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a meta-analysis of the technology acceptance model  
  
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abstract  
  
a statistical meta-analysis of the technology acceptance model (tam) as applied in various fields was conducted using 88 published studies that provided sufficient data to be credible. the results show tam to be a valid and robust model that has been widely used, but which potentially has wider applicability. a moderator analysis involving user types and usage types was performed to investigate conditions under which tam may have different effects. the study confirmed the value of using students as surrogates for professionals in some tam studies, and perhaps more generally. it also revealed the power of meta-analysis as a rigorous alternative to qualitative and narrative literature review methods.  
  
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keywords: technology acceptance model; tam; meta-analysis; perceived usefulness; ease of use; behavioral intention  
  
  
  
one of the continuing issues of is is that of identifying factors that cause people to accept and make use of systems developed and implemented by others. over the decades, various theories and approaches have been put forth to address this problem. for instance, in 1971, king and cleland [49] proposed analyst–user‘‘teamwork’’ during the design development process as a means of overcoming the reluctance of users to actually use is developed for them. schultz and slevin [82] proposed that distinction had to be made between technical and organizational validity to understand why  
  
  
  
have also been created and used in an attempt to address the problem, but often without success.  
  
in 1989, davis [13] proposed the technology acceptance model (tam) to explain the potential user’s behavioral intention to use a technological innovation. tam is based on the theory of reasoned action (tra) [25], a psychological theory that seeks to explain behavior. tam involved two primary predictors—perceived ease of use (eu) and perceived usefulness (u) and the dependent variable behavioral intention (bi), which tra assumed to be closely linked to actual  
  
  
  
 systems that met all technical performance standards behavior.  
  
  
  
still were not universally used or understood. proto-typing [39,96] and other methodological innovations  
  
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tam has come to be one of the most widely used models in is, in part because of its understandability and simplicity. however, it is imperfect, and all tam relationships are not borne out in all studies; there is wide variation in the predicted effects in various studies with different types of users and systems [55].  
  
a compilation of the 88 tam empirical studies that we considered to be the relevant universe shows that the number of studies rose substantially, from a publication  
  
  
  
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fig. 1. tam and four categories of modifications.  
  
 rate of 4 per year in 1998–2001 to a rate of 10 per year in tam has been the instrument in many empirical  
  
 2002–2003. studies [102] and the statistics needed for a meta-analysis  
  
  
  
fig. 1 shows tam as the ‘‘core’’ of a broader evolutionary structure that has experienced four major categories of modifications:  
  
(1) the inclusion of external precursors (prior factors) such as situational involvement [46], prior usage or experience [69,103], and personal computer self-efficacy [15].  
  
(2) the incorporation of factors suggested by other theories that are intended to increase tams predictive power; these include subjective norm [33], expectation [104], task-technology fit [20], risk [22,72], and trust [26,27].  
  
(3) the inclusion of contextual factors such as gender, culture [42,88], and technology characteristics [74] that may have moderator effects.  
  
(4) the inclusion of consequence measures such as attitude [14], perceptual usage [38,67,90], and actual usage [16].  
  
1. summarizing tam research  
  
meta-analysis, as used here, is a statistical literature synthesis method that provides the opportunity to view the research context by combining and analyzing the quantitative results of many empirical studies [31]. it is a rigorous alternative to qualitative and narrative literature reviews [80,108]. in the social and behavioral sciences, meta-analysis is the most commonly used quantitative method [34]. some leading journals have encouraged the use of this methodology [e.g., 21].  
  
  
  
– effect size (in most cases the pearson-moment correlation r) and sample size – are often reported in the articles. meta-analysis allows various results to be combined, taking account of the relative sample and effect sizes, thereby allowing both insignificant and significant effects to be analyzed. the overall result is then undoubtedly more accurate and more credible because of the overarching span of the analysis.  
  
meta-analysis has been advocated by many research-ers as better than literature reviews [e.g., 43, 79]. meta-analysis is much less judgmental and subjective. however, it is not free from limitations: publication bias (significant results are more likely to be published) and sampling bias (only quantitative studies that report effect sizes can be included), etc. [50].  
  
1.1. prior tam summaries  
  
the most comprehensive narrative review of the tam literature may be that provided by venkatesh and colleagues, who selectively reviewed studies centered around eight models that have been developed to explain user acceptance of new technology; a total of 32 constructs were identified there; the authors proposed a unified theory of acceptance and use of technology (utaut) and developed hypotheses for testing it [104].  
  
since there are inconsistencies in tam results, a meta-analysis is more likely to appropriately integrate the positive and the negative. we found two previous tam meta-analyses. legris et al. reviewed 22 empirical tam studies to investigate the structural relationships  
  
  
  
  
  
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 among key tam constructs; they argued that ‘‘the concerning the relative efficacy of pu and peu across  
  
 correlation coefficients between the components applications.’’  
  
observed must be available.’’ unfortunately, only 3 of  
  
  
  
the 22 studies reported these matrices and therefore the meta-analysis included only those, thereby limiting ‘‘the presentation of the findings to thegeneral conclusion,’’ in another meta-analysis, ma and liu [64] avoided the use of correlation matrices and included 26 empirical papers; they examined the zero-order correlations between three key constructs: eu,u, and technology acceptance (ta). they found that the sampled studies employed similar instruments of eu and u and ‘‘the differences in measurement items between studies tend to be the result of adapting tam to different technologies.’’ however, they did not investigate any moderator effects and their focus on correlations (r’s) may be of less interest to researchers and practitioners who want to understand the structural relationships (b’s) among constructs.  
  
there was another inadequate attempt at tam meta-analysis: deng et al. [17] retrieved their needed statistics, such as the effect sizes (structural coefficients and t-values) and the research context (type of application and user experiences) from 21 empirical studies. because of the observed heterogeneity among them, which included modified instruments, various applications, different dependent variables, and different user experience with the application, the authors concluded that it was‘‘difficult to compare studies and draw conclusions  
  
table 1   
journals that have published most tam research articles  
  
  
  
2. methodology of our study  
  
the papers included in the analysis were identified using ‘‘tam’’ and ‘‘technology acceptance model’’ as keywords and specifying ‘‘article’’ as the document type in the social science citation index (ssci) in the fall of 2004. the initial search produced 178 papers. the eliminationofirrelevantpapers(suchasthosereferringto tamoxifen in pharmacology, transfer appropriate mon-itoring in experimental psychology and tam as a family name) produced a total of 134 papers.  
  
this search was supplemented with one using the business source premier (ebsco host database) which identified 11 additional papers, some published prior to 1992, the oldest papers in ssci, and some from journals not covered by the scci database. of these, six were found to be relevant for a total relevant count of 140.  
  
then 52 were eliminated because they were not empirical studies, or did not involve a direct statistical test of tam, or were not available either online or through the university of pittsburgh’s research library. the resulting 88 papers provided tam data and analyses for the meta-analysis.  
  
table 1 shows the distribution of the 140 papers in the 22 journals that published two or more tam papers  
  
  
  
rank  
  
journal  
  
count of papers (total = 140)  
  
1  
  
information & management  
  
23  
  
2  
  
international journal of human-computer studies  
  
9  
  
3  
  
mis quarterly  
  
9  
  
4  
  
information systems research  
  
8  
  
5  
  
journal of computer information systems  
  
8  
  
6  
  
journal of management information systems  
  
7  
  
7  
  
decision sciences  
  
6  
  
8  
  
management science  
  
5  
  
9  
  
behaviour & information technology  
  
4  
  
10  
  
decision support systems  
  
4  
  
11  
  
interacting with computers  
  
3  
  
12  
  
international journal of electronic commerce  
  
3  
  
13  
  
internet research-electronic networking applications and policy  
  
3  
  
14  
  
journal of information technology  
  
3  
  
15  
  
computers in human behavior  
  
2  
  
16  
  
european journal of information systems  
  
2  
  
17  
  
ieee transactions on engineering management  
  
2  
  
18  
  
information and software technology  
  
2  
  
19  
  
information systems journal  
  
2  
  
20  
  
international journal of information management  
  
2  
  
21  
  
international journal of service industry management  
  
2  
  
22  
  
journal of organizational computing and electronic commerce  
  
2  
  
  
  
other  
  
29  
  
  
  
  
  
  
  
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(29 journals published one tam paper). information & management publishes far and away the most tam  
  
  
  
the populations were drawn) [24]. the possible differential effect of moderators across studies, such  
  
  
  
 studies. as the nature of users, the technologies used, etc. also  
  
  
  
coding rules were developed to ensure that all studies were treated consistently. these dealt with the identification and coding of correlations, path coeffi-cients, and possible multiple effects:  
  
  
  
argued for a ‘‘random effects’’ approach.  
  
thus, the studies included in our analysis were taken to be a random sample of all studies that could be performed, which implied that the overall results could be broadly generalized. in effect, the assumptions  
  
  
  
 correlations incorporated both within-study and between-study  
  
  
  
� data reported by the paper, or  
� calculated from path coefficients (only for linear regression-based studies), or  
  
� using the original covariance or correlation matrix to calculate the data of interest (only for lisrel-based  
  
  
  
variance into the meta-analysis, providing a more conservative significance test.  
  
for our analysis, we select the hedges–olkin technique as the primary analysis method. it is one of the three popular meta-analysis methods in behavior  
  
  
  
 studies). and social sciences; the others are the rosenthal–rubin  
  
  
  
 path coefficients (standardized):  
� data reported by the paper, or  
� calculated from correlations (only for linear regres-sion-based studies), or  
� using the original covariance or correlation matrix to calculate the data of interest (only for two lisrel- based studies), or  
� models being converted into the core tam (eu,u, and bi), if there were no confounding factors. multiple effects:   
 if a study had more than one effect size regarding a particular relationship, the effects were combined by conservative averaging. in fact, the multiple effect sizes reported in several papers of this variety were very close to each other and the differences were trivial.  
  
  
  
and hunter–schmidt methods. in general, results for the three methods are similar [23,81].  
  
cohen [10,11] and others have criticized research in behavioral and social sciences for a lack of statistical power analysis for research planning. as a response, we calculated necessary sample sizes for a 0.80 chance of detecting effects at the a = 0.05 level.  
  
3.1. construct reliabilities  
  
table 2 shows the reliabilities of the measures of the tam constructs across the studies. since a reliability of 0.8 is considered to be high, all constructs were deemed highly reliable. the table also addresses ‘‘attitude’’ for those studies that have measured this construct. these reliabilities are consistently high with low variance,  
  
  
  
 3. analysis leading to the conclusion that these simple four to six  
  
items) measures have widespread potential utility in  
  
  
  
this meta-analysis was conducted on a ‘‘random effects’’ basis. the assumption underlying this was that the samples in individual studies are taken from populations that had varying effect sizes. this appeared to be a more descriptive assumption than the alternative (a ‘‘fixed effects’’ model that assumed that there was a single true effect in the ‘‘super population’’ from which  
  
table 2   
key constructs in tam and their reliabilities  
  
  
  
technological utilization situations.  
  
 3.2. tam correlations   
 since some of the 88 studies did not report on all relevant statistics, the ‘‘number of studies’’ varies from table to table in the presentation of results.  
  
  
  
  
  
perceived ease  
  
perceived  
  
behavioral  
  
attitude (a)  
  
  
  
of use (eu)  
  
usefulness (u)  
  
intention (bi)  
  
  
  
average reliability (cronbach a)  
  
0.873  
  
0.895  
  
0.860  
  
0.846  
  
minimum  
  
0.63  
  
0.67  
  
0.62  
  
0.69  
  
maximum  
  
0.98  
  
0.98  
  
0.97  
  
0.95  
  
variance  
  
0.007  
  
0.006  
  
0.008  
  
0.006  
  
number of studies  
  
76  
  
77  
  
531  
  
25  
  
note: 1. 57 studies reported reliability statistics of behavioral intention. among them, four studies used single item measure (for single item measure, cronbach a = 1) and were excluded from this analysis.  
  
  
  
  
  
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table 3   
summary of zero-order correlations between tam constructs  
  
  
  
eu–bi  
  
u–bi  
  
eu–u  
  
number of samples  
  
56  
  
59  
  
77  
  
total sample size  
  
12205  
  
12657  
  
16123  
  
  
  
  
  
reports of correlation matrices are rare, we used two approaches for analyzing structural relationships:  
  
� meta-analyzing the correlations and then converting the results to structural relationships and  
  
  
  
average (r)  
  
0.429  
  
0.589  
  
0.491  
  
� meta-analyzing path coefficients (b’s) directly.  
  
z  
  
13.569  
  
21.381  
  
16.482  
  
  
  
p (effect size)  
  
0.000  
  
0.000  
  
0.000  
  
the tam core model (fig. 1) suggests that eu and u  
  
homogeneity test (q)  
  
51.835  
  
58.755  
  
79.618  
  
  
  
  
  
  
  
  
  
  
  
are  
  
the  
  
important  
  
predictors  
  
of  
  
an  
  
individual’s  
  
p (heterogeneity)  
  
0.596  
  
0.448  
  
0.366  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
95% low (r)  
  
0.372  
  
0.546  
  
0.440  
  
behavioral intention (bi); in addition, u partially  
  
95% high (r)  
  
0.483  
  
0.628  
  
0.539  
  
mediates the effect of eu on behavioral intention.  
  
  
  
  
  
power analysis (80% chance  
  
40  
  
20  
  
30  
  
to conclude significance) (n)  
  
  
  
the correlation coefficients (r’s) and path coefficients (b’s) present the following relationship:  
  
  
  
note: applying eqs. (1)–(3), the structural relationships between eu,  
  
bðeu ! biþ ¼rðeu;biþ � rðu;biþ � rðeu;uþ ð1 � r2 ðeu;uþþ  
  
(1)  
  
u and bi should be close to the following magnitudes: b  
  
  
  
  
  
(eu ! bi) = 0.184; b (u ! bi) = 0.499; b (eu ! u) = 0.491.  
  
  
  
  
  
table 3 shows zero-order correlations effect sizes  
  
  
  
(2)  
  
  
  
bðu ! biþ ¼rðu;biþ � rðeu;biþ � rðeu;uþ ð1 � r2 ðeu;uþþ  
  
  
  
between eu,u, and bi using the hedges–olkin method  
  
  
  
  
  
of random effects.  
  
bðeu ! uþ ¼ rðeu;uþ  
  
(3)  
  
all three correlational effect sizes are significant.  
  
  
  
  
  
  
  
  
  
the correlation between u and bi is particularly strong and the correlation between eu and i is less so, together explaining about 50% of the variance in bi. the 95% confidence interval for the u–bi correlation ranges from 0.546 to 0.628, which is narrow enough to give one confidence in the extent of variance that can be explained and a good large-sample estimate of this parameter. the correlations of eu–bi and eu–u are uniformly distributed over wider ranges, while the correlation distribution for u–bi is roughly normal (all shown in fig. 2a–c).  
  
the homogeneity test for the random effects model is a test of the null hypothesis that the interaction error term (between the sample error and the study error) is zero. testing results are insignificant, to some degree validating the use of a random effects analytic base. this also shows that a sample size above 40 should be adequate for purposes of identifying an underlying correlative effect.  
  
since these results show considerable variability in two of the three tam relationships, the possibility that other variables were significant moderators of the basic relationships was suggested. we addressed two such  
  
  
  
the three equations hold for linear-regression-based analyses; they may differ slightly for structural-equation-modeling-based analyses (e.g., pls and lisrel) because of different algorithms (illustrations basing on some studies are provided in appendix a). but the differences are trivial. thus, we can infer the magnitude and the strength of path coefficients basing on a set of meta-analytically developed correlation coefficients. when applying the second approach (combining b’s as the effect sizes) special caution must be taken that the sampled coefficients represent the relationship between the independent and the dependent variable controlling for other factors. fortunately, most of the proposed tam extensions have been tested against the tam core model, and the restricted structural relationships (b’s) among the three key constructs were reported, making the second approach workable.  
  
using the three equations, we calculate b’s basing on the correlations (r’s). we also meta-analyze bs and report the results in table 4. the results from the two approaches are almost identical, suggesting that both are methodologically acceptable. so we focus our discussion on their path coefficients. all are significant  
  
  
  
 moderators. and the coefficients fail the homogeneity test (support-  
  
ing the validity of the ‘‘random effects’’ analysis). the  
  
  
  
3.3. tam path coefficients  
  
most researchers have been more interested in the structural relationships among tam constructs, which help explain individuals’ acceptance of new technol-ogies, than in the zero-order correlations. because  
  
  
  
paths u–bi and eu–u are the strongest, with large means and rather small standard deviations. in addition, the minimum reported path coefficient for u–bi is 0.139, indicating that almost all studies found this path to be significant and positive in the tam nomological network. the path eu–bi is the weakest,  
  
  
  
  
  
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fig. 2. (a) histogram of correlations (eu–bi); (b) histogram of correlations (u–bi); (c) histogram of correlations (eu–u).  
  
with a mean of 0.179. the median is even smaller  
  
  
  
table 4   
summary of the effect size of path coefficients in tam  
  
number of samples  
  
eu ! bi  
  
u ! bi  
  
eu ! u  
  
  
  
67  
  
67  
  
65  
  
  
  
  
  
(0.152), indicating that the distribution is negatively  
  
skewed  
  
toward  
  
smaller  
  
values.  
  
considering  
  
the  
  
comparatively  
  
large  
  
variation  
  
(standard  
  
devia-  
  
tion = 0.162), this suggests that many studies have  
  
  
  
total sample size  
  
12582  
  
12582  
  
12263  
  
small path coefficients, and unless their sample sizes  
  
average b  
  
0.186  
  
0.505  
  
0.479  
  
  
  
  
  
  
  
  
  
  
  
are very large, they would be insignificant for this path.  
  
z  
  
8.731  
  
17.749  
  
12.821  
  
  
  
  
  
  
  
  
  
  
  
the path eu–u is positive and strong, with a reported  
  
p (effect size)  
  
0.000  
  
0.000  
  
0.000  
  
  
  
  
  
  
  
  
  
  
  
mean of 0.442. however, the large standard deviation  
  
homogeneity test (q)  
  
70.438  
  
66.077  
  
65.816  
  
  
  
  
  
  
  
  
  
  
  
(0.223) suggests that reported coefficients for this path  
  
p (heterogeneity)  
  
0.332  
  
0.474  
  
0.414  
  
  
  
  
  
  
  
  
  
  
  
are less consistent than those of u–bi. it should be  
  
95% low (b)  
  
0.145  
  
0.458  
  
0.415  
  
  
  
  
  
  
  
95% high (b)  
  
0.226  
  
0.549  
  
0.538  
  
power analysis (80% chance  
  
225  
  
28  
  
31  
  
to conclude significance) (n)  
  
  
  
noted that a sample size of 225 or more would be required to have an 80% chance of concluding significance for the eu–bi path.  
  
  
  
  
  
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3.4. summary of effect sizes  
  
the reported correlations for the three tam paths were significant, with the u–bi path strongest: most studies reported positive and significant path coeffi-cients of u–bi. with regard to eu–bi, when only the significance versus insignificance of the results are examined, the results are inconsistent. of the 67 papers that have reported testing results of the core tam model, 30 have reported or it can be concluded from their data that the path eu–bi was insignificant at the a = 0.05 level. however, such inconsistence should not exclude the possibility that the ‘‘true’’ effect sizes are small but positive, in that significance testing is largely  
  
  
  
et al. [4] experimental study on the spoken dialogue system, in which they concluded eu was not a significant predictor for bi, with a positive but small r2 changeof 0.002. their sample size was 10 endoscopists. in fact, of the 67 empirical papers, only 8 studies reported negative path coefficients of eu–bi, all of them being non-significant (all p-values larger than 0.50) and of small magnitudes (from �0.042 to�0.0004). thus, the major effect of eu is through u rather than directly on bi. this indicates the importance of perceived usefulness as a predictive variable. if one could measure only one independent variable, perceived usefulness would clearly be the one to  
  
  
  
 affected by the sample size. one such example is barker choose.  
  
  
  
fig. 3. (a) histogram of path coefficients (eu–bi); (b) histogram of path coefficients (u–bi); (c) histogram of path coefficients (eu–u).  
  
  
  
  
  
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3.5. the search for moderators  
  
fig. 2(a–c) show histograms of the three correlation effect sizes across the studies. the two paths leading to bi have unimodal distributions that are reasonably  
  
  
  
table 6   
moderator analysis by user type: professionals  
  
number of samples  
  
eu ! bi  
  
u ! bi  
  
eu ! u  
  
  
  
26  
  
26  
  
25  
  
total sample size  
  
3949  
  
3949  
  
3911  
  
  
  
  
  
symmetric, while the eu–u path distribution is less so.  
  
average (b)  
  
0.136  
  
0.517  
  
0.421  
  
  
  
z  
  
5.372  
  
14.191  
  
7.1  
  
the standard deviations are somewhat high, particularly  
  
  
  
  
  
  
  
  
  
for the eu–u relationship. generally speaking, the u–  
  
p (effect size)  
  
0.000  
  
0.000  
  
0.000  
  
  
  
homogeneity test (q)  
  
24.784  
  
31.564  
  
24.35  
  
bi relationship shows relatively less variance and is  
  
  
  
  
  
  
  
  
  
  
  
p (heterogeneity)  
  
0.475  
  
0.171  
  
0.442  
  
more consistent and straightforward than the eu–i  
  
95% low (b)  
  
0.087  
  
0.456  
  
0.314  
  
relationship.  
  
95% high (b)  
  
0.185  
  
0.572  
  
0.518  
  
  
  
  
  
 fig. 3(a–c) shows similar distributions for the effect sizes of the path coefficients.  
  
the best-studied moderator variable in tam is the level of experience of the users [100]. inexperienced versus experienced users have consistently been shown to have a moderating effect. as a result, and because we could not determine experience level of subjects in most  
  
  
  
power analysis (80% chance  
  
421  
  
26  
  
41  
  
to conclude significance) (n)  
  
 the effective reliability for the user groupings was 0.95 across the seven judges.  
  
  
  
 studies, we do not discuss it further. 3.5.1. type of user  
  
  
  
in an attempt to better understand the distributions, the studies were broken down into subsets based on the study subject and the nature of the usage. these were the most likely moderator variables that could influence the relationships in the 88 studies.  
  
we grouped users into three categories, based on the judgment of seven knowledgeable people who had no‘‘investment’’ in the research area: ‘‘students,’’ ‘‘pro-fessionals’’ and ‘‘general users’’ (non-students who were not using the system for work purposes). to test for the reliability of the judgment, we selected a random sample of 20 studies, and applied spearman–brown’s‘‘effective reliability’’ statistic where  
  
  
  
table 5 shows the correlation results for the three relationships in the student category; table 6 shows the same results for professionals, and table 7 shows the results for general users.  
  
these show that there are not great differences in the u–bi and eu–u relationships across the categories. however, there are differences in the eu–bi relation-ship. professionals are very different from general users; students lie somewhat in between, perhaps because they are a mixture of them.  
  
homogeneity assumptions were violated for the three subcategories. thus, the notion that there may be one true effect size was not validated, even for  
  
  
  
r  
  
nr  
  
professionals who demonstrated a quite small eu–bi 95% confidence interval (0.087–0.185). this result demonstrated the power of large (combined) sample  
  
 ¼  
  
1 þ ðn � 1þr  
  
  
  
r is the ‘‘effective’’ reliability; n the ‘‘number of judges;  
  
sizes  
  
as  
  
well  
  
as  
  
the  
  
complexity  
  
of  
  
technology  
  
  
  
  
  
r the mean reliability among all n judges (i.e., mean of n(n � 1)/2 correlations).  
  
  
  
acceptance in the real world. indeed, many researchers have pointed out that real-world data are likely to have  
  
  
  
 table 5 table 7  
  
  
  
moderator analysis by user type: students  
  
eu ! bi  
  
eu ! u  
  
u ! bi  
  
  
  
  
  
moderator analysis by user type: general users  
  
eu ! bi  
  
u ! bi  
  
eu ! u  
  
  
  
  
  
number of samples  
  
28  
  
28  
  
28  
  
number of samples  
  
13  
  
13  
  
12  
  
total sample size  
  
5884  
  
5884  
  
5884  
  
total sample size  
  
2749  
  
2749  
  
2468  
  
average (b)  
  
0.168  
  
0.54  
  
0.489  
  
average (b)  
  
0.321  
  
0.386  
  
0.566  
  
z  
  
5.358  
  
11.131  
  
8.435  
  
z  
  
5.802  
  
7.264  
  
7.39  
  
p (effect size)  
  
0.000  
  
0.000  
  
0.000  
  
p (effect size)  
  
0.000  
  
0.000  
  
0.000  
  
homogeneity test (q)  
  
31.49  
  
25.526  
  
27.218  
  
homogeneity test (q)  
  
12.172  
  
11.947  
  
14.019  
  
p (heterogeneity)  
  
0.252  
  
0.545  
  
0.452  
  
p (heterogeneity)  
  
0.432  
  
0.45  
  
0.232  
  
95% low (b)  
  
0.107  
  
0.46  
  
0.389  
  
95% low (b)  
  
0.217  
  
0.289  
  
0.439  
  
95% high (b)  
  
0.228  
  
0.611  
  
0.578  
  
95% high (b)  
  
0.418  
  
0.475  
  
0.67  
  
power analysis (80% chance  
  
275  
  
24  
  
30  
  
power analysis (80% chance  
  
73  
  
50  
  
22  
  
to conclude significance) (n)  
  
  
  
  
  
  
  
to conclude significance) (n)  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
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fig. 4. (a) 95% confidence interval for b (eu ! bi); (b) 95% confidence interval for b (u ! bi); (c) 95% confidence interval for b (eu ! u).  
  
  
  
heterogeneous population effect sizes [71]. therefore, the random effects model used here should generally be preferred for meta-analysis.  
  
fig. 4(a–c) showed 95% confidence intervals for the path coefficients of the three user groups. the most significant finding from these was the significant overlap between the student and professional groups,  
  
  
  
students as surrogates for professionals. these depic-tions also clearly indicated that students are not good surrogates for general users.  
  
 3.5.2. types of usage   
 the second categorization used in the search for moderators was the type of usage. studies were  
  
  
  
 which may provide additional justification for the use of categorized as:  
  
 table 8 table 9  
  
  
  
moderator analysis by type of usage: job-related applications  
  
eu ! bi  
  
u ! bi  
  
eu ! u  
  
  
  
  
  
moderator analysis by type of usage: office applications  
  
eu ! bi  
  
u ! bi  
  
eu ! u  
  
  
  
  
  
number of samples  
  
14  
  
14  
  
13  
  
number of samples  
  
9  
  
9  
  
9  
  
total sample size  
  
2313  
  
2313  
  
2275  
  
total sample size  
  
1570  
  
1570  
  
1570  
  
average (b)  
  
0.098  
  
0.605  
  
0.434  
  
average (b)  
  
0.121  
  
0.636  
  
0.499  
  
z  
  
5.424  
  
7.511  
  
7.202  
  
z  
  
3.323  
  
9.554  
  
5.361  
  
p (effect size)  
  
0.000  
  
0.000  
  
0.000  
  
p (effect size)  
  
0.000  
  
0.000  
  
0.000  
  
homogeneity test (q)  
  
15.946  
  
12.488  
  
13.838  
  
homogeneity test (q)  
  
7.003  
  
7.525  
  
7.269  
  
p (heterogeneity)  
  
0.252  
  
0.488  
  
0.311  
  
p (heterogeneity)  
  
0.536  
  
0.481  
  
0.508  
  
95% low (b)  
  
0.062  
  
0.476  
  
0.326  
  
95% low (b)  
  
0.05  
  
0.535  
  
0.334  
  
95% high (b)  
  
0.133  
  
0.709  
  
0.531  
  
95% high (b)  
  
0.191  
  
0.719  
  
0.634  
  
power analysis (80% chance to  
  
814  
  
18  
  
39  
  
power analysis (95% chance to  
  
533  
  
16  
  
28  
  
conclude significance) (n)  
  
  
  
  
  
  
  
conclude significance) (n)  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
  
fig. 5. (a) 95% confidence interval for b (eu ! bi); (b) 95% confidence interval for b (u ! bi); (c) 95% confidence interval for b (eu ! u).  
  
  
  
  
  
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 table 10 table 11  
  
  
  
moderator analysis by type of usage: general  
  
eu ! bi  
  
u ! bi  
  
eu ! u  
  
  
  
  
  
moderator analysis by type of usage: internet  
  
eu ! bi  
  
u ! i  
  
eu ! u  
  
  
  
  
  
number of samples  
  
24  
  
24  
  
24  
  
number of samples  
  
20  
  
20  
  
19  
  
total sample size  
  
4227  
  
4227  
  
4227  
  
total sample size  
  
4472  
  
4472  
  
4191  
  
average (b)  
  
0.200  
  
0.474  
  
0.356  
  
average (b)  
  
0.258  
  
0.401  
  
0.616  
  
z  
  
6.179  
  
12.646  
  
5.785  
  
z  
  
5.646  
  
9.128  
  
9.074  
  
p (effect size)  
  
0.000  
  
0.000  
  
0.000  
  
p (effect size)  
  
0.000  
  
0.000  
  
0.000  
  
homogeneity test (q)  
  
24.549  
  
16.683  
  
16.853  
  
homogeneity test (q)  
  
22.973  
  
18.3  
  
21.496  
  
p (heterogeneity)  
  
0.374  
  
0.825  
  
0.816  
  
p (heterogeneity)  
  
0.239  
  
0.502  
  
0.255  
  
95% low (b)  
  
0.138  
  
0.41  
  
0.241  
  
95% low (b)  
  
0.171  
  
0.322  
  
0.511  
  
95% high (b)  
  
0.261  
  
0.533  
  
0.461  
  
95% high (b)  
  
0.341  
  
0.475  
  
0.704  
  
power analysis (95% chance to  
  
193  
  
32  
  
59  
  
power analysis (95% chance  
  
115  
  
46  
  
18  
  
conclude significance) (n)  
  
  
  
  
  
  
  
to conclude significance) (n)  
  
- job-related;  
  
  
  
  
  
  
  
table 8 shows the correlation results for job related  
  
- office;  
  
  
  
  
  
  
  
applications. table 9 shows the results for office  
  
  
  
  
  
- general (such as email and telecom);- internet and e-commerce.  
  
the judgment reliability analysis, conducted in the same manner as for user-type judgments, produced a  
  
  
  
applications, table 10 shows the results for general uses, and table 11 shows the internet results.  
  
fig. 5(a–c) depicts the 95% confidence intervals for the paths. there is a minor difference between them and tables 8–11: the categories office and job task have been  
  
  
  
spearman–brown  
  
‘‘effective  
  
reliability’’  
  
of  
  
0.99.  
  
combined in the figures, because each involved a small  
  
  
  
fig. 6. (a) usage type; (b) usage type; (c) usage type.  
  
  
  
  
  
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 number of studies and the confidence intervals were of use on behavioral intention is primary through  
  
 heavily overlapping so we consolidated them into one usefulness.  
  
 (job-office applications). fig. 6(a–c) depicts this the search for moderators in terms of type of user  
  
  
  
consolidation in terms of the betas.  
  
the eu–bi effect is quite consistent across usage groups. the only usage group that is different is for the internet, where eu was of greater importance than for  
  
  
  
and type of use demonstrated that professionals and general users produce quite different results. however, students, who are often used as convenience sample respondents in tam studies, are not exactly like either  
  
  
  
 other types of usage. of the other two groups.  
  
 in terms of the moderating effects of different 4. conclusions varieties of usage, only internet use was shown to be different from job task applications, general use, and  
  
  
  
this meta-analysis of 88 tam studies involving more than 12,000 observations provided powerful  
  
  
  
office application. this suggests that internet study results should not be generalized to other contexts and  
  
  
  
 large-sample evidence that: vice versa.  
  
  
  
 (a) the tam measures (pu,u, and bi) are highly reliable and may be used in a variety of contexts. (b) tam correlations, while strong, have considerable variability, suggesting that moderator variables can  
  
  
  
of course, as in any such analysis, there are possible sources of bias (non-significant results are seldom published and there may be a lack of objective and consistent search criteria).  
  
we hope that this meta-analysis, coupled with the  
  
  
  
help explain the effects. the experience level of  
  
‘‘new’’  
  
economics  
  
of  
  
electronic  
  
publication,  
  
the  
  
users was shown to be a moderator in a number of  
  
existence  
  
of  
  
journals,  
  
which  
  
consider  
  
publishing  
  
  
  
  
  
studies but was not pursued here because of the difficulty in identifying the experience level in studies that did not report it. it was possible to identify two moderators given the data from the sampled studies.  
  
  
  
studies that might not be accepted in ‘‘a’’ journals because of ‘‘negative’’ or insignificant results, and the ease of electronic publication or personal websites will lead to a broader basis of studies available for analysis, whether or not they involve large samples or significant  
  
  
  
 (c) the influence of perceived usefulness on behavioral results. intention is profound, capturing much of the   
 influence of perceived ease of use. the only context  
  
  
  
in which the direct effect of eu on bi is very important is in internet applications.  
  
  
  
appendix a. the interdependence of r’s and b’s  
  
  
  
(d) the moderator analysis of user groups suggests  
  
r’s  
  
b’s  
  
b’s calculated  
  
  
  
  
  
that students may be used as surrogates for professional users, but not for ‘‘general’’ users. this confirms the validity of a research method that  
  
  
  
reported  
  
reported  
  
from r’s  
  
 linear regression examples   
 riemenschneider et al. [77]  
  
  
  
is often used for convenience reasons, but which is  
  
eou ! bi   
u ! bi   
eou ! u  
  
0.46  
  
not significant  
  
�0.003 0.71  
  
rarely tested.  
  
  
  
0.71  
  
0.71  
  
  
  
  
  
  
  
0.65  
  
0.65  
  
0.65  
  
(e) task applications and office applications are quite  
  
  
  
  
  
  
  
  
  
similar and may be considered to be a single  
  
szajna [90]  
  
0.071  
  
  
  
eou ! bi   
u ! bi   
eou ! u  
  
0.40  
  
0.07  
  
  
  
category.  
  
  
  
  
  
  
  
  
  
  
  
  
  
0.72  
  
0.72  
  
0.686  
  
(f) this sample sizes required for significance in terms  
  
  
  
  
  
  
  
  
  
  
  
  
  
0.48  
  
0.48  
  
0.48  
  
of most relationships is modest. however, the eu–  
  
  
  
  
  
  
  
  
  
  
  
structural equation modeling (sem) examples  
  
  
  
bi direct relationship is so variable that a focus on it  
  
  
  
  
  
  
  
hu et al. [41]1(using lisrel)  
  
  
  
would require a substantially larger sample.  
  
eou ! bi   
u ! bi   
eou ! u  
  
0.24  
  
0.12  
  
0.118  
  
5. summary  
  
  
  
0.70  
  
0.60  
  
0.679  
  
  
  
  
  
0.18  
  
0.10  
  
0.18  
  
plouffe et al. [74] (using pls)  
  
  
  
the meta-analysis rigorously substantiates the conclusion that has been widely reached through qualitative analyses: that tam is a powerful and robust predictive model. it is also shown to be a‘‘complete mediating’’ model in that the effect of ease  
  
  
  
eou ! bi u ! bi   
eou ! u  
  
0.38  
  
0.108  
  
0.116  
  
  
  
0.56  
  
0.507  
  
0.499  
  
  
  
0.53  
  
0.531  
  
0.53  
  
note: 1. b’s reported were from a replicated lisrel model testing using a covariance matrix reported in the paper.  
  
  
  
  
  
752