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AN EVALUATION OF A MAJOR VALIDITY THREAT TO THE TECHNOLOGY ACCEPTANCE MODEL [RESEARCH IN PROGRESS]

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ABSTRACT

This research investigates the validity threat to the Technology Acceptance Model on account of the manner in which "use" has been operationalized in the empirical literature. A meta-analysis of the cumulative empirical evidence finds that the average correlation between "perceived usefulness" and "use" is 0.26 in studies employing behavioral measures of use and 0.56 in studies employing perceptual measures of use.

1. INTRODUCTION

The Technology Acceptance Model (TAM) proposed by Davis (1989) has been widely researched and has received considerable empirical support (see, for example, Adams, Nelson and Todd, 1992; Taylor and Todd, 1995; Agarwal and Prasad, 1997). This program of research into the adoption, implementation and use of information systems (IS) innovations has been hailed as an exemplar of research that is both rigorous and relevant (Benbasat and Zmud, 1999). However, the findings of Straub, Limayen and Karahann-Evaristo (1995), Szajna (1996) and others suggest that support for TAM may be subject to a validity threat on account of the manner in which *use* has been operationalized.

This research uses meta-analysis to evaluate the cumulative empirical evidence in support of TAM and examine the potential construct validity threat.

2. THEORY AND HYPOTHESES

The theoretical development of TAM draws upon a number of research streams including expectancy theory (DeSanctis, 1983), diffusion of innovations (Rogers, 1983) and, in particular, the Theory of Planned Behavior (Ajzen, 1991). TAM proposes that end-user acceptance and *use* of information systems (IS)

innovations is influenced by their beliefs regarding the technology. In particular, it proposes that *perceived usefulness* (PU) and *perceived ease of use* (PEU) influence the *use* of IS innovations and that this effect is mediated through *behavioral intentions to use* (Davis, 1989). The model highlights the critical role of extrinsic motivation and, in particular, expectations of task-related performance gains in end-users' adoption and *use* of IS innovations (DeSanctis, 1983; Davis, 1989).

Empirical support for TAM is subject to a number of validity threats that remain to be addressed. In particular, Straub et al. (1995) argue that support for TAM may be an artifact of the manner in which the dependent variable in the model, *use*, has been operationalized. In a study of the adoption of voice-mail, Straub et al. report that "while self-report measures of the dependent variable (system usage) are related to self-reported measures of the independent variables, PU and PEU, objective, computer-recorded measures show only weak relationships with PU and PEU" (Straub et al., 1995: p. 1336). Their study found that *perceived usefulness* accounted for 48.7% of the variance in self-reported system usage, but only 6.9% of the variance in computer-recorded system usage. Similar results are reported by Szajna who concluded that "self-report usage may not be an appropriate surrogate measure for actual usage" (Szajna, 1996: p. 85). Earlier, Davis (1989: p. 334), in his development of TAM, had identified the possibility of such a threat and suggested that future research should investigate the relationship with objective measures of *use*. Despite this, empirical support for TAM relies on studies employing subjective measures of *use* (see, for example, Straub et al., 1995: Table 1, p. 1330).

The manner in which *use* is operationalized may bias results in a number of ways. Studies that capture both the dependent variable, *use*, and the independent variable, *perceived usefulness*, on the same instrument using self-report subjective measures that are only minimally different are susceptible to a validity threat arising from common method variance (Cook and Campbell, 1979). Such instruments can lead to hypothesis guessing and a positive bias towards confirming the researchers' expectations (Straub et al., 1995). In which case, the correlations reported between *perceived usefulness* and *use* may be positively biased.

The purpose of this research is to examine the cumulative empirical evidence in support of TAM and estimate the moderating effect of the type of operationalization of *use* on the reported relationship between *perceived usefulness* and *use*. Formally,

> H1: The reported effect of *perceived usefulness* on *use* is a function of the type of operationalization of *use*.

An empirical estimation of this moderating effect is a necessary condition for estimating the true effect of *perceived usefulness* on *use* and to evaluate the validity threat to TAM on account of different operationalizations of *use*.

2.1. Control Variables

To test the above hypothesis, the effects of other variables that may moderate the relationship between *perceived usefulness* and *use* need to be controlled for. For instance, source bias – the expectation that effect sizes reported in published studies are higher than those reported in unpublished studies (Hunter and Schmidt, 1990) – may moderate the above relationship. Further, differences in the operationalization of *perceived usefulness* may also moderate the relationship – while recent studies operationalize the construct using Davis' *perceived usefulness* scale (1989), earlier studies have employed Rogers' relative advantage scale (1983). Finally, differences in task context across studies – in particular, task interdependence (Yetton, Sharma and Southon, 1999) and technical complexity (Attewell, 1992; Fichman, 1992) – may also moderate the relationship.

3. METHOD

The literature reviewed above hypothesizes that the reported values of the correlation between *perceived usefulness* and *use* may be significantly biased on account of different operationalizations of *use*. In general,

the findings of individual studies are biased on account of various validity threats and sampling error (Hunter and Schmidt, 1990). Further, it is not possible to estimate the magnitude of errors introduced by these threats and correct the findings within individual studies. Hence, theory validation rests on a systematic evaluation of the cumulative empirical evidence rather than the findings of a few selected "well designed" studies (Glass, McGaw and Smith, 1981; Hunter and Schmidt, 1990). The broader, and more important, research question that needs to be addressed is: "To what extent is the cumulative empirical evidence in support of TAM biased as a result of different operationalizations of *use*?"

Meta-analysis is particularly suited to address this question for two reasons. First, the individual studies included within the meta-analysis are likely to employ different measures of *use* – something that is not easily achieved within a single study. Second, the reliability of the results obtained in a meta-analysis is much higher than obtainable in a single small-sample study – the equivalent sample size is the aggregate sample size of the component studies. Both these conditions, different types of measures employed and large sample size, are difficult to obtain simultaneously, except in a meta-analysis.

3.1. Sample

The sample for this meta-analysis consists of empirical studies reported in journals, books and unpublished dissertations. Following Hunter and Schmidt (1990) and Alavi and Joachimsthaler (1992), studies have been located through several literature searches. These include bibliographic databases including ABI/INFORM, Sociological Abstracts and Dissertation Abstracts, manual searches of back issues of journals including *MIS Quarterly*, *Management Science* and *Decision Science* and bibliographies of existing works. Dissertation Abstracts are specifically included in the search in order to overcome the potential bias of higher effect sizes associated with journal articles. This comprehensive search strategy both increases the power of the meta-analysis by maximizing the number of studies and reduces source bias.

Studies have been selected for inclusion in the meta-analysis if they satisfy three conditions. First, the study reports the correlation between *perceived usefulness* and *use*. Second, it reports the measures employed to operationalize *perceived usefulness* and *use*. Third, the description of the task addressed by the IS innovation provides enough data to code the measures of task interdependence and/or technical complexity.

3.2. Measurement of Variables

3.2.1 Type of operationalization of use: *Use* is the most commonly employed measure for the successful implementation of IS innovations (DeLone and McLean, 1992; Agarwal and Prasad, 1997). However, there are few validated measures of *use* employed across studies. This not only inhibits the development of a cumulative tradition, but also poses validity threats to the findings of individual studies (Straub et al., 1995; Benbasat and Zmud, 1999). In particular, differences between behavioral and perceptual measures of *use* can significantly influence the results of theory testing (Straub et al., 1995; Szajna, 1996). Behavioral measures include computer-captured measures of *use* as well as measures capturing level of *use* on specific behaviors, such as "Number of messages sent and received on the previous working day" (Adams et al., 1992). Perceptual measures capture end-users' perceptions of the extent of *use* rather than any specific behavior, such as "Extent to which a system is currently used", ranging from "Not used at all" to "Usage has become standard" (Zmud, 1984).

The measures of *use* employed in individual studies are categorized as "Behavioral" or "Perceptual". Two expert raters were provided with descriptions of the measures employed in individual studies. In addition, they were provided with background information that defines, and distinguishes between, perceptual and behavioral measures. The two raters were in agreement on the categorization of 29 of the 32 measures employed, indicating a high level of inter-rater concordance (Cohen's kappa = 0.80, $p \leq 0.01$). Inter-rater disagreements on the remaining three measures were resolved in discussions with one of the authors.

3.2.2 Control variables: To investigate the effect of source bias, each study was coded according to its source, dissertations or journal. To investigate the effect of different operationalizations of *perceived*

usefulness, two independent experts coded the measures employed in each study into two categories – those derived from Davis' *perceived usefulness* scale and those derived from Rogers' relative advantage scale. Each study was also rated on Pearce et al.'s scale of task interdependence (1992) and a measure of technical complexity adapted from Attewell (1992).

3.3. Analysis

The hypothesis is tested using a weighted least squares regression procedure proposed by Hedges and Olkin (1985: p. 224-246) and Hunter and Schmidt (1990). This procedure involves testing the slope in a regression model with type of operationalization of *use* as the predictor variable, the study correlation as the criterion variable and with each study being weighted by its sample size. H1 predicts that the slope of the function, when the correlation between *perceived usefulness* and *use* is regressed on type of operationalization of *use*, is significantly different from zero.

4. PRELIMINARY RESULTS

A search of studies conducted prior to 1995 has identified 32 studies, with a cumulative sample size of 3692, for inclusion in the meta-analysis. A preliminary analysis based on these 32 studies finds that the reported correlation between *perceived usefulness* and *use* is a function of the type of operationalization of *use*. Table 1 presents the results of a weighted least squares regression of the correlation between *perceived usefulness* and *use* on type of operationalization of *use* ($R^2 = 0.61$, $F = 47.34$, $p \leq 0.01$). The slope for type of operationalization of *use* is significantly greater than zero ($\hat{b}_{use\ \text{operationalization}} = 0.30$, $t = 6.88$, $p \leq 0.01$) and the intercept is significantly greater than zero ($\hat{b}_0 = 0.26$, $t = 9.14$, $p \leq 0.01$). Hypothesis 1, the reported effect of *perceived usefulness* on *use* is a function of the type of operationalization of *use*, is supported.

Model 1	Regression coefficients	Standard error	t	Significance
Intercept	$\hat{b}_0 = 0.26$	0.029	9.14	$p \leq 0.01$
Type of operationalization of *use* [a]	$\hat{b}_{use\ \text{operationalization}} = 0.30$ ($\hat{\beta}_{use\ \text{operationalization}} = 0.78$)	0.043	6.88	$p \leq 0.01$

Table 1: *Effect of type of operationalization of use on the correlation between perceived usefulness and use*

[a] *Coded as 0 = Behavioral measures (18 studies) and 1 = Perceptual measures (14 studies)*
$R^2 = 0.61$, $F = 47.34$, $p \leq 0.01$, Cumulative sample size N = 3692

5. DISCUSSION AND CONCLUSIONS

The above results show that the effect of type of operationalization of *use* on the reported correlation between *perceived usefulness* and *use* is significant. The mean correlation between *perceived usefulness* and *use* when behavioral measures of *use* are employed is 0.26 (calculated as $\hat{b}_0$, see Table 1 above), with a 90% confidence interval between 0.22 and 0.30. In contrast, when perceptual measures of *use* are employed, the average correlation is 0.56 (calculated as $\hat{b}_0 + \hat{b}_{use\ \text{operationalization}}$, see Table 1 above), with a 90% confidence interval between 0.52 and 0.60. The validity threat identified by Straub et al. (1995) is significant. Controlling for the significant bias due to operationalization of *use*, *perceived usefulness* has a "small" to "medium" sized effect on *use* (Cohen and Cohen, 1983). This is in contrast to earlier studies (see, for example, Venkatesh and Davis, 2000) that conclude that the magnitude of effect of *perceived usefulness* on *use* is "strong". The explanatory power of TAM needs to be re-evaluated in the light of the above evidence.

The findings of this study suggest avenues for further theoretical development. It is plausible that the results obtained are on account of theoretical issues, rather than methodological issues discussed above. For instance, it is plausible that models that explain behavior are different from models that explain affect, or perception. In which case, the findings suggest that researchers need to employ measures consistent with theory. Alternatively, researchers could speculate on and test for the moderating effect of theoretically identified contextual variables, such as type of application. In either case, further theoretical development is required to explain the findings reported here.

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