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C-OAR-SE-based single-item measures for the two-stage Technology Acceptance Model

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ABSTRACT

This article addresses the scope and nature of the two-stage (adoption then usage) Technology Acceptance Model, TAM. The first contribution is to use C-OAR-SE theory to provide new and valid single-item measures of TAM's stagewise paired constructs intended to replace the non-valid and inefficient multiple-item measures used by TAM researchers at present. The second contribution is to demonstrate that individual-level frequency counts and cross-tabulations reveal more about how TAM works in its potential adopter stage and its current user stage than the usual group-level correlation and regression analyses.

1. Introduction

The introduction articulates for the first time the scope and nature of Davis' (1989) Technology Acceptance Model, TAM, and then points out the measurement and analysis faults that limit the value of all previous TAM studies.

1.1. Scope and nature of the TAM model

Davis' (1989) Technology Acceptance Model, TAM, is quite evidently too simple to explain major adoption decisions at the corporate level. At the corporate level, a multi-variable model is needed such as Rogers' (2003) Innovation Diffusion Model or variations of it such as that proposed recently by Arts et al. (2011), with the model customized to suit the particular new product or service. However, TAM, with its two independent predictor variables of Perceived Ease of Use (PEOU) and Perceived Usefulness (PU), might be quite adequate to explain acceptance decisions made by individual employees – specifically, their Intention to Use the product (as "potential adopters") and their Actual Usage of it (as "current users").

The predictor variables in Davis' TAM model, Perceived Ease of Use (PEOU) and Perceived Usefulness (PU), are *beliefs* – that is, they are single, concrete, conscious thoughts that are salient in the potential user's mind or the actual user's mind when the individual confronts the new product and considers how often to use it. As a "doubly concrete" construct, each belief, PEOU and PU, is most validly measured with one good *single item* (see C-OAR-SE theory: Bergkvist and Rossiter, 2007; Rossiter, 2002, 2011a,b; Rossiter and Bergkvist, 2009). The dependent variables in the two-stage TAM model, Usage Intention (UI) and Actual Usage (AU) are *also* "doubly concrete" constructs and should be measured single item.

1.2. Criticisms of previous TAM measures and analysis

TAM researchers, however, beginning with Davis (1989), have wrongly regarded PEOU and PU as "abstract" constructs that are merely *inferred* to exist (as the average of scores observed) from *multiple-item* measures. The widely used version of the TAM predictor measures developed by Venkatesh (2000), for example, consists of two sets of factor-analytically derived, content-redundant items (see Table 1), the averaged scores from which the predictor constructs of PEOU and PU are inferred to have been measured accurately.

The multiple items in each predictor measure in TAM suffer from the *general-item mistake* in factor analysis (see Guilford, 1954). This is the mistake of including a general item – item #3 in PEOU ("I find the system to be easy to use") and item #4 in PU ("I find the system to be useful in my job") – among specific *component* items. This erroneous practice virtually guarantees that the multiple items' scores will load significantly on one "factor" and will together produce a high coefficient alpha, which is then claimed as evidence of the "internal consistency" of the items' scores and the "unidimensionality" of the attribute. In the C-OAR-SE approach, only the single general item is necessary.

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Table 1
Davis-type TAM measures used in the Venkatesh (2000) study.

Perceived Ease of Use
1. My interaction with the system is clear and understandable
2. Interacting with the system does not require a lot of my mental effort
3. I find the system to be easy to use
4. I find it easy to get the system to do what I want it to do
Perceived Usefulness
1. Using the system improves my performance in my job
2. Using the system in my job increases my productivity
3. Using the system enhances my effectiveness in my job
4. I find the system to be useful in my job
Intention to Use
1. Assuming I had access to the system, I intend to use it
2. Given that I had access to the system, I predict that I would use it

All items answered on the same "7-point Likert scale" (p. 361) which was presumably the standard "strongly disagree, moderately disagree, slightly disagree, neither agree nor disagree, slightly agree, moderately agree, strongly agree" answer scale scored 1–7.

Previous researchers when operationalizing the TAM *outcome* constructs have also employed unnecessary multiple items. For example, as shown in the table, Venkatesh (2000) measured Usage Intention, UI, the dependent variable in his study, with two completely redundant items. Item #1 in his UI measure is arguably the more clearly worded and would suffice.

A further problem with unnecessary multiple-item measures of doubly concrete constructs is that they are subject to two types of *common-measure* bias (see Rossiter, 2011a). Both types of common-measure bias will tend to make the correlations appear larger than the true correlations. Firstly, there is likely to be *internal* common-measure bias; this is caused by the redundant content of the items *within* each multiple-item measure (see Venkatesh's multiple-item measures of PEOU and PU) which produces an artificially high α coefficient. Secondly, the identical answer scales (7-point Likert scales in Venkatesh's measures used for all of the constructs – PEOU, PU, and Usage Intention) will likely cause *external* common-measure bias, which will inflate the correlations observed *between* the variables in the TAM model. The extent of either type of common-measure bias cannot be detected from the observed scores and therefore cannot be corrected for statistically after the fact. This insight from C-OAR-SE effectively counters the claims of statistical estimation and removal of common-measure bias made in general by Podsakoff et al. (2003, 2012) and made specifically in relation to the TAM model by Davis et al. (1989), Malhotra et al. (2006), and Sharma et al. (2009).

A final criticism of all previous TAM studies is that TAM researchers have invariably analyzed the TAM results with *correlations* and correlation-based regression. The present article argues, and demonstrates, that much better diagnosis of how TAM works can be achieved by examining univariate frequency distributions and computing bivariate cross-tabulations. Used most often by market research practitioners, these basic individual-level forms of analysis *explain* – that is, diagnose – the generally modest correlations observed in TAM studies.

2. The present study

The main purpose of the present study was to design new, highly content-valid, single-item measures for each of the constructs in the two-stage TAM model to suit potential adopters and current users, respectively. The new measures had to be single item to prevent internal common-measure bias and had to have different answer scales to prevent external common-measure bias.

The secondary, though no less important, purpose of the present study was to demonstrate that basic univariate frequency counts, coupled with bivariate cross-tabulations between each predictor and outcome variable, provide all the information needed to properly interpret TAM findings.

3. Method

The method of the present study consisted of two phases. The first phase was to employ C-OAR-SE theory (Rossiter, 2011a,b) to precisely define and then design new single-item measures of the TAM variables.

The second methodological phase was an empirical study (a survey) using the new TAM measures. Online questionnaires were completed by individual managers responsible for the decision to adopt and use the new product. The new product chosen for the present study was a common new technology product – *portable computers* – described for the respondents as a "laptop, notebook, or hand-held computer for work-related use."

3.1. Respondent sample

A multinational online panel of principal managers of small- and medium-sized enterprises (SMEs) was constructed for the purpose of conducting this and several other surveys over a 3-month period in early 2011. As principals of their own businesses, these individuals alone decided whether or not to acquire and use a portable computer. The SME managers were recruited by e-mail invitations from electronic industry lists for four countries, the USA, UK, India, and Australia. Participants received a nominal monetary incentive per completed questionnaire. One reminder e-mail was sent 3 days after the invitation letter, and a further 14-day period from the reminder date was allowed for replies.

As is nowadays all too typical with mail or e-mail surveys, particularly those aimed at business managers, the response rates were very low, despite the reminder, and ranged from 8% in the US to 24% in the UK, with a total-sample response rate of 15%. Potential non-response bias of an unknown nature is a problem with this and all previous studies using the TAM model, except those using "captive" student samples, which of course have their own generalizability problem. The popular check for non-response bias is an early versus late returns analysis but this method is not convincing evidence of response bias because it still only focuses on responders. However, there is no apparent reason to suspect that those managers who did volunteer for this survey as potential adopters or current users would have different attitudes toward adopting or using the new product from those who did not participate. The total usable sample for the present study consisted of 137 non-owners of a portable computer (i.e., potential adopters) and 316 owners (current users).

3.2. Procedure

The SME managers completed the TAM questionnaire online (as a Web survey). Potential adopters and current users answered slightly different questions about the TAM variables in accordance with the redefined constructs.

4. Results

The redefined TAM constructs and their new measures are presented and discussed first. Next, frequency distributions of the scores on the new TAM measures are examined for potential adopters and current users separately and pairwise cross-tabulations between the scores on the TAM measures are then computed. Reported and examined last are the correlations between the TAM