

INVARIANCE OF AN EXTENDED TECHNOLOGY ACCEPTANCE MODEL ACROSS GENDER AND AGE GROUP

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Abstract

In this study, we examined the likelihood of an extended technology acceptance model (TAME), in which the interrelationships among computer self-efficacy, perceived usefulness, intention to use, and self-reported use of computer-mediated technology were tested. In addition, the gender- and age-invariant of its causal structure were evaluated. The data were collected from a self-reported questionnaire administered to 477 administrative staff of a public university in Malaysia. The results of structural equation modeling supported the adequacy of TAME. Although the TAME's causal structure was applicable to both male and female staff, age group appeared to moderate the structural relationships among the constructs of interest.

Introduction

The Technology Acceptance Model or TAM (Davis, Bagozzi, & Warshaw, 1989) is one of the most profound frameworks frequently used in studies to predict and explain the use of computer-based applications and solutions. The model asserts that the adoption of a technology is determined by the user's intention to use, which in turn is influenced by his or her attitudes towards the technology. It is very likely that the variability in these attitudinal and behavioral constructs depends on the user's perceptions — perceived usefulness (PU) and perceived ease of use (PEU). While PU indicates the extent to which the use of the technology is promising to advance one's work, PEU represents the degree to which the technology seems to be free of effort (Davis et al., 1989). This model posits that attitudes and behavioral intention mediate the effects of PU and PEU, the two constructs of extrinsic motivation.

As TAM is reasonable, simple, and robust (Venkatesh & Davis, 2000), the study on TAM has been receiving continual interest from decision-makers, practitioners and researchers. Through the years, research on the efficacy of TAM covers a broad range of settings, samples, and computing technology across knowledge domains. However, recent meta-analyses (Ma & Liu, 2004; Schepers & Wetzels, 2007; Yousafzai, Foxall, & Pallister 2007) suggest that our understanding in this area could further be enhanced if several overriding issues are addressed.

The first of these issues concerns the criterion measures used in previous TAM studies, primarily that the (i) behavioral intention to use, and (ii) use of technology were based on the adoption of specific applications. In educational settings, individual studies used either the adoption of word processors (Davis, et al., 1989), spreadsheets (Mathieson, 1991), PowerPoint (Hu, Clark, & Ma, 2003), e-mail (Shih, 2004), multimedia learning system (Saade, Nebebe, & Tan, 2007), e-learning (Ndubisi, 2006), digital library (Hong, Wong, & Tam, 2002), or learning management system (Yi & Hwang, 2003). Ma and Liu (2004) observe that the “differences in measurement items between studies tend to be the result of adapting TAM to different technologies” (pp. 61–62). Clearly, such measures constitute piecemeal approach to the understanding of technology acceptance, and are insufficient to represent the complexity of technology-based work environment. In their daily work, the administrative staff of a university use a plethora of communication systems, office systems, and general computer-based applications. It is reasonable, therefore, to extend and validate the adequacy of the TAM in an ecologically sound setting, where all sorts of computer-mediated systems and applications are accessible to faculty members.

The second issue in the TAM literature concerns the generality of the model across user populations. The literature indicates that more than 40% of the research on TAM (Scheepers & Wetzels, 2007; Yousafzai, Foxall, & Pallister 2007) used students as the sample. However, results yielded from student samples are not replicable to other types of users within education communities. In fact, Scheepers and Wetzels found that the user-type moderated the causal relationships within the model; on the average, student samples produced reliably superior effect sizes than did the non-student samples. Furthermore, Selwyn (2007) claims that, “the formal use of computer technology [*by faculty and administrators*] in many areas of higher education could best be described as sporadic, uneven, and often low level” (p. 84, emphasis added). It is very likely that each student sample consists of relatively homogenous users who are required, and who are in many cases willing, to try out new technology. The university administrators, on the other hand, are more diverse and more experienced, but are less inclined to adopt new technology unless it is imposed on them.

Third, although TAM is one of the most influential bases to describe technology acceptance, the empirical evidence gleaned from various TAM studies yielded mixed signals. Inconsistent results abound, both in terms of the magnitude and direction of the relationships (e.g., Dasgupta, Granger, & McGarry, 2002) among the constructs of TAM; others pointed to unreliable relationships (Lowry, 2002; Shih, 2004). One possible reason for these discrepancies is the existence of moderating variables influencing technology acceptance inconsistently across the levels of the independent variables. Unfortunately, studying the interactive effects of a third variable is a neglected area in TAM research. Of the limited number of

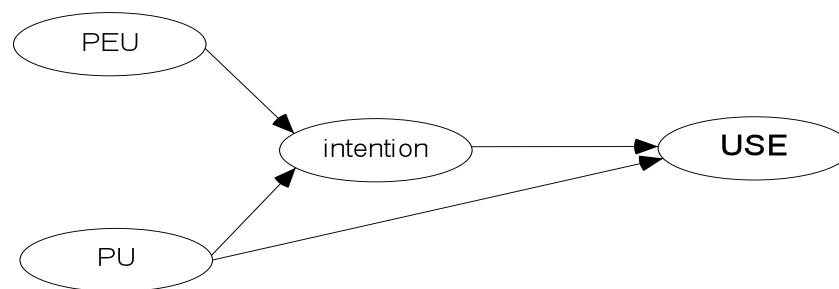
cross-validation research on TAM, there are indications that gender (Gefen & Straub, 2000), and culture (Straub, Keil, & Brenner, 1997) moderated the expected causal relationships. Besides gender and culture, Yousafzai, Foxall, and Pallister (2007) postulate that differences in subject type, method type, technology type, and measurement of usage characteristics are likely to moderate the hypothesized relationships.

Against this backdrop, one purpose of the present study was to validate the likelihood of an extended technology acceptance model (TAME) on the data derived from the members of a university administrative staff in an ongoing computer-mediated work setting. The study extended the original TAM model by including an *intrinsic motivation* component — *computer self-efficacy*. In so doing, the study assessed the direct and indirect effects of *computer self-efficacy* on the use of the technology, via the perceived usefulness and intention to use the technology voluntarily. The second purpose of the study was to evaluate gender- and age-invariant of the causal structure of TAME. This cross-validation procedure determined whether gender and age group moderated the causal structure of the model, and thus the generality of TAME.

The Extended Technology Acceptance Model

Framed within Ajzen and Fishbein's (1980) theory of reasoned action (TRA), Davis et al. (1989) proposed a robust and simple model of technology acceptance (TAM) that would "explain computer usage behavior" (p. 983). The TAM (Figure 1) is a powerful framework because it provides theoretically valid reasons for the variability in one's acceptance and use of computer technology. The model is parsimonious in the sense it is based simply on three antecedent variables — PU, PEU, and behavioral intention — to predict use, albeit PEU has been found to be less influential and reliable. Still both PU and PEU were the factors that extrinsically motivate users to accept, adopt and use the technology (Igbaria, Iivari, & Maragahh, 1995).

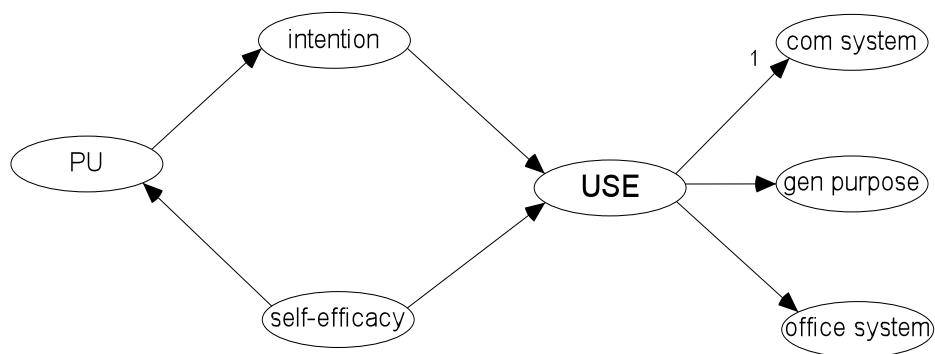
Figure 1: Technology Acceptance Model



(Davis et al., 1989)

The inclusion of an intrinsic motivation construct, most importantly the self-efficacy beliefs, would definitely provide deeper and richer understanding of why and how the technology is used (Figure 2). Bandura (1977) argues that one's sense of efficacy is one's causal judgment in predicting one's ability to perform a behavior successfully. In relation to computer usage, the belief that one can even communicate electronically with other staff members, for example, reflects a high level of efficacy. An efficacious user, in essence, believes that he or she can assess the usefulness of the computer-mediated work environment, thus bringing out positive changes in his or her *behavioral intention* and *use of the technology*.

Figure 2: The Extended Technology Acceptance Model (TAME)



Social cognitive theory indicates that as a variable, *self-efficacy* strongly affects a person's decision to attempt a task, the amount of effort put in and the degree of persistence exhibited in completing the task, and the ability to withstand difficult circumstances (Salomon, 1984). An efficacious staff member has higher comfort and confidence to attempt computer-mediated tasks, varying from using the computer applications to enhance job performance to developing a web-based learning environment. Such a user is committed to accomplishing challenging tasks involving the use of the technology simply because it is intrinsically rewarding (Deci, 1975; Deng, Doll, & Truong, 2004). Based upon these arguments, it is hypothesized that:

Hypothesis 1: Computer self-efficacy directly influences staff members' use of the computer-mediated technology.

The literature suggests that *computer self-efficacy* accounts for substantial variance in an individual's beliefs (Igbaria & Iivari, 1995) and behavior (Compeau & Higgins, 1995) in using the technology. Since an efficacious user has confidence in using the computer, it is reasonable that he or she could anticipate and appreciate the usefulness of computer-mediated technology, which in turn would determine its acceptance. Thus, intrinsic motivation also indirectly affects technology acceptance via the beliefs a person holds about the usefulness of the

technology. Consistently, several previous studies had supported the mediated effects of computer self-efficacy (Doll & Truong, 2004; Deng et al., 2004; Igbaria & Iivari, 1995). Thus in this study, it is hypothesized that:

Hypothesis 2: Computer self-efficacy indirectly influences use of the computer-mediated technology through perceived usefulness and intention to use.

Perceived usefulness is one's belief that a given technology will help one to achieve one's work goals. With respect to administrative staff use of computers, it represents the degree to which the user perceives the technology would facilitate his or her performance. Data from previous findings supported the expectation that perceived usefulness influences one's intention to use, which ultimately determines the use of computer-based technology. In the current study, it is hypothesized that:

Hypothesis 3: Perceived usefulness positively influences intention to use the computer-mediated technology.

Hypothesis 4: Intention to use computer-mediated technology positively influences its use.

Method

The data for this study were obtained from 477 administrative staff of a public university in Malaysia, representing almost 50% of the population of administrative staff. A majority of the sample were females (58%); 52% aged 30 years or below. The respondents, who consisted of middle managers and administrative and technical support staff, were employed in various academic and management departments. The sample size was deemed adequate for the application of structural equation modeling (SEM) to address the research objectives.

To collect the data, we used a self-reported questionnaire containing items that measured three exogenous constructs of interest, namely computer self-efficacy, perceived usefulness (PU), and intention to use. Each construct consists of items to which respondents would indicate on a 5-point scale the extent of their agreement or disagreement with each assertion. In addition, the frequency of using three types of computer-mediated systems — communication systems, general purpose systems, and office systems — collectively served as the endogenous variable (USE).

To test the research hypotheses, the study applied a three-stage structural equation modeling, using the AMOS (version 16) model-fitting program. Using confirmatory factor analysis (CFA), the study first assessed the validity of the

measurement model of use of computer-mediated technology. Next, we examined the good-fit of the full-fledged TAME (Figure 3). Finally, we cross-validated the model to assess the moderating effects of gender and age groups of TAME.

Results

This section presents the results of the structural equation modeling that addressed the objectives of the study.

Validity of the Measure of Use of Computer-Mediated Technology

Figure 2 contains the measurement model of the faculty's use of computer-mediated technology that comprised three first-order and one second-order factors. Each of these first-order factors was measured by three items; each item was assumed to load only on its respective dimension. The three factors, namely the communication systems, general-purpose systems, and office systems were expected to load on the second-order factor, the staff members' use of the technology (USE). Using the maximum likelihood estimation procedure of the confirmatory factor analysis, the validity of this measurement model was tested first.

The results indicated that the hypothesized nine-item measurement model was consistent with the data. The overall fit of the model was adequate, the relative $\chi^2 = 2.23$; RMSEA = .05; CFI = .99; TLI = .98. In other words, the measurement of technology use did generate the observed covariance matrix; there was no evidence that the measurement model is incorrect. In addition, the direction and magnitude of factor loadings were substantial and statistically significant, and the model was free from offending estimates. The Cronbach's alpha for the first-order factors were .82 (communication systems), .91 (general-purpose systems), and .83 (office systems). The data also supported the measurement adequacy in terms of their convergent and divergent validity; these are supports for construct validity of the model.

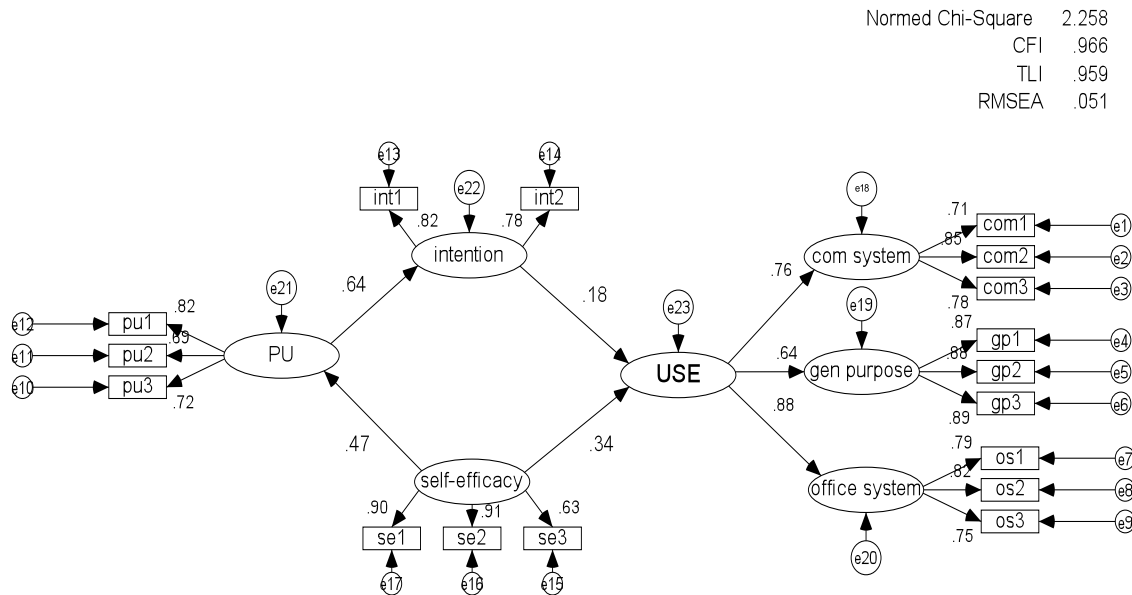
Adequacy of the Causal Structure of the Extended Model (TAME)

Figure 3 summarizes the results of structural equation modeling of TAME. The confirmatory modeling yielded consistency of the hypothesized causal relationships with the data (relative $\chi^2 = 2.26$; RMSEA = .05; CFI = .97; TLI = .96). All these fit indices satisfied their critical cutscores; the results, therefore, indicated a fitting TAME.

The parameter estimates of the hypothesized model were free from offending values. All path coefficients of the casual structure were statistically significant at .005 levels, and were of practical importance. The data indicated that computer

self-efficacy was relatively more influential than was behavioral intention in affecting the use of computer technology. The total standardized effect size of computer self-efficacy \rightarrow use was .39, .06 indirectly via PU and intention to use. In sum, the results provided support for the four research hypotheses.

Figure 3: Standardized Coefficients of the Hypothesized TAME



Gender- and Age-Invariant of the Extended Model

Another objective of this study was to examine the structural invariance of TAME across two likely moderators, gender and age groups. To test gender-invariant, a simultaneous analysis on both the male ($n_1 = 189$) and female ($n_2 = 265$) samples was conducted, first without constraining the structural paths; the results derived a baseline chi-square value. Next, structural paths (self-efficacy \rightarrow USE; self-efficacy \rightarrow PU; PU \rightarrow intention; intention \rightarrow USE) were constrained to be equal for the male and female groups. The analysis of this constrained TAME produced another chi-square value, which was then tested against the baseline value for statistically significant differences. A similar procedure was used to examine the age-invariant of TAME. The results of the multiple-group SEMs are presented in Table 1.

The invariance test across the male and female groups resulted in a statistically insignificant change in the chi-square value, $\chi^2(4) = 13.44$, $p > .005$. Simply said, the difference in the chi-square values between the unrestricted model and the constrained model did not produce a poorer-fit model. The path coefficients did not vary significantly across gender. It is justifiable then to conclude that gender

did not interact with the exogenous variables to influence the staff members' use of computer-mediated technology; hence, gender is not a moderating variable.

Table 1: Results of Multiple Group Modeling

	χ^2	df	Critical-Value	χ^2 Change
Gender				
Unrestricted	479.16	224		
Constrained	488.89	238	14.9	9.73
Age				
Unrestricted	369.10	224		
Constrained	395.97	228	14.9	26.87*

* Statistically significant at .005

On the contrary, the age-invariant test was statistically significant, $\chi^2(4) = 26.87$, $p < .005$. Specifically, the constrained TAME was much worse than the unrestricted model. This shows that the path coefficients varied across the two levels of age group (30 years old or less; more than 30 years old) because age group interacted significantly with the exogenous variables. Thus, group memberships moderated the causal relationships.

Conclusion

The findings of the present study have expanded the existing body of knowledge on TAM in several ways. First, the results substantiated the psychometric properties of the measure of use of computer-mediated technology. The measure seems to be adequate to represent the ongoing use of communication systems, office systems, and general computer-based applications among administrative staff. Second, the results validated the good-fit of the extended technology acceptance model (TAME). The results also support the efficacy of the original TAM (Davis et al., 1989), which posits that perceived usefulness and behavioral intention explain computer usage. In addition, the result is consistent with Compeau and Higgins's (1995) work that found the influential effect of computer self-efficacy on technology use. Finally, the present study provides indications that

while the extended model is applicable for male and female computer users, age factor limits the generality of the TAME.

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