jobs better (Davis 1989). It is thus reasonable to theorize that in the voluntary-use environment, both perceived ease of use and perceived usefulness are the most likely factors contributing to individuals' intention to use an information system. Therefore, these two factors should be better correlated to behavioral intention and usage when voluntariness is present.

Hypotheses and Model

Figure 1 shows the research model. Based on the aforementioned theories, findings, and arguments, we hypothesize that the effect of perceived ease of use and perceived usefulness on behavioral intention and usage is environmentally dependent. That is, the influence of ease of use and usefulness on intention and usage increases as environment-based voluntariness increases. Thus, we present four hypotheses.

Environment-based voluntariness will moderate the correlation between

H1: perceived usefulness and behavioral intention
H2: perceived ease of use and behavioral intention
H3: perceived usefulness and usage
H4: perceived ease of use and usage

At the same time, we argue that environment-based voluntariness lacks an effect on a relationship when behavioral intention or usage is uninvolved. Specially, we argue that the effect of perceived ease of use on perceived usefulness is not influenced by environment-based voluntariness. According to Davis et al. (1989), perceived ease of use contributes to perceived usefulness because increased ease of use contributes to improved performance. If an information system is easy to use, it is likely to save users effort and improve their performance, and thus they perceive it as useful, no matter whether their usage is based on their own decisions or on organizational requirements. This is in accordance with the notion that both perceived ease of use and perceived usefulness are based on the nature of information systems, but not on the system-use environment (Davis 1989). Therefore, we propose that the effect of perceived ease of use on perceived usefulness is environmentally independent: the influence of ease of use on usefulness in voluntary-use environments does not significantly differ from that in mandatory-use environments.[2] Formally,

H5: Environment-based voluntariness will not moderate the correlation between perceived ease of use and perceived usefulness.

Methodology

Meta-analysis has been employed to test the research hypotheses. As a set of statistical techniques, meta-analysis refers to analysis that combines results from many individual studies addressing the same research question (Glass 1976; Hunter and Schmidt 1990). Previous research shows that meta-analysis is not only a useful tool for research synthesis (Hwang 1996; Lee et al. 2003; Ma and Liu 2004), but also an effective instrument for hypothesis testing (Dennis et al. 2001; Sabherwal et al. 2006; Sharma and Yetton 2003).

Sample

The sample of this meta-analysis includes studies from journals, books, dissertations, and conference proceedings. Dissertations and conference proceedings are included to minimize the potential bias of the higher effect sizes associated with journal articles; it is widely accepted that journals are more likely to publish studies with significant, hypothesis-supporting results (Dennis et al. 2001; Rosenthal 1979; Sharma and Yetton 2003). To locate studies, we searched

[2] A directional hypothesis is usually more useful, but this research employs a null hypothesis for H5 because voluntariness is thought not to impact the TAM relationship in this case.

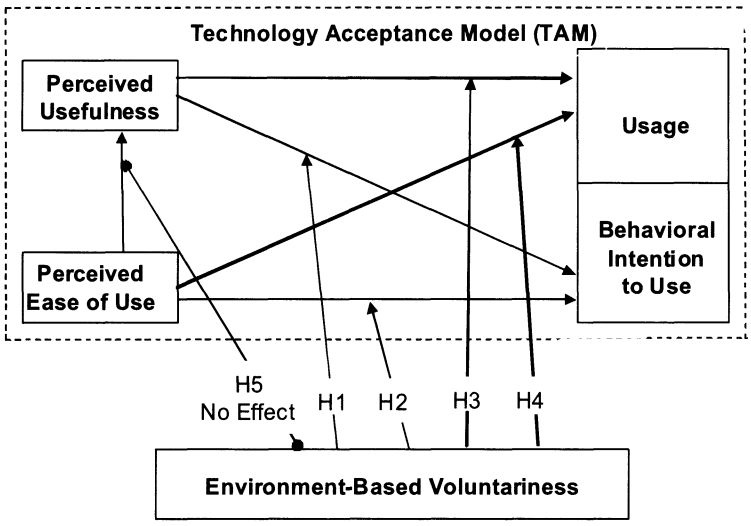

Figure 1. Research Model

bibliographic databases and both electronic and hard copy bibliographies in journals, conference proceedings, and books (Rosenthal 1990). The bibliographic databases were ABI/INFORM, Business Source Premier, ScienceDirect, ProQuest Dissertation and Thesis, WorldCat Dissertation and Thesis, and various conference proceedings such as the International Conference on Information Systems and the Americas Conference on Information Systems. We did manual searches whenever back issues of the journals were unavailable in bibliographic databases. To find more studies, we also sent a general inquiry for working papers and conference proceedings to the IS community through the most popular mailing list in IS field, AISWorld. Via such a comprehensive search strategy, we were able to maximize the number of studies, reduce the source bias, and thus increase the power of the meta-analysis (Sharma and Yetton 2003).

We conducted the computer searches in bibliographic databases with such keywords as technology acceptance model, TAM, adoption, acceptance, behavioral intention, use, usage, ease of use, and usefulness. The searches found more than 650 journal articles, 400 conference proceedings papers, and 400 unpublished dissertations. Those articles, proceedings papers, and dissertations were then examined to locate studies that could provide data to be included in the meta-analysis. Moreover, bibliographies of the articles identified were also scanned to locate additional studies. We thus identified over 100 studies and checked their potential for inclusion.

Studies were chosen if they satisfied the following criteria:

1. They operationalized perceived ease of use, perceived usefulness, and behavioral intention/usage.
2. They reported reliabilities of measures of the variable.
3. They described an information system usage context in a way that gave enough information to code the measure of environment-based voluntariness.
4. They reported sample sizes.
5. They reported the correlations among perceived ease of use, perceived usefulness, and behavioral intention/usage, or they reported other values that could be converted to correlations.[3]

An important assumption in meta-analysis is the independence of each study (Ma and Liu 2004). To satisfy this assumption, we ensured the uniqueness of each study by carefully comparing its description and statistical data with those of others. If two or more studies reported in different articles, proceedings papers, and dissertations were based on same data set, they were treated as one study, and only one was selected. On the other hand, when a study presented multiple data sets based on the same sample, the simple average values were recorded (Heneman 1986). Again, this was done to preserve the assumption. Conversely, when a study presented multiple data sets based on different samples, each data set was treated as a separate study. According to Hunter and his colleagues (1982), this approach was appropriate and did not violate the assumption. Finally, when a study pre-

[3]Appendix A shows the procedures to convert various test statistics into corresponding correlations.

sented one data set for behavioral intention and another data set for usage based on the same sample, the two data sets were treated as two separate studies for the purpose of this meta-analysis.[4]

Table C1 (for behavioral intention studies) and Table C2 (for usage studies) in Appendix C present the studies included in the meta-analysis and the data collected from them. The final sample consists of 39 journal articles, 5 conference proceedings papers, and 10 dissertations. The 39 journal articles contributed 52 studies (36 for behavioral intention and 16 for usage) because 1 journal article reported 3 separate studies and 11 journal articles each reported 2 separate studies. The 5 conference proceedings papers contributed 5 studies for behavioral intention. The 10 dissertations contributed 14 studies (9 for behavioral intention and 5 for usage) since 1 reported 4 separate studies and another reported 2 separate studies. Consequently, the meta-analysis is based on 71 studies; 50 of them measuring the relationships among ease of use, usefulness, and behavioral intention, and 21 of them measuring the relationships among ease of use, usefulness, and usage.

Measurement of Voluntariness

Environment-based voluntariness was evaluated for each study in the meta-analysis. Following Sharma and Yetton's (2003) approach, a description of the system-use environment was created by taking all portions of text from each study literally; no changes were allowed unless to link extracts coming from different parts of the original study.[5] The description included all information given in the original study concerning the introduction of the information system, where and why it was used, whether the use was required by superiors/professors or job/school responsibility, and the end users sampled.

This study employed the four-item scale of voluntariness developed and validated by Moore and Benbasat (1991). Table 1 shows the scale. Two independent judges and the senior author of the current study rated the description of each study on this scale. The results indicated high internal reliability: the three Cronbach's alpha values (one per rater), based on the 63 unique studies[6] were 0.95, 0.94, and 0.97. Moreover, inter-rater Pearson's correlations were 0.82, 0.81, and 0.82, and the average Shrout and Fleiss's (1979) intraclass correlation for the raters was 0.92. Overall, these results provide strong evidence of high inter-rater reliability. The average voluntariness scores for the studies are also shown in Appendix C.

Analysis

Before testing the research hypotheses, we summarized the findings reported by the individual studies. This summarizing, along with identifying studies to be included in the analysis and collecting data from the individual studies, constitutes the three major steps in a meta-analysis (Sabherwal et al. 2006). Appendix D shows the summarization and some other analyses, namely tests of publication bias and heterogeneity.

A weighted least squares regression (WLSR) procedure was employed to test the research hypotheses (Hedges and Olkin 1985). WLSR permits the testing of moderating effects. Unlike linear/nonlinear least squares regression, WLSR incorporates extra nonnegative constants—the weights—into the model-fitting criteria. By assigning a weight to each observation, the researchers give each data point its proper amount of impact on the final parameter estimates. The WLSR procedure in this research tested the slope in five regression models with the sample size of each included study as its weight, environment-based voluntariness as the independent variable, and one of the five correlations among perceived ease of use, perceived usefulness, behavioral intention, and usage as the dependent variable.[7]

One weakness of WLSR is its sensitiveness to the effects of outliers. If potential outliers are not handled appropriately in a WLSR procedure, they will likely negatively affect parameter estimation and statistical analysis. If a large sample size study is an outlier, it is likely to dominate the meta-analysis and cause the generation of deviant results (Argo and Main 2004). In this study, we handle outliers by analyzing the data with and without the two studies reporting disproportionately large sample sizes (26,989 and 31,596).[8] Such an approach allows us to compare the results and discover whether they are significantly different. Those two studies are not included in the aforementioned 71 studies and are numbered as E1 and

[4] Appendix B presents the additional tests related to the independence of the studies included in this meta-analysis.

[5] The context descriptions are available from the authors on request.

[6] Among the 71 (50 + 21) studies, 8 studies present data sets for both behavioral intention and usage. Thus, there are 63 (71 – 8) unique studies.

[7] For example, the first regression model was: $\text{Correlation}_{\text{usefulness and intention}} = b_0 + b_1 \text{Voluntariness} + \text{error}$.

[8] As shown in Table 2, the aggregate sample size of the 50 studies for behavioral intention is 10,182, while the total sample size of the two outlying studies reaches 58,535. This indicates that the two outlying studies are likely to dominate the meta-analysis and thus need to be addressed.

Table 1. Voluntariness Scale

1.	The survey participants' superiors/professors expect them to use the information system.
2.	The survey participants' use of the information system is voluntary (as opposed to being required by their superiors/professors or job/program description).
3.	The survey participants' boss/professor does not require them to use the information system.
4.	Although it might be helpful, using the information system is certainly not compulsory in the survey participants' job/program.

Notes: The scale is adapted almost verbatim from Moore and Benbasat (1991). Items 2, 3, and 4 were rated on a 1 (disagree, meaning low voluntariness) to 5 (agree, meaning high voluntariness) scale, whereas item 1 is reversed.

E2 listed at the end of Table C1. Moreover, in the regression analyses, we employ only correlations corrected for measurement error (see method 1 of Appendix E). Tables C1 and C2 also show the original and corrected correlations.

Results

Figure 2 shows standardized path coefficients and significance levels for each hypothesis. The figure does not present the results with the two outliers included because no substantive difference exists between the results with and without those outliers. Consistent with the predictions, environment-based voluntariness has a significant impact on the correlation between usefulness and intention ($\beta_{voluntariness} = 0.38$, $t = 2.84$, $p < 0.01$) (H1), and on the correlation between ease of use and intention ($\beta_{voluntariness} = 0.42$, $t = 3.23$, $p < 0.01$) (H2). However, environment-based voluntariness impacts neither the correlation between usefulness and usage ($\beta_{voluntariness} = -0.27$, $t = -1.22$, $p > 0.10$) (H3), nor the correlation between ease of use and usage ($\beta_{voluntariness} = -0.25$, $t = -1.13$, $p > 0.10$) (H4). Finally, environment-based voluntariness does not affect the correlation between ease of use and usefulness ($\beta_{voluntariness} = 0.06$, $t = 0.43$, $p > 0.10$), thus supporting H5. Table 2 summarizes the regression analysis results without the two outliers and the results when the two outliers are included (numbers in brackets).

To better understand the magnitude of the research findings for the first two supported hypotheses, we followed Sharma and Yetton (2007) and thus estimated the correlation coefficients between behavioral intention and the two belief variables at low and high levels of voluntariness. When voluntariness is low (one standard deviation below the mean),[9] the correlation between intention and usefulness is 0.59 and the correlation between intention and ease of use is 0.43. When voluntariness is high (one standard deviation above the mean), the correlation between intention and usefulness is 0.71 and the correlation between intention and ease of use is 0.58. In the former situation (low voluntariness), usefulness explains 34.8 percent (0.59^2) of the variance in intention, while ease of use explains 18.5 percent of variance in it. In the latter situation (high voluntariness), usefulness explains 50.4 percent of the variance in intention, nearly 45 percent ((50.4-34.8)/34.8) more, while ease of use explains 33.6 percent of variance in it, nearly 81.2 percent more.[10] These numbers confirm that the higher the level of voluntariness, the greater the impact of ease of use and usefulness on intention, and thus provide additional evidence for the moderating role of voluntariness.

Discussion

As we hypothesized, the results of this study suggest that environment-based voluntariness impacts the correlations between behavioral intention and the two belief variables (i.e., usefulness and ease of use) and that, conversely, environment-based voluntariness does not influence the correlation between these two belief variables. However, the results do not support the two hypotheses related to usage. To help readers better interpret the results, below we discuss potential reasons why two hypotheses are not supported.

In the current meta-analysis, the results on usage are based on 21 individual studies, whereas the findings related to behavioral intention are derived from a sample of 50 individual studies. Compared with the sample size for behavioral intention, the sample size for usage is relatively small (the power for H3 and H4 is 0.21 and 0.27, respectively). Such a relatively small sample may be insufficient to detect the impact of environment-based voluntariness on the correlations

[9] The mean and standard deviation of voluntariness are 11.33 and 4.98, respectively.

[10] A *t*-test comparison of the correlation between usefulness and intention for the high voluntariness group versus the low voluntariness group ($t = 2.28$, $p < .05$), and a *t*-test comparison of the correlation between ease of use and intention for the same two groups ($t = 3.75$, $p < .001$) were both significant, and thus consistent with the H1 and H2 findings.

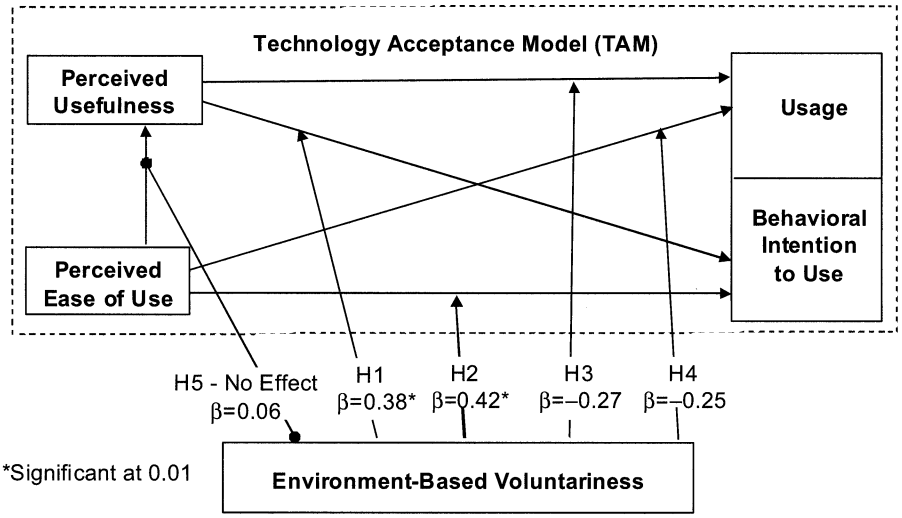

Figure 2. WLSR Analysis Results

Table 2. WLSR Analysis Results

WLSR Model	Number of Observations or studies	Aggregate Sample Size	Unstandardized Coefficients		Adjusted R^2	Beta	t value	p value	Hypothesis Supported
			Constant	Voluntariness					
1	50 (52)	10,182 (68,767)	0.513 (0.454)	0.012 (0.018)	0.13 (0.40)	0.38 (0.64)	2.84 (5.94)	<0.01 (<0.01)	H1 – Yes
2	50 (52)	10,182 (68,767)	0.334 (0.334)	0.015 (0.015)	0.16 (0.18)	0.42 (0.44)	3.23 (3.47)	<0.01 (<0.01)	H2 – Yes
3	21	5,119	0.504	–0.009	0.04	–0.27	–1.22	>0.10	H3 – No
4	21	5,119	0.409	–0.007	0.02	–0.25	–1.13	>0.10	H4 – No
5	63 (65)	13,127 (71,712)	0.538 (0.49)	0.002 (0.004)	–0.01 (0.02)	0.06 (0.18)	0.43 (1.43)	>0.10 (>0.10)	H5 – Yes

Note. Numbers in brackets are for the results with the two outliers included. Because both of the two outlying studies are for behavioral intention, there is only one set of results for usage. See the Power Analysis for Hypotheses section in Appendix F for the relevant power analysis.

regarding usage. Second, the theory of planned behavior (Ajzen 1991) and the unified theory of acceptance and use of technology (Venkatesh et al. 2003) suggest that usage is determined by facilitating conditions, which may weaken the moderating role of voluntariness and prevent finding significance for the two hypotheses.[11] Finally, self-reported usage, despite its popularity, may be not only a poor surrogate for actual usage but also a critical limitation of TAM studies (Lee et al. 2003; Szajna 1996).[12] Therefore, TAM relationships may not appear with objective and independent measures of usage (Straub et al. 1995). Empirical evidence suggests that perhaps no universally acceptable scale exists to measure usage and that a measure of usage should be contextualized; thus, researchers must more carefully measure or even reconceptualize usage (Burton-Jones and Straub 2006).

Implications for Researchers

This study is motivated by a need to understand the impacts of system use environments on user behavior captured by TAM. Prior research largely focuses on the study of voluntary system use because voluntary environments free individuals from other influences to adopt information technology (Hartwick and Barki 1994). However, many behaviors in organizations, particularly those related to technology, are not totally voluntary (Brown et al. 2002). Therefore, it is of great importance and practical interest to study system use behavior in environments at various voluntariness levels, as is this meta-analysis.

This study suggests that when a researcher is investigating system use behavior in nonvoluntary settings, some effects are likely to be muted or attenuated (e.g., perceived ease of use and perceived usefulness may not predict behavioral intention). More to the point, if researchers studying user behaviors in a nonvoluntary environment do not find significance in some of their predicted paths, the muting effects of the nonvoluntary setting itself may be the explanation. This suggests that comparative analysis of voluntary–nonvoluntary environments may be required in such cases to tease out the underlying effects. This is important information for IS researchers. Editors, reviewers, and readers need to be highly circumspect of TAM studies in nonvoluntary settings when the results are mixed.

The theory developed and findings reported in this study provide researchers with new insights into the inconsistent findings in the literature. While most studies on IT adoption report positive correlations between behavioral intention and the two belief variables, a wide variance in the correlations is present across studies, ranging from as low as 0.18 (usefulness-intention correlation) and 0.09 (ease-of-use-intention correlation) (Gefen et al. 2003a) to as high as 0.85 (usefulness-intention correlation) (Davis 1989) and 0.77 (ease-of-use-intention correlation) (Li et al. 2004). Such discrepancy in research findings motivates this meta-analysis and now can be explained by part of the research model developed in this study, which hypothesizes that the effect of perceived usefulness and perceived ease of use on behavioral intention is moderated by the level of environment-based voluntariness. The results of the meta-analysis provide strong support for the hypotheses, and thus indicate that a great proportion of the variance in reported correlations is explained by the moderating effect of environment-based voluntariness.

The results reported above also show that the level of environment-based voluntariness does not moderate the effect of perceived ease of use on perceived usefulness. This validates the fifth hypothesis and suggests that the correlation between these two belief variables is environmentally independent. However, this finding does not imply a narrow variance in the correlations between the two constructs across the studies. In fact, the variance, ranging from as low as 0 (Bajaj and Nidumolu 1998) to as high as 0.81 (Wang et al. 2003), is as wide as the other two variances reported earlier. Because the level of environment-based voluntariness does not account for this discrepancy, it is reasonable to argue that a third variable such as self-efficacy may be responsible for the observed effect. Drawing on Bandura's (1977) social cognitive theory, researchers have posited that self-efficacy positively influences perceived usefulness (Agarwal and Karahanna 2000; Lewis et al. 2003). Thus, future research may be needed to investigate whether self-efficacy plays a moderating role in the effect of perceived ease of use on perceived usefulness.

In addition to the evidence that voluntariness matters in certain cases, this study asserts that voluntariness can be environment-based or user-based. Although previous studies have investigated voluntariness in this manner, none to our knowledge have made such a distinction. To investigate environment-based voluntariness of interest, we code studies based on the descriptions of their system-use settings. However, due to lack of user perception data, we are not able to explore user-based voluntariness, indicating a possible limitation of this study. To deepen our understanding of voluntariness, future studies may not only maintain but also

[11] We thank the review team for suggesting the first two potential reasons.

[12] In this meta-analysis, 18 of the 21 usage studies have used self-report to measure usage, and only 3 have used actual data.

further improve the distinction. Because user-based voluntariness is likely highly correlated with environment-based voluntariness, it is reasonable to hypothesize that user-based voluntariness plays the same role as environment-based voluntariness in TAM. Future research can empirically test such a hypothesis.

Finally, Straub and Burton-Jones (2007) believe that a need exists for parsimony in TAM studies in the future. We think this meta-analysis is in accordance with such need. Because environment-based voluntariness plays a moderating role in the relationships among the three TAM constructs, there may be less need to test it extensively in future studies that focus on the three.

Conclusion

The purpose of this study is to empirically examine the role of environment-based voluntariness in the relationships among the four primary TAM constructs. Hypotheses with their roots in the literature of IT acceptance are developed and tested. Based on a meta-analysis of 71 empirical studies, the results of this research confirm that environment-based voluntariness moderates the effects of ease of use and usefulness on behavioral intention, but not the effect of ease of use on usefulness. Moreover, inconsistent with our expectations, environment-based voluntariness does not moderate the effects of ease of use and usefulness on usage. We suggest this may be because of the relatively small sample size, the presence of other factors, or the inappropriate measurement of usage in previous studies. No doubt, this suggestion presents an important avenue for future research.

Acknowledgments

The authors would like to thank the senior editor, the associate editor, and the three reviewers for their very useful comments and suggestions on earlier versions of this paper.

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About the Authors

Jiming Wu is an assistant professor in Information Technology Management at the California State University, East Bay. He received his Ph.D. from the University of Kentucky. His research interests include knowledge management, Internet-based business applications and IT acceptance, and computer and network security. His work has been published in such journals as *The DATA BASE for Advances in Information Systems*, *Information Systems Frontiers*, *Knowledge Management Research & Practice*, and *Journal of Electronic Commerce Research*.

Albert L. Lederer is a professor in Decision Science and Information Systems at the University of Kentucky. He received his Ph.D. from the Ohio State University. His research interest focuses on information systems management. His research has appeared in *MIS Quarterly*, *Information Systems Research*, *Journal of MIS, Decision Science, Sloan Management Review,* and elsewhere.