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Explaining information technology usage: A test of competing models☆

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Abstract

While much of the prior information technology (IT) research has attempted to explain users' acceptance of new IT, recent research has focused on IT continuance or continued usage. The technology acceptance model (TAM) and the expectation–disconfirmation theory (EDT) are currently the dominant referent theoretical frameworks explaining user acceptance and continuance of IT, respectively. However, no study to date has yet empirically compared the relative ability of the two competing theories in explaining IT continuance intention. This paper fills this gap in the literature by comparing the explanatory ability of the two models via a longitudinal study of computer-based tutorial usage. Our findings confirm that both models have good explanatory power with the TAM providing a better prediction of intention. An integrated model, combining TAM and EDT, provided a marginally better explanatory power.

Keywords: IT usage; Technology acceptance model; Expectation disconfirmation theory; IT adoption

1. Introduction

Information technology (IT) usage has been a major focus of information systems (IS) research for more than two decades. This is so because IT usage has been demonstrated to be a key driver of organizational performance [1]. While most prior IT usage research has focused on initial IT usage or acceptance [2–4], long-term IT usage or continuance has recently gained increased attention among researchers [5,6]. As Bhattacherjee [5] stated, initial acceptance is an important first-step toward realizing IT success; however, IT continuance is more critical toward ensuring long-term viability of IT innovations.

Although both the acceptance and continuance streams of research have evolved from psychology research, they have distinct theoretical foundations. IT acceptance research has been informed primarily by the technology acceptance model (TAM) [2], while IT continuance research has been influenced by expectation–disconfirmation theory (EDT) [7]. TAM is based on the beliefs–attitudes–behavior paradigm of human behavior extended from Fishbein and Ajzen's [8] theory of reasoned action (TRA) in social psychology literature. In contrast, EDT is based on expectation–disconfirmation–satisfaction paradigm

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based on Festinger's [9] prior work on cognitive dissonance theory. TAM is a static model that explains user intention and behavior based on forward-looking or prospective expectations about IT usage, such as perceived usefulness, perceived ease of use, and attitude. EDT, on the other hand, is a process model that explains user intention and behavior based on their backward-looking or retrospective perceptions grounded in actual usage experience, such as performance, disconfirmation, and satisfaction, in addition to initial expectations.

Though TAM is technically a model of IT acceptance, it has also been used to examine post-adoptive usage. For instance, Davis et al. [2] used TAM to examine students' usage of a word processing software (WriteOne) at two points in time—following their initial exposure to the system and then again 14 weeks after initial acceptance—in order to demonstrate model's predictive ability for short-term and long-term (post-adoptive) usage. Recent longitudinal studies have also employed TAM to examine post-adoption intention and/or behavior (e.g., [10–12]). In contrast, EDT is designed solely to explain post-adoptive behavior following one's first-hand experience with the target system. Since each theory has distinct roots and is based on a different set of antecedent variables, we contend that they independently provide a partial understanding of users' cognitive processes related to IT usage. It is therefore possible that, when combined, these theories may collectively provide an improved and more comprehensive understanding of the cognitive processes and behaviors related to IT usage, than each theory considered alone.

While prior research have examined TAM and EDT independently in explaining IT usage, to the best of our knowledge, no study has yet theoretically compared or contrasted these two models or empirically compared their explanatory power. Additionally, the potential value and insight that may be derived from an integrated model combining these two theories has also not been examined yet. The primary contributions of this study are its examination of theoretical differences between TAM and EDT in explaining long-term IT usage intention and empirical evaluation of whether a research model integrating the two theories can explain IT usage more than either model considered alone. Findings from this paper may therefore help bridge the extant gap between acceptance and continuance streams of IT usage research.

The next section provides a brief overview of TAM and EDT, as well as the theoretical justification for their integration. Section 3 describes the research methods employed in our empirical study. Section 4 discusses variable operationalization and validation. Section 5 presents data analysis techniques and results. The final section discusses the study's limitations, the significance of its findings, and implications for future research.

2. Theory and research model

2.1. Technology acceptance model

TAM was proposed by Davis et al. [2] to explain IT users' intention and behavior regarding IT usage. TAM identified two salient beliefs, perceived usefulness and ease of use, as the primary predictors of user's attitude or overall affect toward IT usage (see Fig. 1). Perceived usefulness is the extent to which a person believes that using a system will enhance her performance, and perceived ease of use is the extent to which a person believes that using the system will be relatively free of effort. User attitude is posited to influence behavioral intention to use IT, which in turn, influences actual usage behavior. Davis et al. [2] also hypothesized perceived usefulness to have a direct effect on intention, in addition to its indirect effect via attitude, to account for circumstances where utilitarian considerations may dominate users' decision to use IT, over and above any negative attitude toward such usage. Davis et al. [2] also observed a positive association between perceived usefulness and ease of use.

Numerous empirical investigations have established strong empirical support for TAM [3,10–12]. Perceived usefulness has consistently been the predominant predictor of user attitude toward IT usage, though ease of use has had a somewhat inconsistent effect, especially during later stages of usage [3]. Longitudinal studies suggest that the decreasing effect of EOU over time indicates a "wearing out" of users' initial inhibitions concerning ease of use as they gain experience with and become comfortable in using the target system [13]. While perceived usefulness has a consistently strong positive

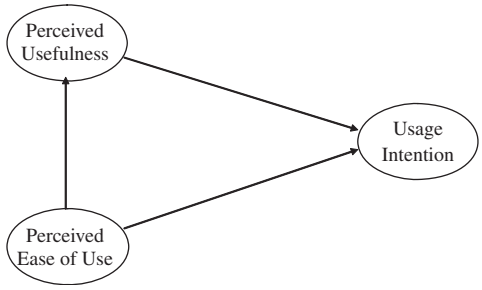

Fig. 1. Simplified technology acceptance model.

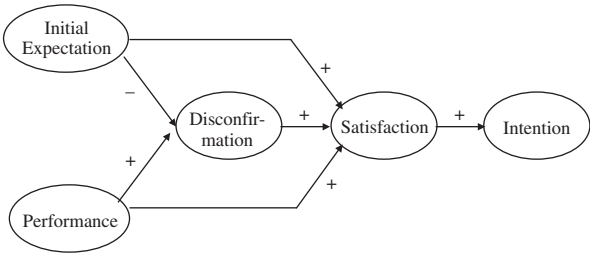

Fig. 2. Expectation–disconfirmation model.

effect of intention, attitude has tended to have a mixed effect, especially when perceived usefulness is included as a predictor of intention [3]. Contrary to TRA, Davis et al. [2] suggested that, in the specific case of IT usage, attitude may only partially mediate the associations between beliefs and intention and that IT usage decisions tend to be more dominated by beliefs such as perceived usefulness than affect such as attitude. This has led many recent TAM studies to drop attitude entirely from their models (e.g., [3,12]).

Among cognitive models, Azjen [14] proposed the TPB as an extension of TRA, to include social influence (subjective norm) and behavioral control as additional determinants of behavioral intention. Some IT usage studies have empirically compared the predictive power of TAM versus TPB (e.g., [4,15]). Taylor and Todd [4] observed that TPB explained 60% of the variance in intention and 36% of IT usage, compared to 52% and 34% for TAM, respectively. Though TPB provides an better understanding of the complex patterns of associations among the antecedents (e.g., beliefs, attitude) of intention, its predictive power is only slightly better than TAM for understanding IT usage intentions, and the parsimony and simplicity of TAM makes it a preferred model for studying IT usage [12]. Hence, consistent with recent TAM studies, a parsimonious model of three variables, consisting of perceived usefulness, perceived ease of use, and IT usage intention is employed as the base model in this study (see Fig. 1).

2.2. *Expectation disconfirmation theory*

EDT was proposed by Oliver [7] in the marketing literature to explain the determinants of consumer satisfaction/dissatisfaction and consequent retention of products and services. Oliver [7] suggested that consumers go though a five-step process in making product or service acquisition and retention decisions (see Fig. 2). First, they form an initial (pre-usage) expectation of the product, based on product information, media reports, feedback from prior users, and the like. Then, they use the product and form a perception of its performance (alternatively viewed as quality) based on their actual product experience. Third, they compare the perceived performance with their initial expectations and determine the extent to which their initial expectations were disconfirmed. Fourth, they establish a satisfaction level, based on their level of disconfirmation and initial expectations. Finally, their satisfaction level influences their intention to repurchase or continue using the product.

EDT posits that consumer satisfaction with actual product or service usage is the primary determinant of their post-purchase intention (see Fig. 2). Satisfied users continue using the product/service, while dissatisfied users stop using it subsequently. Satisfaction, in turn, is based on users' initial expectation from product or service usage and the extent to which this expectation is met during actual usage (disconfirmation). Hence, users can therefore be satisfied in two alternative ways: if they are positively disconfirmed (i.e., experience meeting or exceeding initial expectations), or if they had high expectations to begin with even if such expectations were not met in practice.

Disconfirmation is a function of product or service performance, as perceived by users following their actual usage experience, as well as their initial expectation of the product or service. Initial expectation provides a baseline or reference frame from which performance is evaluated as a deviation in the formation of disconfirmation perceptions. Initial expectation is posited to have both direct and indirect effects on disconfirmation; a negative direct effect since high expectations are most likely to be negatively disconfirmed and a positive indirect effect since high expectations are more likely to lead to higher performance evaluations (halo effect), which in turn, causes greater positive disconfirmation.

Though not included in the original EDT, some researchers have empirically validated performance as an additional determinant of satisfaction (e.g., [16–18]). These studies posit a direct effect of performance on satisfaction, as well as an indirect effect via disconfirmation. However, the relative significance of the two effects vary with product type; high-involvement consumer durables tend to have stronger direct effects than low-involvement products [16].

In IT usage research, EDT was validated by Bhattacherjee [5] in an empirical study of online banking. McKinney et al. [19] found support for EDT in a study of online retailing, separately focusing on users' disconfirmation with the online site and with the quality of information presented on that site. Staples et al. [20] examined the impact of different levels of

disconfirmation on perceived system benefits. Bhattacherjee and Premkumar [6] used the core constructs of this theory (i.e., disconfirmation and satisfaction) to explain how users' beliefs and attitude toward IT usage change with time, as the result of their direct experience with IT usage. Across all of these studies, EDT has held up very well as a potent explanation for post-adoptive IT usage.

2.3. An integrated model of IT usage

TAM and EDT present complementary perspectives for understanding IT usage intention or behavior for at least three reasons. First, TAM is theoretically a cross-sectional model in that it predicts IT usage based on user perceptions at any given point in time, though this model has been studied in longitudinal settings as well. However, EDT is a longitudinal (process) model where pre-usage expectations are temporally separated from post-usage constructs such as performance, disconfirmation, and satisfaction, which collectively shape post-adoptive IT usage. Second, given that EDT delves into post-usage cognitions, it includes emergent post-usage constructs such as disconfirmation and satisfaction, arising out of users' direct first-hand experience with the target IT, that are not included in TAM. Third, EDT is episodic in that subjects post-adoptive IT usage intentions are based on their experience with a specific transaction, which may change following a different experience (see [6]), while TAM includes more generic cognitions such as perceived usefulness and attitude, which, even in a post-adoptive setting, may be the result of all prior IT usage experiences or episodes.

Given their complementary nature, a model that integrates the key research constructs from TAM and EDT should explain more variance in IT usage intention than either model alone. Such an integrated model is depicted in Fig. 3. In this model, we postulate three separate effects on intention: satisfaction, perceived ease of use, and perceived usefulness. Since the research constructs are derived from two distinct and independent theoretical domains, no interactions are postulated in the integrated model between constructs from the two theories.

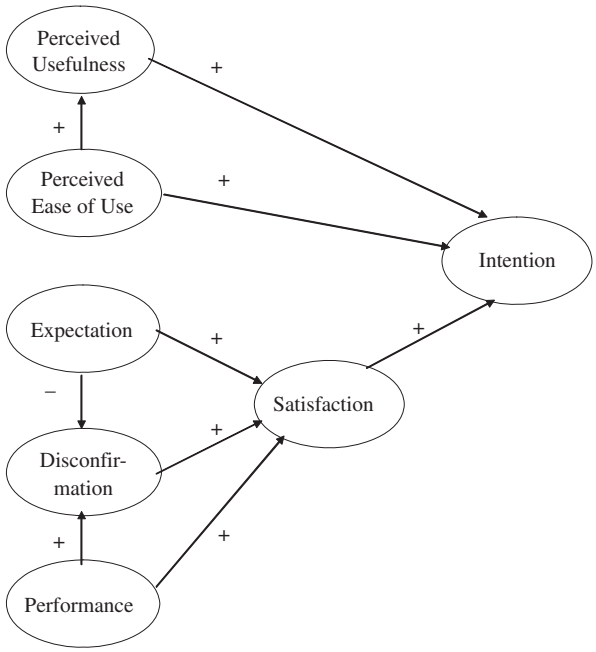

Fig. 3. Integrated model.

3. Research method

The three models described in the previous section (TAM, EDT, and the integrated model) were empirically tested using data collected from a longitudinal survey of computer-based tutorial (CBT) users. CBT is a web-enabled software program that provides online tutorials on various IT concepts and software such as office automation applications, database management systems, programming languages, system development methodologies, telecommunication concepts, and operating systems. The purpose of CBT is to guide IT users through a self-paced yet structured learning process and are particularly helpful when formal training programs on specific topics of interest are unavailable or infeasible. CBT has been gaining wide acceptance among business enterprises in recent times, given the rapid rate of IT-related changes and the high costs of continuously training the internal workforce in these technologies.

Subjects for this study were junior and senior level undergraduate students enrolled in an IS course at a large public university. At the time of this study, CBT was being introduced in this university to supplement classroom instruction and to assist students in self-learning concepts or technologies that were not specifically covered in the formal curriculum. While some students had heard about CBT, most had no direct experience with CBT prior to the study.

Data was collected in two phases. At the start of the semester, one of the researchers visited each class separately, made a presentation on CBT, and walked students through one of the CBT modules to help them understand how the CBT worked and its relevance to their future careers. At the end of this session, subjects were asked to complete a survey instrument that

assessed their perceptions of ease of use and their expectations from CBT usage (prior to actual usage). Subjects were then given approximately 1 month to complete an assignment that required the use of CBT (to ensure first-hand CBT usage). After 1 month, subjects completed a second survey that measured the other constructs of interest (e.g., performance, disconfirmation, satisfaction, perceived usefulness, attitude) and their intention to continue using CBT for the rest of the semester and beyond. Usage of CBT after the completion of the assignment was completely voluntary and not required for any course activities.

The purpose of our two-phase longitudinal design was to clearly delineate users' pre-adoption perceptions (expectation) from post-adoption beliefs and intentions. This design was intended to overcome a critical problem with most cross-sectional studies, namely relying on respondents' post-usage recall of pre-usage perceptions, which may themselves be selectively colored or changed following their actual usage experience. Further, since EDT is a temporal process model that captures the evolution of the psychological process from initial expectations to satisfaction and continuance intentions, a longitudinal field survey was deemed necessary.

In all, 189 students participated in the first round of survey, and 175 students completed the second round. Responses from the two surveys were matched to create a single record for each respondent, resulting in a total of 175 matched pairs that were used for further analysis. The sample consisted of 74% male respondents and 26% female respondents.

4. Operationalization and validation

4.1. Construct measurement

Each construct was measured using multiple-item perceptual scales, wherever possible, drawn from prevalidated measures. All scale items were rephrased to relate specifically to CBT use. Appendix A provides a listing of the scale items.

Expectation has been measured in EDT studies as ex ante consumer beliefs regarding specific product or service attributes [21,22]. Hence, this construct was measured using four Likert-scale items that related to four typical benefits of CBT usage, such as learn new skills and knowledge, learn at the respondent's own pace, and so forth (see Appendix A). Performance is normally assessed perceptually by consumers using the same set of attributes as expectations, but measured after their consumption experience [22]. This correspondence in attributes between expectation and performance is required because users evaluate performance using an attribute space created during the formation of prior expectation. Hence, performance was measured in this study using the same set of four items as the expectation scale, but as an ex post evaluation following 1 month of CBT usage. Though expectation and performance are both perceptual beliefs based on the same items, they refer to two distinct cognitive constructs separated across time. Expectation is ex ante belief, while performance is an ex post evaluative judgment based on one's own usage experience.

Disconfirmation is a mental comparison of the expectation-performance gap, and can be perceived as worse than expected (negative disconfirmation), or better than expected (positive disconfirmation), or as expected (zero disconfirmation) [7,23]. This construct has been operationalized in prior studies either as the algebraic difference between expectation and performance measures on each attribute (inferred disconfirmation) or as the subjective perception of the difference in each attribute (perceived disconfirmation) anchored between a "worse than expected" ··· "better than expected" scale [7]. Perceived disconfirmation is more predictive of subsequent user behavior than inferred disconfirmation because user behavior is conditioned by their perceptions regarding that behavior rather than actual behavior per se [24]. This study measured perceived disconfirmation using four attributes similar to those in the expectation scale.

Satisfaction as a psychological construct has been studied in various contexts, including job satisfaction, satisfaction with product or service consumption, and end-user satisfaction with IT usage. Satisfaction represents an individual's emotive state following first-hand experience with the target object or behavior. Satisfaction was designed as a four-item prevalidated measure adapted from [22], which assessed both the intensity and direction of affect using four semantic differential items anchored between adjective pairs "dissatisfied/satisfied", "displeased/pleased", "frustrated/contented", and "terrible/delighted."

Perceived usefulness and ease of use were each measured using four items developed and validated by Davis et al. [2]. Behavioral intention is the intention to continue using the system and was assessed via three items that measured respondents' inclination to continue using CBT for learning new technologies, acquiring new software skills, and for future classes. These items were based on similar items used in prior studies employing student settings (e.g., [4]).

4.2. Scale validation

Scale reliability and validity were assessed using confirmatory factor analysis (CFA). Bagozzi and Phillips [25] recommended CFA over exploratory factor analysis in areas with strong a priori theory, where the purpose of the study is theory testing and where prevalidated scales are being employed, as were the case in this study. CFA was performed in this study using the partial least-squares (PLS) approach using the PLS Graph software version 3.00 [26]. PLS was preferred over covariance-based techniques such as LISREL in light of our small sample size, relative to the number of indicator items in the model. All scale items were modeled as reflective indicators of their corresponding latent constructs, the raw data set was used as input to the PLS program, and significance analysis was done using jackknife resampling (of size 1) after pre-processing with construct-level changes.

Convergent validity, which examines whether individual indicators are indeed measuring the constructs they are purported to measure, was assessed using three criteria recommended by [27]: (1) all indicator factor loadings (λ) should be significant and exceed 0.7, (2) construct reliabilities should exceed 0.80, and (3) average variance extracted (AVE) by each construct should exceed the variance due to measurement error for that construct (i.e., AVE should exceed 0.50). The CFA results, presented in Table 1, indicate that all 27 items corresponding to the seven TAM and EDT constructs had λ-values exceeding the minimum 0.70 norm (λ-values ranged between 0.73 and 0.96) and were significant at $p < 0.001$. Composite reliabilities (ρ_c) of all constructs exceeded 0.80, with the least ρ_c being that of the expectation construct at 0.91 (see Table 2). AVE, listed along the principal diagonal in Table 2, ranged between 0.84 for expectation and 0.94 for intention, well above the threshold value of 0.50. Hence, convergent validity was assured for all of our measurement scales.

Discriminant validity, which assesses whether individual indicators can adequately distinguish between different constructs, is assured if the square root of AVE for each construct is greater than the correlation between that and all other constructs in the CFA model [27]. The correlation matrix in Table 2 indicates that the square root of AVE (listed within parentheses along the principal diagonal) of each construct was higher than corresponding correlation values for that variable in most cases, thereby assuring discriminant validity. We did notice some high correlation between constructs, but such correlations were understandable given the similarity between some EDT and TAM constructs.

5. Data analysis and results

One of the potential problems with single-respondent data is the possibility of common method bias (CMB). The risk of this bias was considerably less in this study, given that our data was collected at two different points in time spaced 1 month apart. Because the three models being examined in this study were all individual level cognitive models, we had no choice but to collect perceptual data from individual respondents. However, to test for the possibility of CMB, we conducted Harmon's single-factor test [28]. In this test, if a substantial amount of common method variance is present in the data sample, either a single factor will emerge from the factor analysis or one general factor will account for the majority of the covariance in the independent and dependent variables. A factor analysis of all items used in this study revealed five factors explaining 79% of the total variance, with the first factor explaining 30% of the variance and the last factor explaining 11% of the variance. To examine whether any CMB existed within our two measurement instruments, we conducted two more Harmon's tests, separately for constructs measured using our pre-usage and post-usage questionnaires. In the first test, all items measuring expectations and ease of use were combined into a single-factor analysis. The results revealed two factors explaining 37% and 36% of variance, respectively. The items loaded on their appropriate constructs with low cross-loading. In the second test, all the items measuring perceived usefulness, performance, disconfirmation, satisfaction, and intention were factor analyzed together. The results revealed three factors explaining 80% of the total variance (34%, 23%, and 22% of variance, respectively). Upon relaxation of eigenvalue, five factors emerged from our analysis matching with our five constructs of interest with explained variances of 22%, 20%, 15%, 14%, and 13%, respectively. Only two items had cross loading above 0.5, and were retained as such in our measures. These figures indicate that the variances are well distributed among multiple factors, suggesting the lack of CMB in our data sample.

The next step in our data analysis was to compare the three models (TAM, EDT, and the integrated model) described earlier in terms of the significances and effect size (β) for each hypothesized path and variance explained (R^2 value) for each dependent variable. This analysis was also done using PLS, using the same measurement model as the earlier CFA, but modifying the associations between latent constructs to represent the causal structure specified in our three models of

Table 1
Confirmatory factor analysis results

Scale item	Item mean	Item S.D.	Item loading[a]	Jacknife estimate	*t*-statistic	*t*-statistic (adjusted) [b]
EXP1	5.43	1.07	0.89	0.89	41.90	29.62
EXP2	4.72	1.11	0.73	0.73	13.83	9.78
EXP3	5.45	1.14	0.88	0.88	39.35	27.83
EXP4	5.62	1.05	0.86	0.85	33.44	23.64
PERF1	5.22	1.44	0.91	0.91	67.60	47.80
PERF2	4.40	1.30	0.84	0.84	35.34	24.99
PERF3	5.57	1.37	0.91	0.92	56.71	40.09
PERF4	5.62	1.35	0.90	0.90	42.82	30.28
DISC1	4.74	1.35	0.90	0.90	57.14	40.40
DISC2	4.18	1.19	0.83	0.83	25.78	18.23
DISC3	4.93	1.26	0.91	0.92	65.87	46.57
DISC4	4.96	1.30	0.91	0.90	51.91	36.71
SAT1	4.94	1.39	0.94	0.93	67.48	47.71
SAT2	4.99	1.39	0.95	0.94	67.11	47.45
SAT3	4.73	1.52	0.90	0.89	45.10	31.89
SAT4	4.82	1.34	0.94	0.94	68.87	48.70
PU1	4.74	1.35	0.95	0.96	86.77	61.36
PU2	4.61	1.36	0.94	0.94	80.31	56.79
PU3	4.71	1.36	0.96	0.96	126.69	89.58
PU4	4.78	1.45	0.89	0.89	43.07	30.45
EOU1	5.22	1.17	0.79	0.78	10.26	7.25
EOU2	5.09	1.14	0.91	0.90	50.59	35.77
EOU3	5.00	1.06	0.91	0.91	55.86	39.50
EOU4	5.44	0.99	0.86	0.86	40.14	28.38
INT1	4.77	1.59	0.96	0.96	116.35	82.27
INT2	4.86	1.62	0.95	0.95	91.24	64.52
INT3	4.49	1.65	0.90	0.91	39.39	27.85

Legend: EXP = expectation; PERF = performance; DISC-disconfirmation; SAT = satisfaction; PU = perceived usefulness; EOU = ease of use; INT = intention.
[a]All item loadings were significant at $p < 0.001$.
[b]*t*-statistic adjusted for Jacknife analysis.

Table 2
Scale properties and descriptive statistics

Construct	Mean	S.D.	ρ_c	Inter-construct correlations						
				EXP	PERF	DISC	SAT	PU	EOU	INT
EXP	5.30	1.09	0.91	*0.84* (*0.71*)						
PERF	5.20	1.37	0.94	0.51	*0.89*(*0.80*)					
DISC	4.70	1.27	0.94	0.34	0.77	*0.89*(*0.80*)				
SAT	4.87	1.41	0.96	0.31	0.63	0.66	*0.93* (*0.86*)			
PU	4.71	1.38	0.96	0.40	0.85	0.71	0.68	*0.93* (*0.86*)		
EOU	5.19	1.09	0.92	0.52	0.25	0.10	0.16	0.11	*0.87* (*0.76*)	
INT	4.71	1.62	0.95	0.41	0.78	0.71	0.70	0.83	0.17	*0.94* (*0.88*)

Diagonal elements represent AVE values (square roots of these values are enclosed within parentheses).

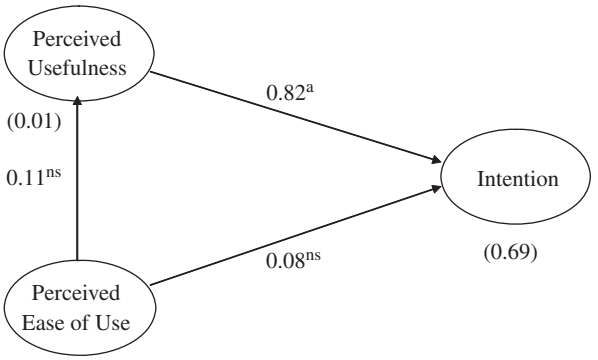

Fig. 4. PLS analysis of TAM. Path significance: [a] $p < 0.001$; [b] $p < 0.01$; [c] $p < 0.05$; [ns] $p > 0.05$. Parentheses indicate R^2 values.

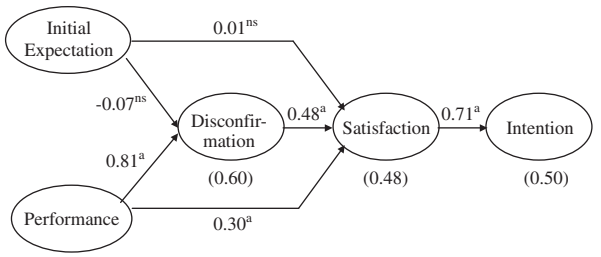

Fig. 5. PLS analysis of EDT. Path significance: [a] $p < 0.001$; [ns] $p > 0.10$. Parentheses indicate R^2 values.

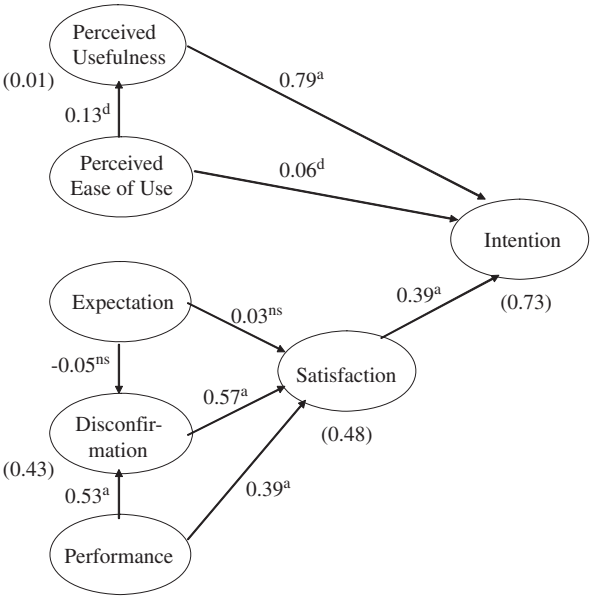

Fig. 6. PLS analysis of the integrated model. Path significance: [a] $p < 0.001$; [b] $p < 0.01$; [c] $p < 0.05$; [d] $p < 0.10$; [ns] $p > 0.10$. Parentheses indicate R^2 values.

interest (Figs. 1–3). Results of these analyses are presented in Figs. 4–6, respectively.

PLS analysis of TAM (Fig. 4) explained 69% of the variance in intension to continue using CBT. This explanation came mostly from perceived usefulness, with an effect size of 0.82 ($p < 0.001$). However, perceived ease of use did not significantly influence either perceived usefulness or intention, consistent with some prior TAM studies (e.g., [12]). While ease of use may initially influence pre-usage intention, this effect tends to wear off with time as users become familiar with the technology and learn how to use it. The importance of ease of use may also depend on the specific technology being examined. In this study, most users were familiar and comfortable with CBT's user interface, namely the Internet browser. This familiarity may have contributed to the lack of effects involving the ease of use construct. However, we should note that there is a possible confound between "learning content" in CBT and "learning to use" CBT, but we did not assess them separately.

PLS analysis of EDT (Fig. 5) explained 60% of the variance in disconfirmation, 48% in satisfaction, and 50% in intention. The ability of EDT to explain CBT usage intention was slightly less compared to TAM. Investigating individual paths in EDT, we can see that satisfaction had a significant effect on intention ($\beta = 0.34$; $p < 0.001$). In turn, satisfaction was successfully predicted by disconfirmation ($\beta = 0.48$; $p < 0.001$) and performance ($\beta = 0.30$; $p < 0.01$), but not initial expectation ($\beta = 0.01$; $p > 0.05$). Initial expectation also had an insignificant effect on disconfirmation ($\beta = -0.07$; $p > 0.05$), though the effect of performance on disconfirmation was significant ($\beta = 0.81$; $p < 0.001$).

The non-significant effects of initial expectation on disconfirmation and satisfaction could possibly be attributed to subjects' limited exposure to the CBT software at the time expectation was measured in this study. Though respondents were provided a presentation and demonstration of CBT prior to measuring their expectation, this introduction could have been inadequate for our novice subjects to form stable or realistic expectations of CBT usage. Hence, their disconfirmation and satisfaction with CBT usage, measured 1 month later, could have been more influenced by their performance perceptions rather than their original expectations regarding its use.

Finally, the results of PLS analysis for the integrated model, combining EDT and TAM constructs, are presented in Fig. 6. In this model, the total variance explained was 73% for intention, 48% for satisfaction, 53% for disconfirmation, and only 1% for perceived

usefulness. The largest predictor of intention was perceived usefulness ($\beta = 0.79$; $p < 0.001$), followed by satisfaction ($\beta = 0.39$; $p < 0.001$). The effect sizes, path significances, and variance explained of other hypothesized associations in this model were largely similar to corresponding associations in the preceding TAM and EDT models.

To examine whether the increase in variance explained in IT usage intention from TAM (0.69) or EDT (0.50) to the integrated model (0.73) was statistically significant, we conducted pairwise nested F-tests comparing the R^2 values of the integrated model with that of TAM and EDT individually.[1] We found the R^2 improvement in the integrated model to be statistically significant at $p < 0.001$ from the EDT model, and at $p < 0.05$ from TAM. These findings attested to improved explanatory ability of the integrated model over and above its constituent models.

Although the increase in explanatory power of the integrated model relative to TAM was somewhat marginal, the integrated model provides a more detailed understanding of the post-adoption process that unfolds during actual IT usage experience, ultimately culminating in post-adoption behavioral intention. This model combines the strengths of both of its constituent models, TAM and EDT, and is hence, more useful for researchers interested in a deeper understanding of the process and the emergent constructs arising out of IT usage experience, and for practitioners interested in formulating an evolving strategy to influence the post-adoption usage in organizations. Further, the integrated model also provides a better understanding of the determinants of user satisfaction, an increasingly important dependent variable in contemporary IS research [29].

6. Discussion

The primary objective of this study was to empirically compare two of the most dominant contemporary models of IT usage research, namely TAM and EDT, and then extend these models to an integrated model of IT usage. As argued before, TAM has its roots in the IT acceptance stream of research though it has also been used to study post-adoption usage, while EDT was designed to explain IT continuance. Consequently, TAM is based on user perceptions, while EDT is based on actual user experiences. Given the complementary nature of TAM and EDT, a comparison and integration of the two models was expected to provide a better explanation of IT usage intention than each component model considered alone. Further, such model comparison helped to explore the interrelationships between the two referent theories and bridge the gap between the two domains of IT usage research.

In this study, we measured the constructs derived from TAM and EDT models over two time points. Comparing TAM with EDT, we found that TAM provided a stronger explanation of IT usage intention than did EDT. The integrated model had greater explanatory power than either TAM or EDT, as indicated by the significant increase in R^2 in IT usage intention. Moreover, the integrated model provided a better understanding of the relationships between user beliefs and attitudes related to IT usage and emergent factors arising from their direct first-hand usage experience. Understanding relationships between theoretical constructs derived from multiple theoretical domains is important for advancing theories in each of its referent domains.

The integrated model provides some interesting results. While satisfaction had a very significant impact on intention in the EDT model, its effect on intention was less in the integrated model compared to that of perceived usefulness. The dominance of perceived usefulness over satisfaction in predicting intention could be an artifact of our measurement time being only 1 month after their first exposure to the CBT system. It is possible that a 1-month time frame is inadequate for subjects to evaluate a software product, particularly for busy students who have other things to attend (such as coursework and personal life).

However, the relative dominance of perceived usefulness could also suggest the continuing role of system utility as a critical driver in continuance decisions involving IT that are primarily utilitarian in nature (rather than hedonic). IS for the workplace have primarily focused on utilitarian outcomes such as improvements in productivity and effectiveness, and the same can be said for many personal usage technologies such as spreadsheets and word processing software. The continuing influence of utilitarian considerations may have led Bhattacherjee [5] to include perceived usefulness in his version of EDT, even though this construct was not directly derived from the core EDT (Fig. 2). It is important to note that in post-adoption models like EDT, perceived usefulness is grounded in actual usage experience and hence reflects realized utility, in contrast to acceptance models such as TAM, where perceived usefulness is based on pre-usage expectations and is hence reflective of expected utility. Nonetheless, this suggests the need for mixed-mode models, integrating pre-usage

[1] Computed as: $F\left(R^2_{\text{outer}} - R^2_{\text{inner}}\right) / \left[\left(1 - R^2_{\text{inner}}\right) / \text{df}_{\text{difference}}\right]$.

and post-usage constructs, for unraveling the complex dynamics driving post-adoption usage intentions.

It is also worthwhile examining why satisfaction added little explanation to IT intention in the integrated model but explained a substantial proportion of intention in the pure-EDT model. In prior TAM research, attitude, an affect-based variable, has exhibited inconsistent results on its effect on intention [10], and perhaps, satisfaction, another affect-based variable, has a similar issue in the presence of TAM variables. Another explanation would be that satisfaction is typically defined as a transaction-oriented affect based on first-hand experience with the product/service, and therefore may be more appropriate for short-term usage decisions. Satisfaction may therefore be more important for impulsive purchases where there are competing products and user's first experience has to be satisfying in order to continue buying/using the service. While most IT product usage decisions typically involves considerable time and effort of the user, newer web-based application services, such as e-Bay versus Amazon auctions, may be more akin to impulsive purchases. In such circumstances involving IT services, as opposed to IT products, satisfaction with transaction experience may be critical for retaining user loyalty and continuance of that service. Of course, more research is required in this area before any definitive conclusions can be derived.

6.1. Limitations of the study

The results of this study should be interpreted in light of its limitations. First, to the extent that our sample of undergraduate students were younger than and had less work experience than working adults at large, findings reported in this study may have limited generalizability to the general population of organizational users. Future research could compare these models in corporate or work settings to examine how TAM fares vis-à-vis EDT in predicting later-stage IT usage. In our case most subjects were not very familiar with CBT and to that extent may not have well-formed expectations on the product. Their expectations were based on the initial introduction and sample walkthrough of the system. Perhaps, users in workplace settings are more familiar with applications to form more realistic expectations, thereby reducing the extent of disconfirmation and their subsequent effects on IT continuance intentions. Further, in real world, varying levels and extent of user involvement in packaged software implementation versus customized software development may influence the formation of user expectation in each case, further shaping their continuance intentions.

Second, since this study was focused specifically on CBT usage, it is unknown to what extent our results may be extended to other software systems at large. CBT does have some unique features (e.g., web-based, graphics-rich, interactive interface) and purpose (e.g., learning new concepts and software) that are different from that of most traditional organizational systems such as transaction processing or accounting systems. Such contextual differences may alter some of the path effects reported in our study. However, the increasing use of Windows-based interfaces and intranet systems in the corporate workplace may make this limitation less relevant in future.

Third, users in our study had different usage experiences based on whether they accessed the CBT system from home (via dial-up or broadband connections) or from campus (via high-speed local area network connections). Though not discussed in this paper, the mode of system delivery, especially for remotely hosted distributed systems or services, may constrain subjects' experiences, perceptions, and intentions regarding continued IT usage. Since prior research has not distinguished between localized and remote systems, holding system delivery as constant, such distinction may be another way of extending the current research.

Finally, we assessed perceived usefulness after subjects' direct usage experience with the CBT system, rather than before exposure, because we believed that subjects would have more realistic and accurate usefulness perceptions after system usage. However, TAM and related theories recommend that such perceptions be measured before system usage.

6.2. Implications for research and practice

The role of user satisfaction in IT usage research is particularly interesting because this construct is often viewed as a surrogate for IT success [29]. Since disconfirmation and expectations are critical antecedents to satisfaction, future research may explore what factors influence these variables and how they can be manipulated for improving eventual user experience with the IT and hence its subsequent continuance. For example, whether creating very high expectations before launching the system benefit or hurt subsequent usage may be a worthwhile avenue for future research. Another area for future research is the "halo" effect of expectations and how long it lasts before users start discounting the effect of initial expectations and focus more on the realized value from system usage experience in framing their continued usage intentions. In generic terms, given that TAM and EDT both offer reasonable

explanations of IT continuance intentions, future researchers may also find it useful to further explore the interrelationships between user expectations, performance, disconfirmation, satisfaction, perceived usefulness, ease of use, and attitude toward IT usage, if they are to achieve the ultimate goal of having long-term satisfied users.

For practitioners, our results emphasize the importance of perceived usefulness as predictor of IT continuance intention. Today, computer applications are ubiquitous in all aspects of our life, and are no longer fad or image enhancer, but utilitarian tools without which businesses may come to a halt. Hence, users are going to increasingly demand usefulness, particularly in the long run, for the system to be successfully used. System developers must be cognizant of user's requirements while developing the system and provide ongoing adaptive system maintenance to continually match system features to the evolving needs of the workplace. Further, to enhance user satisfaction as a means of ensuring their continued use of IT and loyalty, practitioners should consider various implementation strategies, such as user involvement in the design process, user education, and user training to ensure that users build realistic expectations of a system, confirm their initial expectations, and are satisfied with their use.

Appendix A. Measurement indicators

A.1. Perceived usefulness: (Strongly disagree ... Strongly agree)

1. Using CBT will improve my performance.
2. Using CBT will increase my productivity.
3. Using CBT will enhance my effectiveness.
4. CBT will be useful for my studies.

A.2. Ease of use: (Strongly disagree ... Strongly agree)

1. Learning to use CBT is easy for me.
2. My interaction with CBT is clear and understandable.
3. I believe it is easy to get the CBT to do what I want it to do.
4. Overall I believe CBT would be easy to use.

A.3. Intention: (Strongly disagree ... Strongly agree)

1. I plan to continue using CBT to learn about new technologies.
2. I intend to continue using CBT to learn new software skills.
3. I plan to continue using CBT after this class.

A.4. Expectations: (Strongly disagree ... Strongly agree)

1. Using CBT will help me learn new skills and knowledge.
2. Using CBT will help me get better grades in class.
3. CBT will provide me flexibility to learn on my own time.
4. CBT will give the ability to learn at my own pace.

A.5. Performance: (Strongly disagree ... Strongly agree)

1. Using CBT helps me learn new skills and knowledge.
2. Using CBT helps me get better grades in class.
3. CBT provides me flexibility to learn on my own time.
4. CBT gives me the ability to learn at my own pace.

A.6. Disconfirmation

Compared to my initial expectations the ability of CBT

1. To help me learn new skills and knowledge was (much worse than expected ... much better than expected).
2. To help me get better grades in class was (much worse than expected ... much better than expected).
3. To provide me flexibility to learn on my own time was (much worse than expected ... much better than expected).
4. To give me the ability to learn at my own pace was (much worse than expected ... much better than expected).[a]

A.7. Satisfaction

I am _ with my use of CBT.

1. Extremely displeased ... Extremely pleased.
2. Extremely frustrated ... Extremely contented.
3. Extremely terrible ... Extremely delighted.
4. Extremely dissatisfied ... Extremely satisfied.

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