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External Variables and the Technology Acceptance Model

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BACKGROUND

The Technology Acceptance Model (TAM) predicts the user acceptance of end-user applications by specifying causal relationships among select belief and attitudinal constructs that mediate the influence of external variables on usage behavior. Previous researchers (Davis, 1993) have cited the need to validate TAM across different user populations. Although the perceived usefulness and perceived ease of use constructs have received a great deal of recent attention in the MIS literature (Adams, et al., 1992; Davis, 1986, 1989 and 1993; Davis, et al., 1989; Davis and Venkatesh, 1995; Hartwick and Barki, 1994; Hendrickson, et al., 1993; Mathieson, 1991; Moore and Benbasat, 1991; Segars and Grover, 1993; Subramanian, 1995; Venkatesh and Davis, 1994), very few studies have validated the full TAM model using all of the original belief and attitudinal constructs. TAM asserts that the principal influence of beliefs is *on attitudes* that subsequently impact behavior. In addition, there are no published studies that use structural equation modeling and path analysis to validate the full TAM model. To assess TAM, there is a requirement to simultaneously measure the cascading direct and indirect effects of model variables. Validating TAM in this way enables the simultaneous assessment of the effects of *attitude toward using* on different measures of usage. Thus, a more finely-grained representation of TAM in predicting qualitatively distinct usage behaviors, or metrics, may be assessed. Furthermore, existing research has not addressed the implications of standardized user interfaces on TAM. To the extent that end-user applications have a similar "look and feel" (e.g. consider MicroSoft windows applications), is there an implication for the role of the *ease of use* construct in TAM? Finally, the role of *external variables* vis a vis TAM has not been well explored. Davis (1993) called for (p.483): "future research [to] consider the role of additional [external] variables within TAM." This study extends and refines previous related research by addressing each of these points.

METHOD

Subjects were 125 staff, professional and managerial employees of a large federal government agency in the mid-Atlantic states. A questionnaire was circulated that solicited their beliefs and attitudes about two different MS-windows-based end-user applications, Cc:mail electronic mail and WordPerfect word processing software. The respondents were screened to ensure that they had used the target software applications. Subjects were instructed to omit any section of the questionnaire if they had not used that corresponding system. Of the 125 subjects, 122 had used the electronic mail package and 118 had used the word processor, for a total of 240 usable responses.

The empirical research model is presented as Figure 1. Structural equation modeling and path analysis using the CALIS procedure in SAS are utilized to estimate parameter values for model linkages. There are six variables in the empirical model; three are latent constructs and three are measured (or manifest) variables. Latent variables include *perceived usefulness, perceived ease of use* and *attitude toward using*. The *usefulness* and *ease of use* constructs were measured with Davis' (1989) original six-item, seven-point semantic differential scales. *Attitude toward using* was measured with a five-item, seven-point semantic differential rating scale as suggested by Ajzen and Fishbein (1980) and used by Davis (1993). Measured variables include three different *external variables, usage frequency* and *usage volume*. The three external variables are self-reported measures of: years of computer experience, system familiarity (length of elapsed time since first using that application), and organizational job category (staff support, programmer, analyst, or manager). *Usage frequency* was measured as the number of times per week that the respondent reported using that application. *Usage volume* was measured as the number of hours per week that the respondent reported using that application.

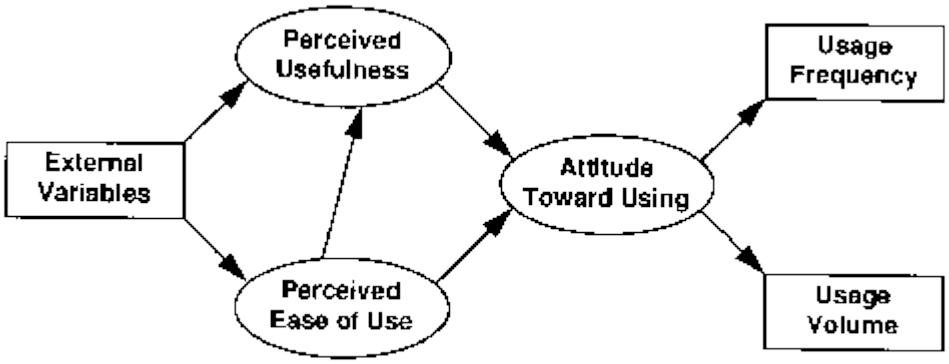

Figure 1: Empirical Research Model.

RESULTS

The factor loadings of questionnaire item responses confirm the factorial validity of three distinct latent constructs: (1) perceived usefulness; (2) perceived ease of use; and (3) attitude toward using. In addition, Cronbach's alpha is 0.97 for usefulness, 0.96 for ease of use, and 0.97 for attitude toward using, reflecting high levels of construct reliability.

Path parameter values are estimated using generalized least squares (GLS). Fit measures for the structural equations are acceptable (chi-square divided by degrees of freedom is 2.03; adjusted goodness of fit index is 0.80; root mean square residual is 0.21). The model explains the following percentages of variance for model variables: 8.04% for ease of use, 52.45% for usefulness, 75.11% for attitude, 27.59% for usage frequency and 19.53% for usage volume. For the external variables, the following standardized path coefficients are significant ($p < 0.025$): system familiarity to ease of use (rho = 0.16); job category to ease of use (rho = 0.16); job category to usefulness (rho = 0.13). The remaining path linkages from the external variables to ease of use and to usefulness are not significant. All of the following remaining path linkages in the model are significant ($p < 0.0001$): ease of use to usefulness (rho = 0.67); usefulness to attitude (rho = 0.66); ease of use to attitude (rho = 0.26); attitude to usage frequency (rho = 0.53); and attitude to usage volume (rho = 0.45).

DISCUSSION

The purpose of TAM is to predict or explain usage behavior. This study confirms the structural validity of TAM and shows that TAM does explain significant proportions of the variances in usage frequency (27.59%) and usage volume (19.53%) behaviors. Many previous studies have documented the influence of various external variables on system usage behavior, including individual variables (age, gender, education, cognitive abilities, computer anxiety, professional and computer experience), task variables (complexity) and organizational variables (user participation and involvement, organizational position, job role, and training), to name just a few. TAM asserts, through its theoretical foundations in the Theory of Reasoned Action (TRA), that the influence of these external variables is *indirect*, as mediated by the relevant beliefs and attitudes.

We re-examined the direct and indirect influences of the external variables upon attitude, usage frequency and usage volume. Alternative models were explored such that the original structural relationships predicted by TAM among ease of use, usefulness, attitude, usage frequency and usage volume were unchanged. However, direct structural effects of the three external variables upon attitude, usage frequency and usage volume were analyzed. There were no significant effects of any of the external variables directly upon attitude. However, there were significant direct effects ($p < 0.0001$) of system familiarity on usage frequency (rho = 0.37) and on usage volume (rho = 0.39). Furthermore, in this alternative model, the direct effects of system familiarity on each of the two belief constructs (e.g. usefulness and ease of use) became nonsignificant. Most importantly, this alternative model explained much larger proportions of the variances in usage frequency (38.82% versus 27.59%) and usage volume (37.15% versus 19.53%) than did the original empirical model.

This study reaffirms the basic validity of the original TAM. The structural and measurement characteristics of the empirical research model show that TAM is useful in predicting different kinds of end-user behavior. The predictive power of TAM remained high in spite of a different user population (government versus private). Moreover, the ease of use construct retained its predictive role in the model, in spite of standardized

(MS-windows) user interfaces on the target applications. Davis' instrument exhibited very high levels of factorial validity and construct reliability, similar to previous studies (Davis, 1989 and 1993).

However, our findings indicate that the belief and attitudinal constructs do not fully mediate the influence of all external variables upon usage behavior. The power of the model to predict usage behavior (and, ultimately, the acceptance of end-user applications) is improved when the direct influence of system familiarity is considered. The clear implication is that end-user behavior may be better predicted by considering the direct influence of select external variables. But which external variables have a direct influence and which do not?

An unanswered question is: Which external variables are mediated by TAM and which are not? Are there characteristics or features of these external variables that account for whether they are mediated or whether they have a direct effect on usage? This question is important because the predictive power of TAM may be enhanced by exploring this issue.

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