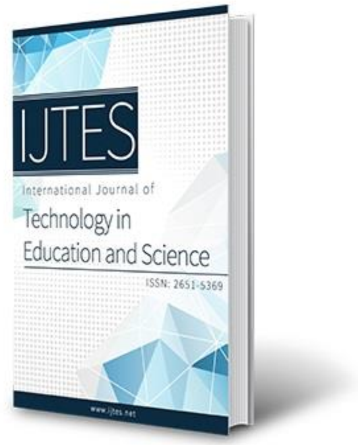

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The Role of Attitude in the Unified Theory of Acceptance and Use of Technology: A Meta-analytic Structural Equation Modelling Study

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Abstract

The Unified Theory of Acceptance and Use of Technology (UTAUT) model has been widely used to explain user intention and use behavior. Past research has added attitude to the UTAUT framework to examine further how it influences technology adoption. This study utilized a combined meta-analysis and structural equation modelling [approach] to examine how the model, when extended with attitude as a variable, differs from its original UTAUT model and whether there are emerging relationships among the existing constructs. Based on 21 empirical studies that included attitude in various extended models, the results showed that attitude was a significant predictor of behavioral intention and use behavior. The study also revealed that facilitating conditions emerged as the strongest predictor of use behavior in the presence of attitude as a construct. In conclusion, while the inclusion of attitude as a separate construct in the UTAUT model has provided a more comprehensive understanding of technology adoption and usage behavior, this study showed that it did not enhance its explanatory power.

Introduction

The Unified Theory of Acceptance and Use of Technology (UTAUT) has been widely used to explain and predict technology adoption and usage behavior (Dwivedi et al., 2019; Or, 2023a; Williams et al., 2015). The model proposes that performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC) are the critical determinants of users' behavioral intention (BI) and use behavior (UB) (Venkatesh et al., 2003). However, recent studies have suggested that adding attitude as a separate construct to the UTAUT model can enhance its explanatory power and provide a more comprehensive understanding of technology adoption (Altalhi, 2021; Sarkam, 2019; Suki & Suki, 2019; Sangeeta & Tandon, 2021; Yun & Park, 2020). In retrospect, past research on technology adoption and usage behavior has often omitted attitude as a separate construct for several reasons.

First, some researchers might have assumed that the core constructs of the earlier technology acceptance models already capture users' attitudes. For instance, when Davis (1985) refined the Technology Acceptance Model (TAM), he posited that user's motivation could be explained by 3 factors: (1) perceived ease of use; (2) perceived usefulness; and (3) attitude toward using. Later, Davis (1989) found that attitude did not fully mediate perceived ease of use and perceived usefulness, and a later version of the parsimonious TAM was suggested without the inclusion of attitude. Second, there may have been a lack of clear consensus on operationalizing attitude in technology adoption. Attitude is a complex construct encompassing a person's overall evaluation of technology and can be influenced by a wide range of factors, such as personal beliefs, emotions, and experiences. For example, Edison and Geissler (2003) attempted to develop an instrument to measure attitudes towards general technology. They discovered that although they developed an instrument, it was not comprehensive enough as it contained only a few factors that affected attitudes towards technology. Findings also showed that a broader study incorporating additional factors would be informative and should include a wide range of participants from different age groups. Therefore, researchers may have found it challenging to develop a standardized set of measurement items to capture attitudes in a technology adoption context effectively. Finally, some researchers may have focused more on examining technology adoption's practical and technical aspects, such as system features and user interface design, rather than the psychological factors underlying users' attitudes and intentions. Looking at both TAM (Davis, 1989) and UTAUT (Venkatesh et al., 2003) models, or even the later UTAUT2 model (Venkatesh et al., 2012), they are all measuring the system or technology features as well as the user experiences instead of the psychological factors.

This study aims to synthesize past empirical studies that extended the UTAUT model with attitude as a construct and provide a critical analysis of the findings from these studies using the extended model. In particular, this study will examine this impact on the UTAUT model's explanatory power, discuss the theoretical and practical implications of extending the UTAUT model with attitude, and identify areas for future research in this field.

The Role of Attitude in UTAUT

Attitude is a user's positive or negative feelings about displaying the intended behavior (Davis et al. 1989). First introduced in the original TAM (Davis, 1986) (Figure 1), attitude became the primary construct in information system acceptance models, including the theory of reason action (Fishbein & Ajzen, 1977) and the theory of planned behavior (Ajzen, 1991).

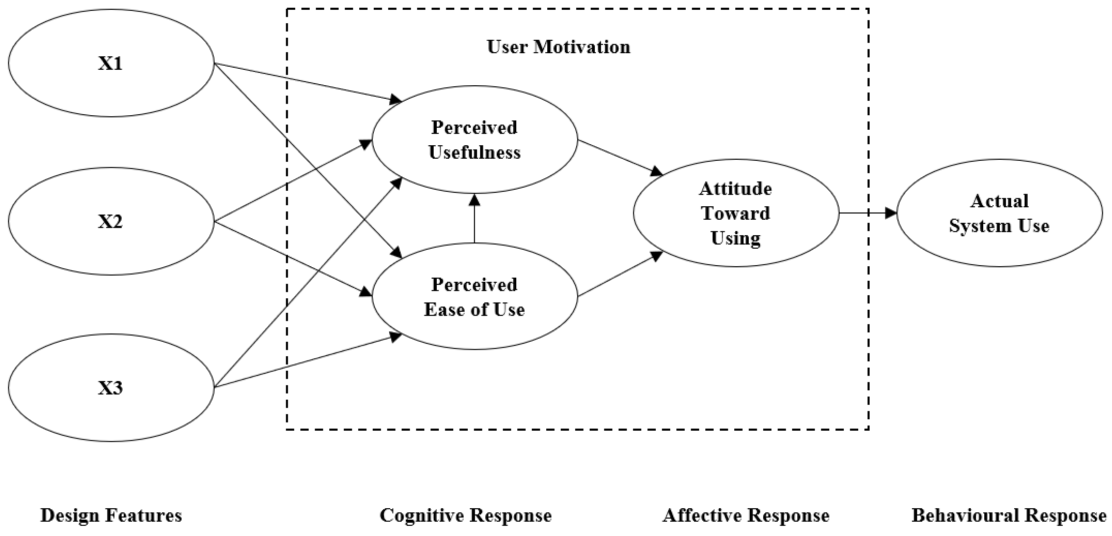

Figure 1. Original Technology Acceptance Model

The UTAUT model has its roots in TAM, as Venkatesh et al. (2003) formulated the framework based on 8 earlier technology acceptance models, and TAM was one of them. In the UTAUT model, user intentions and usage of a particular system or technology are explained by 4 factors: PE, EE, SI and FC. In UTAUT, PE is the extent an individual believes that using a system will benefit him or her in terms of job performance (Venkatesh et al., 2003) (Figure 2). EE is the ease with which users can adopt the system (Venkatesh et al., 2003). SI is the extent an individual perceives that 'important others' consider that he or she should use the system (Venkatesh et al., 2003). FC is the extent an individual believes that there is an existing organizational and technical infrastructure to support the system's users (Venkatesh et al., 2003). BI is the individual's intention to use the technology. UB is measured by the frequency of a particular technology use (Venkatesh et al., 2003). Concerning the importance of these factors for predicting BI and UB, PE, EE, and SI are all proposed to be predictors of BI and via BI as a mediator of UB.

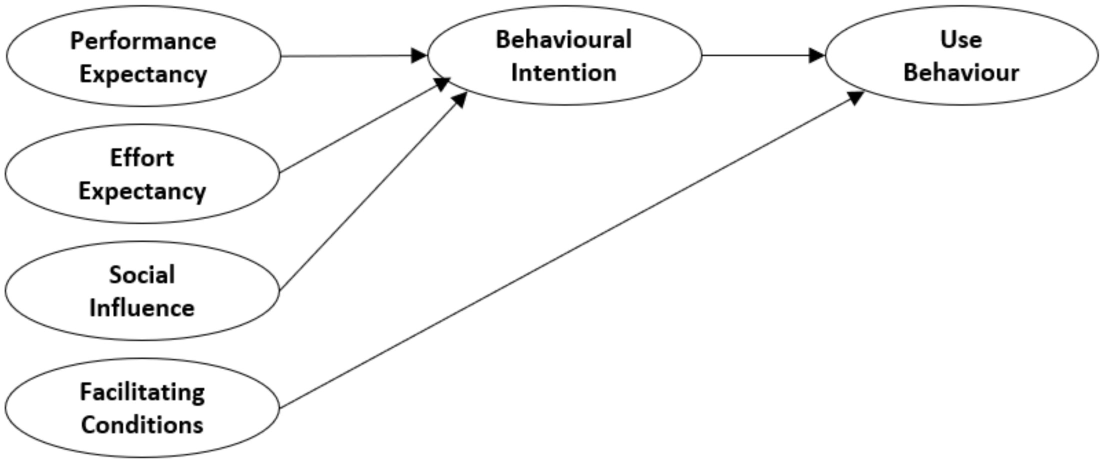

Figure 2. Unified Theory of Acceptance and Use of Technology

The original UTAUT does not include attitude as one of the variables influencing users' intentions. Later, when researchers started to extend the UTAUT model in their studies, they discovered that attitude significantly affected BI and UB. For instance, Altalhi (2021) found that attitude had a significant effect on both BI and UB when the researcher examined the acceptance of MOOCs in Saudi Arabian higher education with 169 students. However, recent studies also found that attitude had no significant effect on BI and UB. For example, Sarkam (2019) discovered that attitude had no significant effect on UB when the researcher conducted a study with 201 academicians on the acceptance of a blended learning system in Malaysian educational institutions. In another extended UTAUT study, Or and Chapman (2021) found that attitude was influenced by PE, SI and FC and had a significant effect on BI in their study with 213 Singaporean lecturers on the acceptance of the online assessment system.

As there were inconsistent past research findings, this study examines the role of attitude as a construct in the extended UTAUT model and how it influenced the relationships between the rest of the variables, using the meta-analysis approach and structural equation modelling method. Meta-analytic structural equation modelling (MASEM) is a powerful statistical technique combining meta-analysis and structural equation modelling (SEM) principles (Cheung, 2021, Cheung & Chan, 2005). It is beneficial for studying the role of attitude in the UTAUT theoretical framework. MASEM allows researchers to integrate findings from multiple studies investigating the relationships between attitude and other UTAUT constructs, enabling the examination of the overall effect sizes and patterns across different studies and providing a comprehensive understanding of the role of attitude in the UTAUT framework. Combining data from multiple empirical studies increases the statistical power of the analysis. By aggregating a larger sample size, MASEM improves the precision of the estimated parameters and allows for more robust conclusions. It is essential when examining the complex relationships within the UTAUT model, which involves multiple interrelated constructs. MASEM enables researchers to overcome this limitation by pooling data from multiple studies. It increases the sample size and provides a more diverse and representative sample, enhancing the external validity of the results.

Meta-analytic Structural Equation Modelling (MASEM) and UTAUT

Recent research has used a combined meta-analysis and structural equation modelling method to study the UTAUT model. MASEM has been increasingly applied to advance theories by synthesizing past research findings in recent years. For example, Or (2023b) utilized MASEM to re-examine the existing relationships among the UTAUT constructs. Using the MASEM approach, it was found that FC was a new predictor of BI and EE and SI were new predictors of UB. In another MASEM study, Dwivedi et al. (2019) re-examined the UTAUT model by including attitude as one of the variables. The researchers found that attitude was central to accepting and using information systems and technological innovations. Attitude was influenced by PE, EE, FC and SI, had a significant effect on BI and UB. In other words, attitude also served as a mediator between all the original UTAUT constructs.

The MASEM approach is a two-stage method (Cheung & Chan, 2005): (1) a pooled correlation matrix is estimated based on the individually reported correlation coefficients from the past empirical studies in stage 1, and (2) a path model or a structural model is fitted to explain the pooled correlations in stage 2. Tang and Cheung (2016) explained that researchers could benefit from utilizing MASEM by introducing a two-stage meta-analytic structural equation modelling (TSSEM) in their research. The researchers demonstrated that the illustration and comparison of MASEM with the conventional method showed that the TSSEM was a viable approach. However, the limitation of the MASEM approach then was that not all the individual empirical studies provided the correlation coefficients between the factors, which was required in the calculation. That limitation was later addressed by Jak and Cheung (2018) when they modified the original MASEM approach to address the missing correlation coefficients and compared the performance with the existing structural equation modelling methods. Jak et al. (2021) developed a one-stage meta-analytic structural equation modelling (OSMASEM) built on the fundamentals of the R software by utilizing existing metaSEM and semPlot packages. The TSSEM is used to examine fixed effects, while the OSMASEM developed by Jak et al. (2021) is a random-effects technique in which each study is assumed to have a population correlation matrix. In OSMASEM, the differences between the population correlation matrices are calculated by estimating a matrix that includes variances and covariances between the individual empirical studies. OSMASEM is based on the average correlation matrix across individual studies. Unlike TSSEM, OSMASEM does not require calculating a pooled correlation matrix as an initial step but restricts the pooled correlations in the multivariate meta-analysis to the model-implied correlations using the specified structural equation modelling, utilizing regression weights and covariances. In other words, the advantage of using the OSMASEM approach is that it directly estimates the structural equation modelling parameters without first calculating the pooled correlations. In short, OSMASEM is relatively more robust and can also include study-level moderators for each structural equation modelling parameter, although both OSMASEM and TSSEM result in highly comparable results (Jak & Cheung, 2022).

The Current Study on the Role of Attitude in UTAUT using OSMASEM

The current study synthesized 21 empirical research on the role of attitude in UTAUT in educational contexts by capitalizing on the advantage of calculating the correlation matrices through OSMASEM (Jak et al., 2021). The current OSMASEM study addresses these research questions:

1. To what degree does the extended UTAUT model, with the inclusion of attitude as an additional factor, fit the data model using the OSMASEM?
2. Does the additional factor, attitude, affect the existing relationships among the UTAUT constructs?
3. Does the inclusion of attitude improve the explanatory power of the extended UTAUT model?

Method

Literature Search and Screening Procedures

The Google Scholar database was searched to identify the relevant literature to the current UTAUT study. The advantages of using the Google Scholar database over other scholarly search engines are: (1) it offers advanced search options and various filters that enable researchers to refine their searches effectively. Users can search by author, publication, keyword, or specific phrases; (2) it indexes a substantial amount of open-access content, including articles from institutional repositories and preprint servers. Such a feature allows users to access research publications freely, promoting open science and widening access to scholarly information; and (3) it provides a comprehensive list of search results, including both peer-reviewed articles and non-peer-reviewed sources. The following search terms and Boolean operators were used, "UTAUT" AND "Attitude" AND "education". The other advanced search settings were included "anywhere in the articles" and "return articles dated between 2003 and 2023." After the search, an initial screening of the identified 17,500 studies was performed based on the following criteria: (1) the studies must address school or university's technology acceptance; (2) the studies must describe the relationships between the UTAUT constructs; (3) the studies must describe the relationship between UTAUT constructs and attitude; and (4) the studies must analyze, report and discuss the findings in English. The initial screening resulted in 7,300 eligible empirical studies. Some studies were then excluded by applying the following criteria: (1) the studies did not target teachers, lecturers, educators or students in K-12, college or university education; (2) the studies were based the UTAUT2 model; (3) the studies had insufficient statistical reporting of the correlations between UTAUT constructs and attitude; (4) correlations between variables were negative where R package, metaSEM, is unable to compute; and (5) UTAUT was examined outside of educational contexts. Figure 3 summarizes the results of the literature search and screening procedures. Table 1 lists the various research from which the data is used in this OSMASEM study.

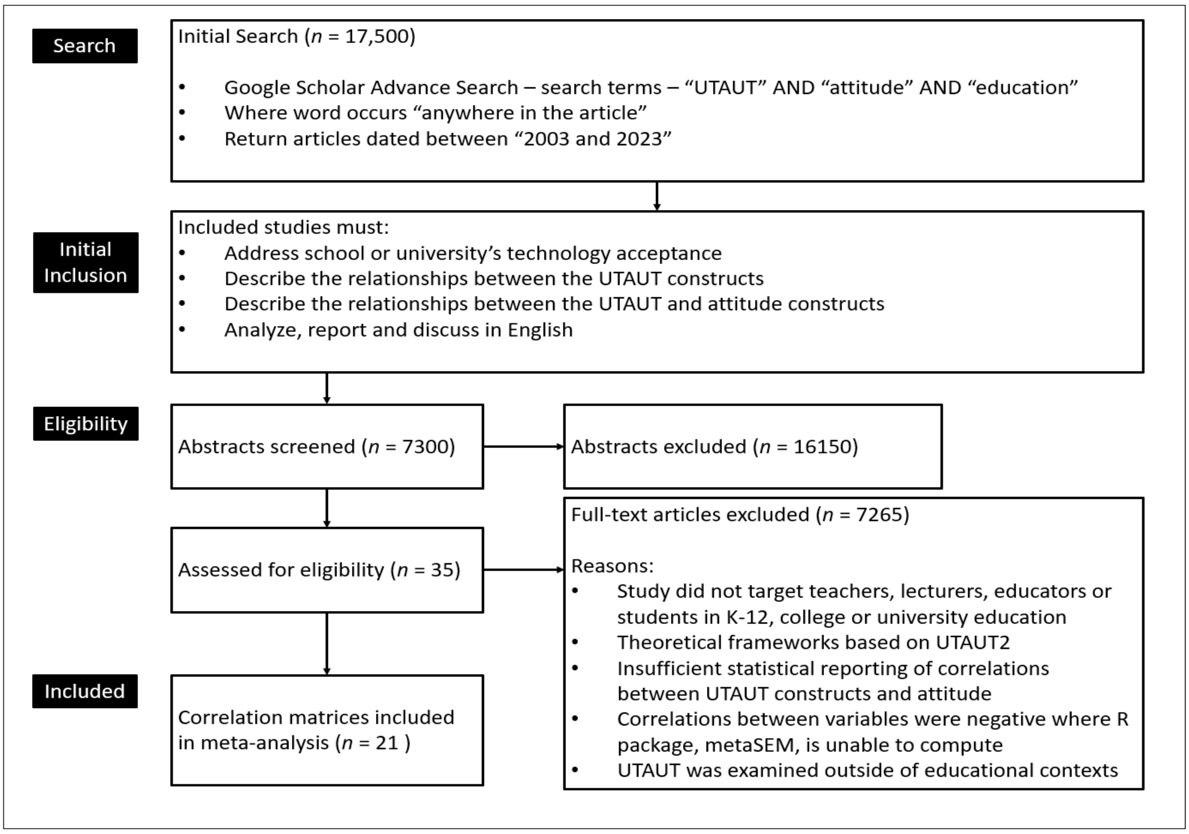

Figure 3. Diagram describing the Literature Search and the Selection of Eligible Studies for Meta-analysis

Table 1. UTAUT Studies from which Data are used

S/N	Technology / System	Sample Size	UTAUT Constructs	Study
1.	Artificial Intelligence	329	PE, EE, FC, Attitude, BI	Chatterjee, S., & Bhattacharjee, K. K. (2020). Adoption of artificial intelligence in higher education: A quantitative analysis using structural equation modelling. *Education and Information Technologies, 25*, 3443-3463.
2.	Blended Learning	201	PE, EE, SI, FC, Attitude, BI, UB	Sarkam, N. A. (2019). Factors affecting levels of acceptance of academicians in using blended learning (BL) system in teaching by using extended model of UTAUT. *Management Academic Research Society, 9(*13), 329-339.
3.	Digital Textbooks	493	PE, EE, SI, FC, Attitude, BI	Hermita, N., Wijaya, T. T., Yusron, E., Abidin, Y., Alim, J. A., & Putra, Z. H. (2023, February). Extending unified theory of acceptance and use of technology to understand the acceptance of digital textbook for elementary School in Indonesia. *In Frontiers in Education (*Vol. 8, p. 958800). Frontiers.

S/N	Technology / System	Sample Size	UTAUT Constructs	Study
4.	E-learning	259	PE, EE, SI, Attitude, BI	Sugandini, D., Istanto, Y., Arundati, R., & Adisti, T. (2022). Intention to Adopt E-Learning with Anxiety: UTAUT Model. *Review of Integrative Business and Economics Research*, *11*, 198-212.
5.	Embedded Role-play Games	200	PE, EE, SI, FC, Attitude, BI, UB	Suki, N. M., & Suki, N. M. (2019). Structural relationships in the embedding of role-play games in a class for Japanese language proficiency: Towards a Unified View. *Technology, Knowledge and Learning, 24*, 65-87.
6.	Flipped Classroom	213	PE, EE, SI, FC, Attitude, BI, UB	Alyoussef, I. Y. (2022). Acceptance of a flipped classroom to improve university students' learning: An empirical study on the TAM model and the unified theory of acceptance and use of technology (UTAUT). *Heliyon*, e12529.
7.	Interactive Whiteboard	438 (pre-adopters) 460 (post-adopters)	PE, EE, SI, FC, Attitude, BI, UB	Šumak, B., & Šorgo, A. (2016). The acceptance and use of interactive whiteboards among teachers: Differences in UTAUT determinants between pre-and post-adopters. *Computers in Human Behavior, 64,* 602-620.
8.	Learning Management System	213	PE, EE, SI, FC, Attitude, BI	Fidani, A., & Idrizi, F. (2012). Investigating students' acceptance of a learning management system in university education: a structural equation modeling approach*. ICT Innovations 2012 Web Proceedings, 2*(23), 311-320.
9.	Learning Management System	244	PE, EE, SI, FC, Attitude, BI, UB	Garone, A., Pynoo, B., Tondeur, J., Cocquyt, C., Vanslambrouck, S., Bruggeman, B., & Struyven, K. (2019). Clustering university teaching staff through UTAUT: Implications for the acceptance of a new learning management system. *British Journal of Educational Technology*, *50*(5), 2466-2483.
10.	MOOCs	169	PE, EE, SI, FC, Attitude, BI, UB	Altalhi, M. (2021). Toward a model for acceptance of MOOCs in higher education: The modified UTAUT model for Saudi Arabia. *Education and Information Technologies*, *26*, 1589-1605.
11.	Online Teaching	652	PE, EE, SI, FC, Attitude, BI, UB	Sangeeta, & Tandon, U. (2021). Factors influencing adoption of online teaching by school teachers: A study during COVID-19 pandemic. *Journal of Public Affairs, 21*(4), e2503.
12.	Mobile	386	SI, FC,	Naveed, Q. N., Alam, M. M., & Tairan, N. (2020).

S/N	Technology / System	Sample Size	UTAUT Constructs	Study
	Learning		Attitude, BI	Structural equation modeling for mobile learning acceptance by university students: An empirical study. *Sustainability*, *12*(20), 8618.
13.	Mobile Learning	247	PE, EE, SI, FC, Attitude, BI, UB	Yun, H., & Park, S. (2020). Validating a Structural Model of Using Mobile Technology for Learning among High School Students. *Educational Technology International*, *21*(1), 1-29.
14.	Mobile Learning	1156	EE, FC, Attitude, BI	Pratama, A. R. (2021). Fun first, useful later: Mobile learning acceptance among secondary school students in Indonesia. *Education and Information Technologies, 26*(2), 1737-1753.
15.	Mobile Learning	362	PE, EE, SI, FC, Attitude, UB	Alyoussef, I. Y. (2021). Factors Influencing Students' Acceptance of M-Learning in Higher Education: An Application and Extension of the UTAUT Model. *Electronics, 10*(24), 3171.
16.	Mobile Learning	316	SI, FC, Attitude, BI	Islamoglu, H., Kabakci Yurdakul, I., & Ursavas, O. F. (2021). Pre-service teachers' acceptance of mobile-technology-supported learning activities. *Educational Technology Research and Development, 69*(2), 1025-1054.
17.	Mobile Learning	322	PE, EE, SI, FC, Attitude, BI	Zhang, Y., Zhang, L., Chen, T., Lin, H., Ye, S., Du, J., Tao, Y. & Chen, C. (2022, May). Acceptance and Use of Mobile-Assisted Language Learning for Vocational College Students. In 6GN for Future Wireless Networks: *4th EAI International Conference*, 6GN 2021, Huizhou, China, October 30–31, 2021, Proceedings (pp. 573-589). Cham: Springer International Publishing.
18.	Social Learning Platform	99	PE, EE, SI, FC, Attitude, BI	Khechine, H., & Augier, M. (2019). Adoption of a social learning platform in higher education: An extended UTAUT model implementation. *Proceedings of the 52nd Hawaii International Conference on System Sciences, 2019*.
19.	Social Media	326	SI, FC, Attitude, BI	Harnadi, B., Prasetya, F. H., & Widiantoro, A. D. (2022, November). Understanding Behavioral Intention to Use Social Media Technology: Two Comparing Model, TAM and UTAUT. *In 2022 6th International Conference on Information Technology (InCIT)* (pp.

S/N	Technology / System	Sample Size	UTAUT Constructs	Study
				352-357). IEEE.
20.	Video Conferencing	777	PE, EE, FC, Attitude, BI	Camilleri, M. A., & Camilleri, A. C. (2022). Remote learning via video conferencing technologies: Implications for research and practice. *Technology in society*, *68*, 101881.

Internal Structure

R Studio (version 2023.06.0, Build 421) and its metaSEM package (version 1.3.0) were used to examine the fit of the data model. In Model 1, attitude, the additional construct, was posited to have a significant effect on UB. The analysis examined whether the actual factor structure and its loadings aligned with the theorized structure. It is done by statistically testing the fit between the proposed measurement model and the observed correlations (Albright & Park, 2009; Bollen, 1989; Hair et al., 2006; Kline, 2005). The following indices were used to assess the fit of Model 1 to the data: (a) $\chi 2$/ Degree of Freedom $\chi 2/df$), (b) Root Mean Square Error of Approximation (RMSEA) (Steiger, 1990), (c) Standardised Root Mean Square Residual (SRMR), (d) Comparative Fit Index (CFI) (Bentler, 1990) and (e) Tucker-Lewis fit index (TLI; Bentler & Bonett, 1980) (Table 2). The values for Model l fell within the recommended thresholds for acceptable model fit based on all five indices ($\chi 2/df$ = 2.150, p>.005; RMSEA = .012; SRMR = .029; CFI = .992, TLI = .966) (Table 2). The data reliability was analyzed using IBM SPSS (version 28.0.1.1) and was highly reliable (N = 21; α = .973).

Table 2. Goodness-of-fit Indices of Model 1

Measure	Threshold	Value
$\chi 2$	--	10.753
df	--	5
$\chi 2/df$	< 3.000	2.150
p-value	> .050	.057
RMSEA	< .050	.012
SRMR	<.080	.029
CFI	> .950	.992
TLI	> .950	.996

The correlation matrices obtained from the 21 UTAUT studies were analyzed with the R package, metaSEM (version 1.3.0). Using the R software, the metaSEM package derived originally from the openMX package provides analysis for the OSMASEM method through the SEM approach. The OSMASEM method, most suitable for processing longitudinal relationships between factors at continuous time points (Cheung, 2014), was a good fit for this study that extracted 21 UTAUT empirical studies from 2003 to 2023. Moreover, the metaSEM package improved the sensitivity of significance tests by utilizing the maximum likelihood estimation for analyses while using the sum rather than the mean of sample sizes to compute the standard errors for the path coefficients.

Results

Model 1, with the inclusion of attitude as a construct in this study, underperformed when compared to the original model by Venkatesh et al. (2003). The original UTAUT model performed at an adjusted R^2 of 74% for BI. The UTAUT model in this study only attained an R^2 of 45.8%. The original UTAUT model attained an explained variance at 52% for UB. However, the explained variance of UB for Model 1, with the additional attitude construct, also underperformed compared to the original UTUAT model at R^2 of 46.8% (Table 3).

Table 3. Comparison of Variances Explained

Variance Explained (R^2)		
	Original Model	**Model 1**
BI	.740	.458
UB	.520	.468

Like the original UTAUT model proposed by Ventakesh et al. (2003), PE remained the best predictor of BI (β= .369; p<.001) compared to EE and SI in Model 1: (1) EE had a significant positive effect on BI (β= .234; p< .001); and (2) SI had a significant positive effect on BI (β= .207; p<.001). PE, EE, SI and FC all had a significant effect on the additional construct, attitude: (1) PE had a significant positive effect on attitude (β= .419; p< .001); (2) EE had a significant positive effect on attitude (β= .217; p< .001); (3) SI had a significant positive effect on attitude; and (4) FC had a significant positive effect on attitude (β= .097; p< .001). However, in Model 1, FC emerged as the strongest predictor of UB (β= .376; p< .001), while both attitude (β= .261; p< .001) and BI (β= .204; p< .001) had significant positive effects on UB. The results for the variables are summarized in Figure 4.

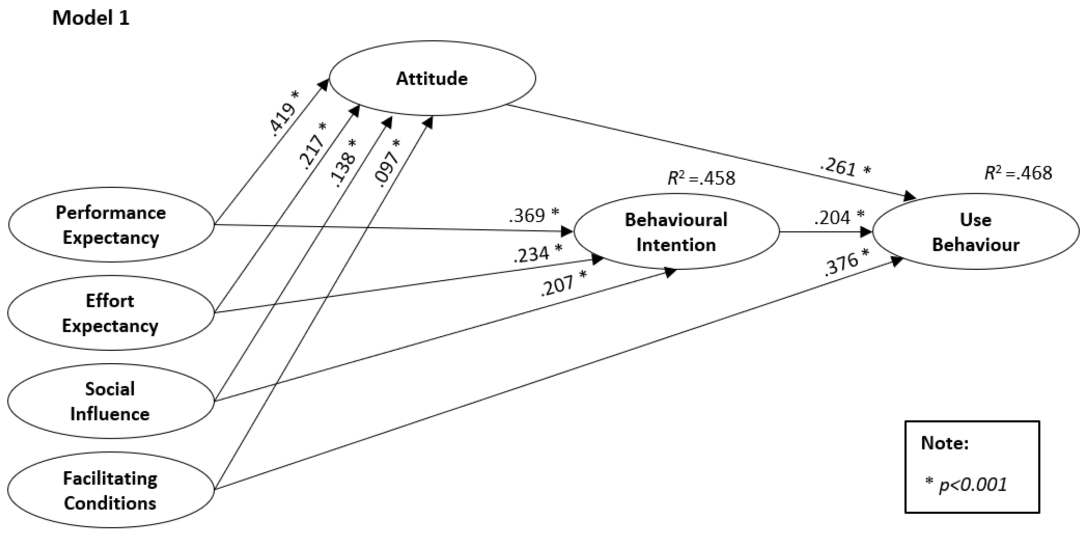

Figure 4. Path Diagram of UTAUT Model 1

In Model 2, attitude was posited as a predictor of BI instead of UB. The values for Model 2 were within the recommended thresholds for acceptable model fit based on all five indices ($\chi2/df$ = 1.539, p>.005; RMSEA = .008; SRMR = .032; CFI = .996, TLI = .984) (Table 4). Model 2 also underperformed as compared to the original model by Venkatesh et al. (2003) (Table 5). Explained variance for BI and UB were at adjusted R^2 of 45.2% and

51.5%, respectively. It was observed that with attitude as a predictor of BI instead of UB, the explained variance of UB is relatively higher than in Model 1. In Model 2, PE (β= .376; *p*<.001), EE (β= .213; *p*<.001), SI (β= .001; *p*<.001) and FC (β= .369; *p*<.001) had significant positive effect on BI. The effect of SI on attitude was much reduced compared to Model 1. Attitude emerged as the strongest predictor of BI (β= .297; *p*<.001) instead of PE (β= .225; *p*<.001) while EE (β= .123; *p*<.001) and SI (β= .172; *p*<.001) both had significant positive effects on BI. With the inclusion of attitude, FC was a better predictor of UB (β= .476; *p*<.001) than BI (β= .371; *p*<.001).

Table 4. Goodness-of-fit Indices of Model 2

Measure	**Threshold**	**Value**
$\chi 2$	--	7.696
df	--	5
$\chi 2/df$	< 3.000	1.539
p-value	> .050	.174
RMSEA	< .050	.008
SRMR	<.080	.032
CFI	> .950	.996
TLI	> .950	.984

Table 5. Comparison of Variances Explained

Variance Explained (R^2)		
	Original Model	**Model 2**
BI	.740	.452
UB	.520	.515

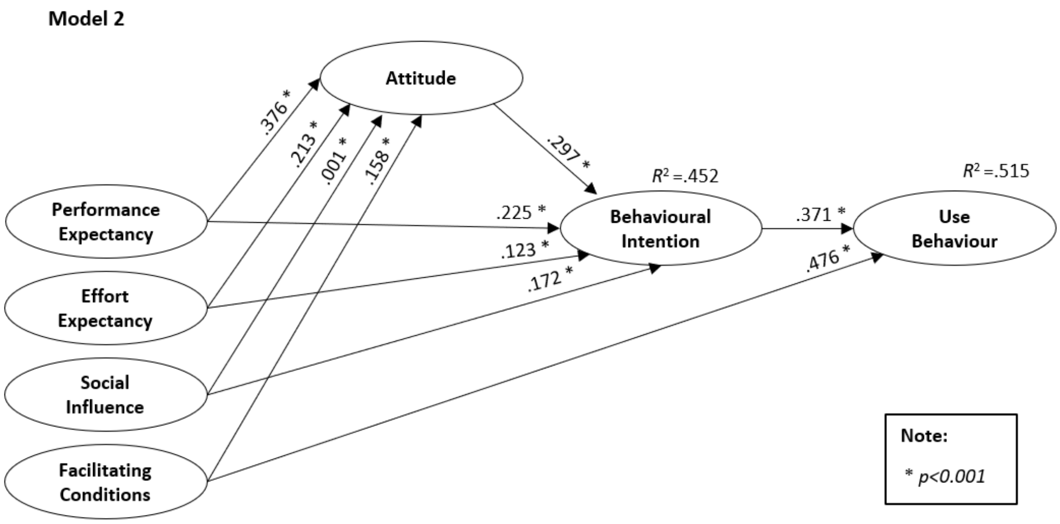

Figure 5. Path Diagram of UTAUT Model 2

Model 3 tested in this OSMASEM study was to include all possible exogenous variables and stimulate the various possible direct relationships between them (see Figure 5). The goodness-of-fit indices for Model 3 were within the recommended thresholds for acceptable model fit ($\chi 2/df$ = 1.804, $p>.005$; RMSEA = .027; SRMR = .027; CFI = .993, TLI = .963) (see Table 6).

Table 6. Goodness-of-fit Indices of Model 3

Measure	Threshold	Value
$\chi 2$	--	9.020
df	--	5
$\chi 2/df$	< 3.000	1.804
p-value	> .050	.061
RMSEA	< .050	.013
SRMR	<.080	.027
CFI	> .950	.993
TLI	> .950	.963

Table 7. Comparison of Variances Explained

Variance Explained (R^2)		
	Original Model	**Model 3**
BI	.740	.443
UB	.520	.473

While there was an excellent internal data structure in Model 3, both explained variances for BI (44.3%) and UB (47.3%) underperformed as compared to the initial UTAUT model introduced by Venkatesh et al. (2003) (see Table 7). In fact, Model 3 performed the worst in terms of explained variances among the three models. In Model 3, PE (β= .420; p<.001), EE (β= .200; p<.001), SI (β= .128; p<.001), and FC (β= .125; p<.001) had significant positive effects on attitude (see Figure 6).

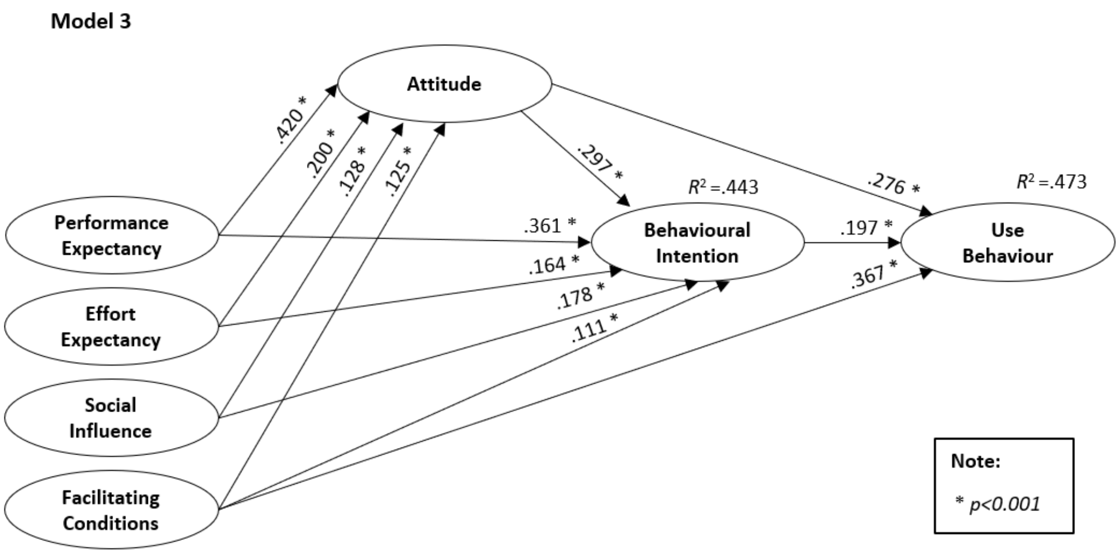

Figure 6. Path Diagram of UTAUT Model 3

Similar to the original UTAUT model, PE (β= .361; *p*<.001), EE (β= .164; *p*<.001) and SI (β= .178; *p*<.001) were predictors of BI. While there was a new observation effect of FC on BI ((β= .111; *p*<.001), PE remained the best predictor of BI. The additional construct, attitude, appeared to be a predictor of both BI (β= .297; *p*<.001) and UB (β= .276; *p*<.001). FC (β= .367; *p*<.001), instead of BI (β= .197; *p*<.001), appeared to be the best predictor of UB in Model 3.

Discussion

The OSMASEM method was employed to revisit the extended UTAUT model first introduced by Ventakesh et al. (2003). In Model 1, it was posited that attitude has a significant positive effect on UB. This aligns with a few past studies that revealed that such a relationship existed. For instance, Sangeeta and Tandon (2021), in their studies on factors influencing online teaching with 643 teachers, found that attitude had a significant positive effect on UB. In another study by Alyoussef (2022) on the acceptance of flipped classrooms with 213 undergraduates, it was found that attitude towards using flipped classrooms had a significant positive effect on UB. Comparatively, more past studies showed that attitude had a significant positive effect on BI, like in Model 2 (Bervell et al., 2020; Camilleri & Camilleri, 2022; Dulle & Minishi-Majanja, 2011; El-Gayar & Moran, 2006; El-Gayar et al., 2011, García Botero et al., 2018; Islamoglu et al., 2021; Moran et al., 2010; Nassuora, 2012; Shuhaiber, 2015; Thomas et al., 2013; Naveed et al., 2020; Nicholas-Omoregbe et al., 2017; Pratama 2021); Sugandini et al., 2022; Suki & Suki, 2019; Yun & Park, 2020). It was also in Model 2 where attitude emerged as the best predictor of BI. Such a finding was not unprecedented. The study by El-Gayar and Moran (2006) on the acceptance of Tablet PCs with 263 college students found that attitude was the strongest predictor of BI.

In Model 3, all possible relationships in the UTAUT model were examined, and it was found that there was a new observation effect of FC on BI ((β= .111; *p*<.001). A similar finding was also found in the study by Or (2013), where FC was found to have a significant positive effect on BI, where the OSMASEM study was conducted with 41 UTAUT studies. Ventakesh et al. (2012) eventually included the relationship between FC and BI in the later UTAUT2 theoretical framework. The other finding worth noting is that in the presence of attitude as a construct, FC appeared to be the best predictor of UB in all 3 models. This finding is similar to that from the large-scale study by Nistor et al. (2013) on cross-cultural validation of the UTAUT model by examining a sample (N = 4,589) of educational technology users from Germany, Romania and Turkey. Traditionally, BI in many past UTAUT studies, had the largest effect on UB (Ventakesh et al., 2003).

Table 8. Comparison of Variances Explained for Models 1,2 & 3

	Variance Explained (R^2)			
	Original Model	**Model 1**	**Model 2**	**Model 3**
BI	.740	.458	.452	.443
UB	.520	.468	.515	.473

The variances explained calculated in all the models in this study all underperformed compared to the original UTAUT model developed by Ventakesh et al. (2003) (Table 8). Apart from the comparisons with the original

UTAUT model, Model 1 showed the highest variance explained for BI (45.8%) when the explained variances were calculated. Model 2 displayed the highest explained variance for UB (51.5%). For future UTAUT models extended with attitude as a construct that examines a single outcome, such as BI, it is recommended that Model 1 be adopted. For the examination effect outcome of UB, Model 2 is recommended as it yielded the highest explained variance for UB among the three models. For research that examines both BI and UB as exogenous outcomes, Model 3 should be adopted.

Limitations

While new direct relationships were discovered between constructs in the extended UTAUT models when attitude was included, there are a few limitations in such an approach. One limitation is that measuring attitude can be more challenging and time-consuming than measuring the core constructs of the UTAUT model, such as PE, EE, SI and FC. Attitude is a complex construct encompassing a user's overall evaluation of technology and can be influenced by factors such as personal beliefs, emotions, and experiences. Therefore, developing a standardized set of measurement items that can effectively capture attitudes in a technology adoption context can be difficult. The metaSem package in R software helps conduct SEMs and estimate the overall effect sizes and model parameters across multiple empirical studies. However, one limitation of the metaSEM package used in the R software is that it cannot compute negative correlation coefficients. Future research will benefit as the software package develops in the next few years to enable it to do so.

Conclusion

The current study synthesized empirical data from UTAUT empirical studies from 2003 to 2023 in the educational context using the OSMASEM approach (Jak et al., 2021). Many diverse findings have been discovered from past UTAUT studies since its inception in 2003. OSMASEM, the method introduced in this study, offers an alternative approach without duplicating similar studies for researchers to use past empirical data to examine the UTAUT model or its extended models. Therefore, the OSMASEM approach allows researchers to focus on the critical relationships in models like UTAUT and advise staff on implementing technologies and learning systems in higher educational institutions.

Only a few studies utilized MASEM or OSMASEM in educational research compared to other methods in the field (Or, 2023b, Scherer et al., 2019, Wu et al., 2021). OSMASEM is gaining popularity as an essential tool for synthesizing and analyzing data from multiple empirical studies, particularly in psychology and education. In the near future, OSMASEM's popularity may increase as more researchers become aware of its potential advantages over traditional meta-analytic methods and the availability of similar software packages such as metaSEM increases. As such, OSMASEM is a recent yet valuable tool for technology acceptance studies like the UTAUT and the TAM models. It allows researchers to synthesize data from multiple empirical studies and evaluate measurement invariance, resulting in a more robust and comprehensive understanding of the relationships between the factors proposed in models like UTAUT and the adoption and usage of technology in higher education.

In conclusion, while the inclusion of attitude as a separate construct in the UTAUT model has provided a more comprehensive understanding of technology adoption and usage behavior, this study showed that it did not enhance its explanatory power. Based on the 21 empirical studies, all 3 models in this study underperformed as compared to the original UTAUT model (Ventakesh et al., 2003). Nevertheless, much research must be done to fully understand attitude's role in the UTAUT model. Future studies should explore different approaches to operationalizing and measuring attitudes in the context of technology adoption and investigate how this construct interacts with the core constructs of the UTAUT model. For instance, in the presence of attitude as a construct, FC appeared to be the best predictor of UB in this study. Additionally, future studies should examine the impact of other individual and contextual factors on the relationship between attitude and technology adoption, such as personality traits, cultural differences, and organizational support. Overall, extending the UTAUT model with attitude provides a valuable framework for understanding and predicting technology adoption and usage behavior and has significant implications for researchers and practitioners in information systems and system implementations in higher education.

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