Extending the Technology Acceptance Model and the Task-Technology Fit Model to Consumer E-Commerce

Inge M. Klopping

Earl McKinney

The proliferation of business-to-consumer e-commerce activities has created a need to understand how and why people participate in e-commerce. This study treats consumer e-commerce as a technology adoption process and evaluates the suitability of two popular adoption models. This research supports the use of the technology acceptance model (TAM) to predict online shopping activity, both the intention to shop online and actual purchases. Two minor alterations are made to the traditional use of TAM—perceived ease of use is not linked to perceived usefulness, and perceived usefulness is directly linked to actual use. This research also finds that the task-technology fit (TTF) model is a valuable addition to TAM for online shopping tasks. A web-based survey of 263 undergraduates was used.

Introduction

The emergence of the Internet as a tool for the business-to-consumer aspect of e-commerce has far reaching ramifications. Most importantly, it has created opportunities for businesses to reach out to consumers in a very direct way and create electronic markets. Also by virtue of the technology, it has allowed consumers immediate access to these electronic markets. There are approximately 113 million Americans, or 59% of the total population, using the Internet for a myriad of activities (Pew Research Center, 2000; National Telecommunications and Information Administration [NTIA], 2002). It is expected that the number of people engaging in e-commerce activities will continue to rise.

As one would predict, the activity that is predominant on the Internet is email, with 45.2% of the population using it (NTIA, 2002). Searching for product or service information was next, however, at 36.2%, and making actual purchases online was at 13.3 % (NTIA, 2002). Another study (Pew Research Center, 2000) listed "researching a product or service before buying it" as an activity that 75% Americans do online, while 55% "buy a product." The proliferation of business-to-consumer e-commerce activities has created a need to understand how and why people participate in e-commerce activities. This study treats consumer e-commerce as a technology adoption process and evaluates the suitability of two popular adoption models.

Despite the popularity of online shopping, insufficient empirical research has been reported on the factors that might explain e-commerce adoption among consumers (Gefen & Straub, 2000; Lederer, Maupin, Sena, & Zhuang, 2000; Lee, Park, & Ahn, 2001; Lin & Lu, 2000; Magal & Mirchandani, 2001; Shaw, Gardner, & Thomas, 1997). To examine this issue, we viewed shopping online as an example of technology adoption. A number of recent e-commerce studies have used technology adoption as a theoretical foundation (Chen, Gillenson, & Sherrell, 2002; Childers, Carr, Peck, & Carson, 2001; Lee et al., 2001; Liaw, 2002; Lin

Inge M. Klopping is Assistant Dean, Information Technology Services, College of Business Administration, Bowling Green State University, Bowling Green, Ohio.

Earl McKinney is Assistant Professor, Department of Accounting and Management, College of Business Administration, Bowling Green State University, Bowling Green, Ohio.

& Lu, 2000). We selected two models of workplace technology adoption and evaluated their suitability to predict consumer online shopping. Specifically, we examined the technology acceptance model (TAM) and a model that combined TAM with the task-technology fit (TTF) model. The key purpose of this study is to determine the merits of these workplace technology adoption models in modeling consumer e-commerce. We first review the TAM and its use in online shopping studies, followed by the combined model with hypotheses.

Modeling Online Shopping

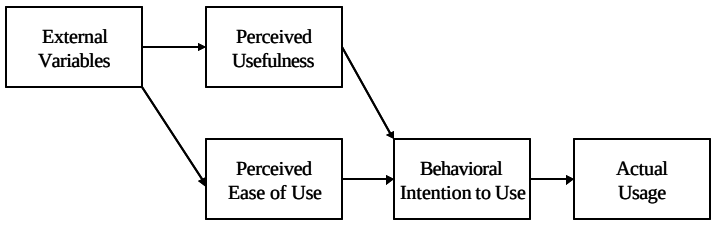
The Technology Acceptance Model (TAM) and Modifications for Online Shopping

Technology adoption research has flourished in recent years (Agarwal & Prasad, 1999; Davis, 1989; Dishaw & Strong, 1999; Gefen & Keil, 1998; Igbaria, Parasuraman, & Baroudi, 1996; Moon & Kim, 2000; Taylor & Todd, 1995; Venkatesh, 2000; Venkatesh & Davis, 2000). Currently, the most effective tool to describe adoption is the technology acceptance model (Davis, 1989). TAM was developed to explain and predict computer-usage behavior. It has its theoretical grounding in Fishbein and Ajzen's (1975) theory of reasoned action (TRA) which stated that beliefs influence attitudes, which lead to intentions, and finally to behaviors. The TRA introduced two independent determinants, attitude toward behavior and subjective norm, which are tied to behavioral and normative beliefs. Attitude toward behavior refers to the degree that an individual has a positive or negative reaction toward a specific behavior. Normative beliefs consider the probability that important persons or groups approve or disapprove of performing a specific behavior. According to the TRA, individuals' attitudes towards behaviors are determined by their most important beliefs and the consequences of performing specific behaviors. As Fishbein and Ajzen (1975) demonstrated through their theory, behavior is best predicted by intentions, and "intentions are jointly determined by the person's attitude and subjective norm concerning the behavior" (p. 216).

The theory of planned behavior (TPB) modifies the TRA by incorporating the construct "perceived behavioral control" to address situations in which individuals lack substantive control over a specific behavior (Ajzen, 1991). The TPB suggests that behavior can be explained by behavioral intention, which is influenced by attitude, subjective norms, and perceived behavioral control. As the TPB was based on the TRA, the determinants attitude and subjective norm are defined in similar ways. Perceived behavioral control is the determinant that is unique to the TPB and refers to an individual's perception of whether or not the requisite resources or opportunities are present to perform a behavior (Ajzen & Madden, 1986). The TAM adapts these theories of belief, attitude, intention, and behavior into an information technology (IT) acceptance model (see Figure 1).

According to Davis, Bagozzi, and Warshaw (1989), "the goal of TAM is to provide an explanation of the determinants of computer acceptance that in general is capable of explaining user behavior across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified" (p. 985). The major determinants are defined by Davis (1989) as perceived usefulness and perceived ease of use. Perceived usefulness is "the degree to which a person believes that using a particular system would enhance his or her job performance," and perceived ease of use is "the degree to which a person believes that using a particular system would be free of effort" (p. 320). While perceived usefulness has been identified consistently in the literature as significant in attitude formation (Agarwal & Prasad, 1999; Davis, 1989; Dishaw & Strong, 1999; Gefen & Keil, 1998; Igbaria et al., 1996; Moon & Kim, 2000; Taylor & Todd, 1995;

Figure 1: TAM (Davis & Venkatesh, 1996)



Venkatesh, 2000; Venkatesh & Davis, 2000), the evidence for perceived ease of use has been inconsistent. For perceived usefulness and for perceived ease of use antecedents have been suggested including information quality (Lin & Lu, 2000), enjoyment (Teo, Lim, & Lai, 1999), and risk (Lee et al., 2001).

To date there has been limited but promising use of the TAM to predict web technology adoption by consumers (Chen et al., 2002; Childers et al., 2001; Magal & Mirchandani, 2001). Lederer et al. (2000) found that both perceived usefulness and perceived ease of use predicted web use for work-related tasks. In addition, their work suggested that information quality also predicted adoption of web technology at work. Teo et al. (1999) reported similar results: Both perceived usefulness and perceived ease of use predict Internet use at work. They also found that perceived enjoyment or playfulness was a significant antecedent of Internet use. In one of the first applications of the TAM to consumer web adoption, Lee et al. (2001) found that the TAM predicted individual purchasing behavior online. They also showed that perceived risk affects perceived usefulness. They admitted their model is incomplete, however, and suggested it misses important factors such as demographic and type of product measures. Magal and Mirchandani (2001) found that the TAM predicted time and frequency of web use. Chen et al. (2002) found the TAM is effective in evaluating online shopping at a particular "virtual" on-line store. Childers et al. (2001) also found the TAM predicted attitude toward online shopping.

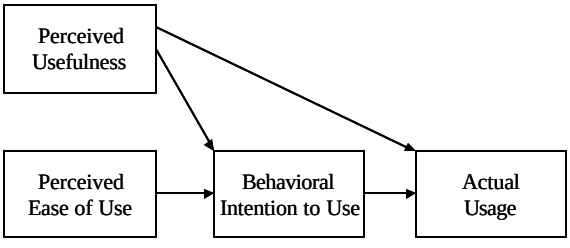
Building on this emerging view that the TAM is suitable for e-commerce, we propose a modified TAM and a broader view of the shopping task. We make two common modifications of the original TAM to tailor it to the online shopping domain, as shown in Figure 2. First we drop the perceived ease of use—perceived usefulness path. Many workplace technology adoption studies (Keil, Beranek, & Konsynski, 1995; Lederer et al., 2000) have found this to be the least significant relationship, and in consumer e-commerce adoption this link is also dropped where it is argued that web tools are exceptionally easy to use (Childers et al., 2001; Magal & Mirchandani, 2001). Second, many studies further simplify the original TAM by dropping attitude and instead studying the relationship between perceived usefulness and perceived ease of use on intention to use (Gefen & Straub, 2000; Lederer et al., 2000; Teo et al., 1999).

To further enhance the model for e-commerce use, we also modify the TAM in an important and unique way. We add a direct effect of perceived usefulness on actual use. Consumers may view online shopping as a necessity even if their intention to use the technology is relatively unchanged. That is, some consumers may report that they do not have an improved intention toward online shopping, while at the same time increasing their actual online shopping use. In other words, the habit of shopping online may lead to increased actual use while the intention is unchanged. In addition, busy or "wired" consumers (Bellman, Lohse, & Johnson, 1999) may increase actual use as a direct result of perceived usefulness while not improving the intention to use. For this busy group, perceived usefulness may be borne out of necessity or convenience in addition to rising intentions, therefore increasing actual use.

The Shopping Task

Before examining the second adoption model, task-technology fit (TTF), it is necessary to identify the shopping task used in this study. Understanding online shopping behavior is difficult, as many measures of shopping have been used and consumer e-commerce behavior is still evolving with the technology. Some studies of online shopping used actual purchases as a measure of shopping (Lee et al., 2001), whereas others used self-reports of time online and frequency of use (Lederer et al.,

Figure 2: Modified TAM for E-Commerce



2000; Magal & Mirchandani, 2001; Teo et al., 1999). Childers et al. (2001) used shopping for a gift for a friend, while Chen et al. (2002) used shopping or information seeking at one particular website.

Increasingly, commercial websites seek to provide useful product information to attract potential online shoppers (Totty, 2001). Keeney (1999) pointed out that measuring only actual purchases may be too narrow a scope when assessing the online shopping activity of consumers. He contended that gathering product information is a second aspect of the online shopping activity. One recent e-commerce study (Chen et al., 2002) adopted this two-fold definition. We also employ this definition of the shopping task in order to get a more complete picture of adoption. Online shopping in this study is a combination of both the purchase and the product information search activities. Finally, we generalize the two-fold definition. Rather than evaluating shopping at a particular site (as in Chen et al., 2002), we asked respondents to generalize to all online shopping activities.

Adding the Task-Technology Fit Model to the TAM for Online Shopping

A second model of technology adoption, the task-technology fit (TTF) model, extends the TAM by considering how the task affects use. More specifically, the TTF model suggests that technology adoption depends in part on how well the new technology fits the requirements of a particular task. A technology will be adopted if it is "... a good fit with the task it supports" (Goodhue & Thompson, 1995, p. 213). The TTF model has recently been applied successfully to predicting group decision support system acceptance (Zigurs, Buckland, Connolly, & Wilson, 1999), and to system adoption for accounting decision making (Benford & Hunton, 2000).

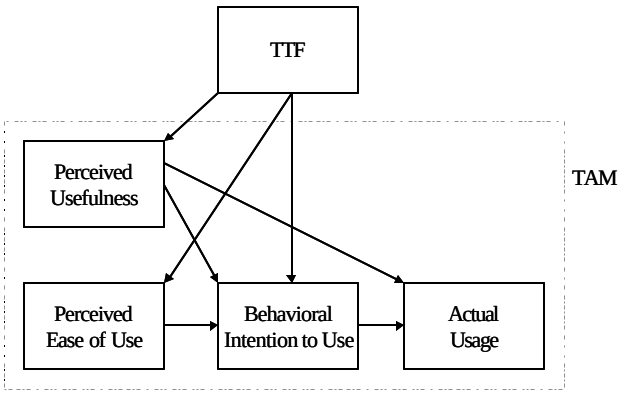
Clearly, in e-commerce, use may be related to how well the consumer feels web technology fits the task. Dishaw and Strong (1999) have demonstrated the efficacy of using a combined TAM and TTF model for workplace technology adoption; the present study is the first to suggest its use in consumer e-commerce adoption. The combined model is shown in Figure 3.

According to this combined model, a construct called TTF is a measure of the fit between the task and the technology (Goodhue & Thompson, 1995). This TTF measure affects both the precursors of use and of productivity. Precursors of use in the TAM would be perceived ease of use, perceived usefulness, and the intention to use.

Dishaw and Strong (1999) found that TTF was somewhat more effective than the TAM for predicting use in work-related tasks; however, their study also concluded that a combination of TTF and the TAM into one extended model is a superior model to either the TAM or the TTF model alone. They also found that task and technology affect TTF, and TTF affects perceived ease of use and actual use. In that study, surprisingly, TTF did not affect perceived usefulness as expected. Chen et al. (2002) have recently evaluated a construct similar to fit labeled "compatibility." They found compatibility affects perceived usefulness and attitude toward use. Compatibility is broader than TTF, however. Compatibility measures how the adopting technology fits users' values, beliefs, and ideas as well as the task needs. To date, there have been no studies that used TTF to evaluate online shopping.

When applying the TTF model to consumer online shopping activities several problems must be addressed. First, TTF was developed to evaluate workplace technology adoption and the impact of that adoption on performance. There are, however,

Figure 3: Combined Model



no clear and valid measures of individual productivity to use to evaluate online shopping activity. As a result, we substituted actual use for productivity. This substitution is fairly common in previous TAM/e-commerce studies (Lederer et al., 2000; Lee et al., 2001), and in one TTF study (Dishaw & Strong, 1999).

A second problem with TTF in this context is task. According to Goodhue and Thompson (1995), tasks are actions carried out that turn inputs into outputs. Goodhue and Thompson (1995) found that non-routineness ("I frequently deal with ill defined business problems") and job interdependence ("The problems I deal with involve more than one business function") are dimensions of task that matter for their domain (p. 1842). Dishaw and Strong (1999) measured task in terms of complexity and found that task complexity was negatively related to the TTF construct. As noted previously, the task of online shopping has not been previously modeled using TTF. As a result, online shopping in this study is a combination of both the purchase and the product information search activities.

Hypotheses

It is expected that perceived usefulness will influence intention to use and the actual use of online shopping activities. Perceived ease of use will influence intention to use and intention to use will influence actual use of online shopping activities. As Davis (1989) showed, beliefs about perceived usefulness and perceived ease of use influence the actual outcomes. Therefore, the following hypotheses are proposed:

Hypothesis 1: The TAM predicts intention to use and actual use.

Hypothesis 1a: Perceived usefulness is positively related to the intention to use online shopping.

Hypothesis 1b: Perceived usefulness is positively related to actual online shopping.

Hypothesis 1c: Perceived ease of use is positively related to the intention to use online shopping.

Hypothesis 1d: The intention to use is positively related to actual use of online shopping.

The task-technology fit model suggests that individuals not only consider beliefs about perceived usefulness and perceived ease of use, but also the extent to which online shopping activities meet their task needs and individual abilities (Goodhue, 1995). The following hypotheses are proposed:

Hypothesis 2: The combined TTF/TAM predicts the intention to use and actual use.

Hypothesis 2a: Task-technology fit is positively related to perceived usefulness.

Hypothesis 2b: Task-technology fit is positively related to perceived ease of use.

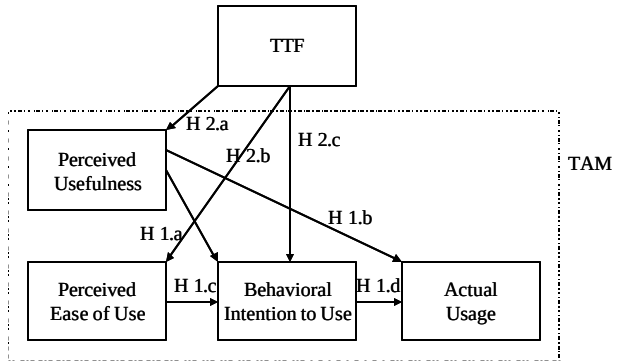
Hypothesis 2c: Task-technology fit is positively related to the intention to use online shopping.

Methodology

Subjects and Procedures

The participants for this study were 429 undergraduate students. Permission was obtained from instructors to enter their classrooms, explain the purpose of the study, and to ask for volunteers. Participating students received a random user ID and password to retrieve the questionnaire from a website. The questionnaire consisted of 26 items of which three gathered demographic information. The approximate time necessary to complete the questionnaire was 10 minutes. Of the 429 students, 263 participated, providing a response rate of 61%. Fifty-eight percent were male and 42% were female. The majority of the students, 64%, were under the age of 20, and 32% were between 21 to

Figure 4: Combined Model and Hypotheses



25 years of age. The majority of students who participated were sophomores (62%) or juniors (23%). Because of the homogenous nature of our subjects, we did not check for non-response bias.

The following questions were asked to determine the amount of online shopping activity. When asked, "On average, how frequently do you use the Internet for your shopping activities?" 27% indicated they shopped monthly, 36% indicated they shopped two or three times a year, and 34% indicated once a year. For the question, "How much time do you spend doing online shopping activities per week?" 22% spent between 6 and 15 minutes per week engaged in that activity, 23% indicated that they spent between 16 to 60 minutes, and 51% spent between zero and 5 minutes. When asked, "How much did you spend in the last year for online purchases?" 30% indicated they spent nothing online, 23% reported spending between $1 and $50, 26% reported that they spent between $51 and $200, and 13% reported they spent between $201 and $500. Eight percent reported spending over $500.

While students' e-commerce behavior is sometimes criticized as not being representative of the world at large, we would argue that for this study students are the upcoming market segment that businesses are targeting for online shopping. According to a recent study, college students shop online on a regular basis and are expected to significantly increase their online shopping activities in the future (CSRE Campus Market Research Series, 2001). Another study of 15 million college students reported that 75% of the students planned to do their holiday shopping online (PR Newswire, 2000). Furthermore, other studies report that college students represent one of the most active online shopping segments (PR Newswire, 2000; Yoo & Donthu, 2001). Finally, the use of student populations is not uncommon in e-commerce studies (Chang & Cheung, 2001; Gefen, 2002; Lee et al., 2001; Lin & Lu, 2000; Magal & Mirchandani, 2001).

Instrument Development

The instrument was pilot tested by a similar group of students. The students were asked to volunteer to participate; 51 students completed the pilot questionnaire. Based on their feedback, some questions were reworded and/or deleted. Cronbach's alpha and factor analysis were used to analyze the data from the pilot study resulting in eliminating questions that were similar or did not measure the construct.

The scales used to measure perceived usefulness, perceived ease of use, intention to use, and actual use, were adapted from Davis' research (1989), which established their reliability and validity. The items used to measure these constructs asked individuals to agree or disagree with statements using a Likert scale of 1-5 with end points of "strongly agree" and "strongly disagree."

The scales used to measure task-technology fit were adapted from Goodhue's research (1995), which also established their reliability and validity. Eight items measured the task-technology fit dimension for online shopping activities. Individuals were asked to use the same Likert scale of 1-5 with end points of "strongly agree" and "strongly disagree."

Internal Consistency

Internal consistency was measured by applying the Cronbach's alpha test to the individual scales. The overall measures are reported in Table 1. As all of the items had an alpha above the standard guideline of 0.70, the scales can be used for analysis with acceptable reliability.

Construct Validity

Factor analysis with varimax rotation was performed to ascertain that perceived usefulness, perceived ease of use, intention to use, actual use, and task-technology fit are distinct constructs. The results confirmed the existence of five factors with eigenvalues greater than 1.0 that accounted for 68.4% of the total variance. Table 2 shows that factor 3, with 3 items, measures perceived usefulness. Similarly, factor 4, with 3 items, and factor 2, with 5 items, measure perceived ease of use and intention to use, respectively. These factors showed no-cross construct loadings above 0.50, indicating good discriminant validity. In factor 5,

Table 1: Scale Reliability: Descriptive Statistics and Cronbach's Alpha

Scale Items	Mean	SD	Cronbach's Alpha
Perceived usefulness (PU)			0.88
PU1	2.49	0.98	
PU2	2.55	0.93	
PU3	2.63	0.97	
Perceived ease of use (PEU)			0.85
PEU1	2.14	0.87	
PEU2	2.14	0.88	
PEU3	2.21	0.93	
Intention to use (IU)			0.90
IU1	2.40	0.96	
IU2	2.45	1.03	
IU3	2.76	0.99	
IU4	2.47	0.88	
IU5	2.75	1.00	
Actual use (AU)			0.78
AU1	3.86	1.06	
AU2	3.48	1.03	
AU3	3.17	0.96	
AU4	2.98	0.88	
Task-technology fit (TTF)			0.85
TTF1	2.57	0.85	
TTF2	2.48	0.84	
TTF3	2.40	0.80	
TTF4	2.44	0.81	
TTF5	2.35	0.77	
TTF6	2.23	0.71	
TTF7	2.41	0.80	
TTF8	2.64	0.87	

actual use, with 4 items, and factor 1, task-technology fit, with 8 items, however, the items are not all similar to each other, with one item in each factor having a loading less than 0.50. These factors are still considered to be good measures for online shopping activities in aggregate, however.

Data Analysis

To test the hypotheses, confirmatory factor analysis using the CALIS procedure in SAS was used. "Path analysis is a method of measuring the influence of explanatory variables along each separate path in a system and finding the degree to which variation of a given effect is determined by each particular cause" (Teo et al., 1999, p. 30)**.** Path analysis is a multivariate analytical methodology for empirically examining sets of relationships in the form of linear causal models (Duncan, 1986; Li, 1975). As shown in Figure 4, unidirectional arrows linking two variables together represent the hypothetical causal relationships. Path analysis was chosen to be consistent with the methodology used by others in similar studies (Dishaw & Strong, 1999; Lee et al., 2001; Magal & Mirchandani, 2001; Teo et al., 1999).

Results

Technology Acceptance Model and Online Shopping

The path analysis results of the TAM, shown in Figure 5, indicate that the model fits the data ($\chi^2 = 0.0009$, df = 1, $\chi^2/df = 0.0009$, p = 0.98, AGFI = 1.0).

Hypothesis 1, which states that the TAM predicts the intention to use and actual use, and its component parts 1a through 1d, are fully supported. The model accounts for 36% of the variance in actual use and 47% of the variance in the intention to use. The total direct effects on actual use were 0.41 for intention to use and 0.24 for perceived usefulness. The direct effects on the intention to use were 0.65 for perceived usefulness and 0.14 for perceived ease of use. Support for hypotheses 1a-1d is shown in the significant path coefficients labeled in Figure 5.

Technology Acceptance Model with Task-Technology Fit Model and Online Shopping

For hypothesis 2, the combined TTF/TAM results shown in Figure 6 also indicate an acceptable fit to

Figure 5: Path Coefficients of TAM Model

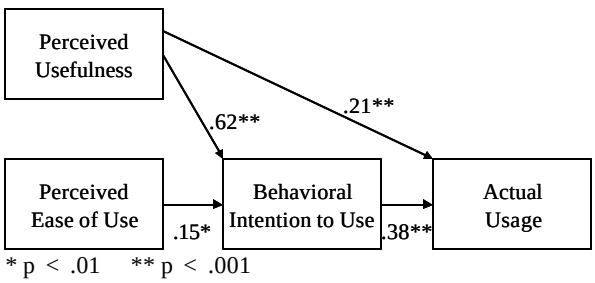


Table 2: Factor Analysis

Scale Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
PU1			0.808		
PU2			0.788		
PU3			0.777		
PEU1				0.830	
PEU2				0.830	
PEU3				0.844	
IU1		0.713			
IU2		0.799			
IU3		0.753			
IU4		0.682			
IU5		0.542			
AU1					0.303
AU2					0.740
AU3					0.857
AU4					0.803
TTF1	0.688				
TTF2	0.782				
TTF3	0.756				
TTF4	0.747				
TTF5	0.749				
TTF6	0.729				
TTF7	0.742				
TTF8	0.162				
Eigenvalue	8.05	2.71	2.44	1.41	1.10
Cumulative % of variance					
	35.01	46.81	57.44	63.56	68.37

the data ($\chi^2 = 3.0$, df = 3, χ^2/df = 0.99, p = 0.40, GFI = 0.99, AGFI = 0.98). Hypotheses 2a-c are fully supported as shown by the path coefficients**.** The combined model accounts for 52% of the variance in the intention to use, and 36% of actual use. The total direct effects on the intention to use were 0.57 for perceived usefulness, 0.11 for perceived ease of use, and 0.24 for task-technology fit. The direct effect on perceived usefulness for task-technology fit was 0.38; the direct effect on perceived ease of use for task-technology fit was 0.19.

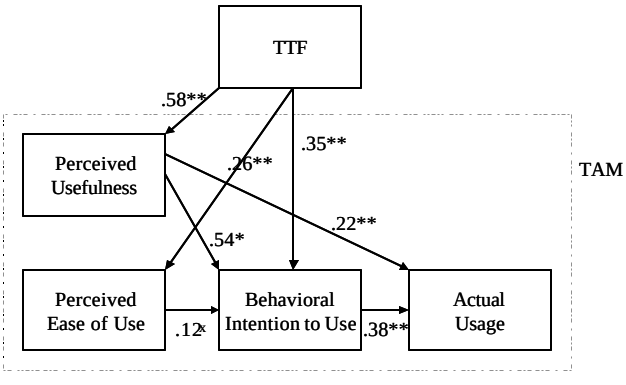
The combined TTF/TAM may even be a more effective model that the TAM alone. First, more variance in the intention to use is explained with the combined model than the TAM alone, 52% versus 47%. Second, the total effect for TTF on the intention to use is 0.48, while perceived use is 0.57 and perceived ease of use is 0.11. According to Lewis-Beck (1974), the total effect is an accurate reflection of the relative merits of the independent variables.

Discussion

This study finds strong support for the use of a modified TAM in e-commerce. Further, the study also finds support for a model that includes TTF and the TAM to predict consumer intentions, as shown in Table 3.

For this study, the TAM was modified by removing the perceived ease of usefulness-perceived usefulness link and adding the perceived usefulness-actual use relationship. The original TAM produced a model with a relatively poor fit, as indicated by χ^2/df = 6.4, p < .002, AGFI = .88, RMSEA = .14, NNI = .89, NFI = .96 with an explained variance of intention of 47% and actual use of 33%. In the modified TAM, all four of the expected path weights were significant. Here, as elsewhere (Gefen & Straub, 2000; Lederer et al., 2000; Lin & Lu, 2000; Mathieson, 1991; Teo et al., 1999), perceived usefulness is the key aspect of adoption; perceived ease of use has only a minor effect. One interpretation is that as systems become easier to use and users become more technologically savvy, the variation in the

Figure 6: Path Coefficients of Combined Model



* p < .01 ** p < .001 x p < .05

Table 3: Comparisons of the Two Adoption Models

	TAM	TTF/TAM
Intention to Use Variance Explained	0.47	0.52
Actual Use Variance Explained	0.36	0.36
X2/df (below 2 better)	0.00	0.99
P (not significant better)	0.98	0.40
GFI ((above .9 is good fit)	1.00	0.99
AGFI (above .8 is good fit)	1.00	0.98
RMSEA (.05 or less better)	0.00	0.00
NNI (higher better)	1.02	1.00
NFI (above .9 good fit)	1.00	0.99

perceived ease of use dimension is reduced. This argument has been made for Internet adoption (Teo et al., 1999), and this may be particularly true in current e-commerce adoption.

The TAM presented here also includes a direct effect of perceived use on actual use. Within this domain, not only does perceived usefulness impact intent it also impacts actual use directly. This may be due to consumers developing habits to shop online without realizing it, or busy consumers shopping more frequently online without intending to do so. Another explanation may be related to the two-fold task definition of purchasing and gathering product information. We suspect consumers do not recognize in their intention response an awareness of their growing actual dependence on the web for product information. Clearly more study on this direct effect is required, but it is reasonable to expect differences between workplace and consumer e-commerce adoption.

A second finding shows that a combined TTF/TAM is also appropriate. Adding TTF and its relationships to the TAM also fit the data, as seen in Table 3. While measures of goodness of fit shown in Table 3 for the combined model are equivalent to the TAM alone, the combined model explains more of the variance of the intention to use, 52% to 47%. Again, all of the hypothesized paths are significant; although the perceived ease of use-intention to use path is only marginally significant. These findings are similar to those of Dishaw and Strong (1999). They suggest that in workplace technology adoption, a combined TTF/TAM is superior to the TAM only.

One key difference between the present study and Dishaw and Strong's study (1999) is that, although they expected a strong association between TTF and perceived usefulness, their analysis indicated a non-significant relationship. In the present study this strong association is obtained, possibly due to a different domain. E-commerce is more voluntary than some workplace adoptions. This may suggest that consumer perceptions of usefulness are more dependent on technology fit to the task at hand rather than in the workplace environment where perceptions of usefulness may be more influenced by work factors such as reward and social norms. Further, our fit-usefulness relationship may be due to a cleaner, or better understood, task definition. Perhaps our respondents know how well the web supports the shopping task defined here, more than Dishaw and Strong's (1999) respondents understood their workplace task. This conclusion may be supported by Chen et al.'s (2002) study of e-commerce, where compatibility affected perceptions of usefulness. In that study, compatibility, a more encompassing term than task-technology fit, was related to perceptions of use for the specific and clear task of using a particular website.

Our study extended and broadened the e-commerce task used by Chen et al. (2002) beyond a predetermined and particular website to Internet shopping in general. In doing so, we found similar results to theirs, but, in addition, found that TTF also affects perceptions of ease of use. The broader compatibility in Chen et al. (2002) was not linked to perceptions of ease of use, possibly due to constraining the shopping task to one virtual store. The store was chosen by the respondent and might have been a site that was easy for consumers to use. As mentioned earlier, by constraining the variance in perceived ease of use to easy-to-use websites, studies may statistically mask important relationships. By extending shopping beyond a particular site, and therefore allowing perceived ease of use to vary, the current study has found the more complete set of relationships suggested by the TTF/TAM.

Conclusion

This study was designed to break new ground and explore whether a modified TAM and TTF/TAM

could be extended to technology adoption of e-commerce where the task was generalized to both information gathering and purchasing. Apparently these models are an appropriate theoretical foundation and, as a result, it may be possible to test other aspects of these workplace models in consumer e-commerce. For example, it may be valuable to evaluate if antecedents of perceived usefulness in workplace settings apply to e-commerce such as self efficacy (Salanova, Grau, Cifre, & Llorens, 2000), lifestyle (Lohse, Bellman, & Johnson, 2000), result demonstrability (Moore & Benbasat, 1991), playfulness (Childers et al., 2001; Moon & Kim, 2000; Teo et al., 1999), risk (Yoon, 2002), social factors (Karahanna & Straub, 1991), and gender (Kolsaker & Payne, 2002; Venkatesh, Morris, & Ackerman, 2000). In a similar fashion, antecedents of TTF such as site characteristics (Helander & Khalid, 2000) and task elements (Keeney, 1999) might be evaluated in e-commerce. Finally, the TAM and TTF/TAM may be broadened, linking recent factors such as customer loyalty (Gefen, 2002), trust (Jarvenpaa & Tractinsky, 1999), and service quality (Reichheld & Schefter, 2000) to usefulness or fit. By establishing the appropriateness of TAM and TAM/TTF as theoretical anchors for e-commerce adoption, this study suggests a rich series of follow up issues that would improve our understanding of e-commerce behavior.

There are several limitations to this study. First, self-reports are used to measure actual use. Self-reports may create self-generated validity and thus inflated causal linkages (Feldman & Lynch, 1988; Taylor & Todd, 1995). Second, although statistically both the TAM and TTF/TAM are good fits, the relatively low variance in actual use, around 36%, suggests that the model may be omitting important factors. Third is the ability to generalize. Our narrow demographic sample may generate results not applicable to users in other age groups. Our sample did vary in web experience and frequency of shopping activities, however.

These exploratory and preliminary results suggest further study. The most important suggestion might be a clearer understanding of the task. Although workplace technology adoption models fit the online shopping domain studied here, a clearer identification and specification of the shopping task may improve the predictive power of the models. For example, the task of gathering information seems clearly different from purchasing, the task of shopping on behalf of someone else is different than for oneself, the task of sifting through a large site is different from a small site, and the task of looking for a known and specific commodity is different from shopping for an unspecified or highly differentiated product.

In addition to articulating the task better, further research is needed to understand how e-commerce experience impacts use. The adoption models used here may suggest factors that influence the extent of online shopping for consumers that are adopting a technology. But how do experienced e-commerce shoppers differ from new e-commerce entrants on usefulness, task-technology fit, and other factors in these models? A longitudinal study examining prior expectations of the intention to use and post hoc re-evaluations would be a valuable one.

For practitioners, this study suggests that use depends on both task fit and usefulness, which will be discussed separately. Clearly this study suggests web site developers might carefully evaluate how and why a visitor uses their site. More specifically, what shopping process or task is the site designed to support, and how well does the site and the technology fit that specific shopping task? For example, users may visit the site to seek data on one product, to compare products, to find information about criteria for comparison, to obtain information in the future about the product, to make one purchase, or to make multiple purchases. For each of these potential tasks that a website may serve, the developer should assess how well the site fits these needs. To assess fit the developer should determine if product information is sufficiently detailed, if the information is obvious, accurate, and easy to find, and if the site is current, readable, and understandable.

In addition to addressing how well the site fits the task, practitioners should pay attention to perceptions of site usefulness. Like other studies, the current study suggests perceptions of usefulness are more related to use than perceptions of ease of use. This suggests that developers of the site must

address usefulness to the user, rather than focusing on how easy the site is to use. One of the questions used to assess perceptions of usefulness was speed, "Using the Internet enables me to accomplish my shopping tasks more quickly." Practitioners might use the simple metric of time as a guide in site assessment. It would be useful to make decisions about site layout on the clear measure of time saved, assuming other factors are equal. As more is learned about how to model the consumer e-commerce task, it will become more evident how to improve the site's fit and usefulness for various tasks.

References

Agarwal, R. & Prasad, J. (1999). Are individual differences germane to the acceptance of new information technologies? *Decision Sciences, 30*(2) 361-391.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Ajzen, I., & Madden, T. J. (1986). Prediction of goal-directed behavior: Attitudes, intention, and perceived behavioral control. *Journal of Experimental Social Psychology, 22*, 453-474.

Bellman, S., Lohse G. L., & Johnson E. J. (1999). Predictors of online buying behavior. *Communications of the ACM, 42*(12), 32-38.

Benford, T. L., & Hunton, J. E. (2000). Incorporating information technology considerations into an expanded model of judgment and decision making in accounting. *International Journal of Accounting Information Systems, 1*(1), 54-65.

Chang, M. K., & Cheung, W. (2001). Determinants of the intention to use Internet/WWW at work: A confirmatory study. *Information & Management, 39*(1), 1-14.

Chen, L., Gillenson, M., & Sherrell, D. (2002). Enticing online consumers: An extended technology acceptance perspective. *Information & Management, 39*(8), 705-719.

Childers, T., Carr, C., Peck, J., & Carson, S. (2001). Hedonic and utilitarian motivations for online retail shopping behavior. *Journal of Retailing, 77*(4), 511-535.

CSRE Campus Market Research Series. (2001, March 12). College students more inclined to shop online, survey finds. *Westchester County Business Journal, 40*(11), 21.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-339.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35*(8), 982-1003.

Davis, F. D., & Venkatesh, V. (1996). A critical assessment of potential measurement biases in the technology acceptance model: Three experiments. *International Journal of Human-Computer Studies, 45*(1), 19-45.

Dishaw, M. T., & Strong, D. M. (1999). Extending the technology acceptance model with task-technology fit constructs. *Information & Management, 36*(1), 9-21.

Duncan, O. D. (1986). Path analysis: Sociological example. *The American Journal of Sociology, 72*(1), 1-16.

Feldman, J. M., & Lynch, J. (1988). Self-generated validity and other effects of measurements on belief, attitude, intention, and behavior. *Journal of Applied Psychology, 73*(3), 421-435.

Fishbein, M., & Azjen, I. (1975). *Belief, attitude, intention, and behavior*. Reading, MA: Addison-Wesley.

Gefen, D. (2000). E-commerce: The role of familiarity and trust. *Omega: The International Journal of Management Science, 28*(6), 725-737.

Gefen, D., & Keil, M. (1998). The impact of developer responsiveness on perceptions of usefulness and ease of use: An extension of the technology acceptance model. *The DATA BASE for Advances in Information Systems, 29*(2), 35-49.

Gefen, D., & Straub, D. (2000). The relative importance of perceived ease-of-use in IS adoption: A study of e-commerce adoption. *Journal of the Association for Information Systems, 1*(8), 1-21.

Goodhue, D. L. (1995). Understanding user evaluations of information systems. *Management Science, 41*(12), 1827-1844.

Goodhue, D. L., & Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly, 19*(2), 213-236.

Helander, M. G., & Khalid, H. M. (2000). Modeling the customer in electronic commerce. *Applied Ergonomics, 31*(6), 609-619.

Igbaria, M., Parasuraman, S., & Baroudi, J. J. (1996). A motivational model of microcomputer usage. *Journal of Management Information Systems, 13*(1), 127-143.

Jarvenpaa, S. L. & Tractinsky, N. (1999). Consumer trust in an Internet store: A cross cultural validation.

Journal of Computer Mediated Communication, 5(2), 1-35.

Karahanna, E., & Straub, D. W. (1999). The psychological origins of perceived usefulness and ease-of-use. *Information & Management, 35*(4), 237-250.

Keeney, R. L. (1999). The value of internet commerce to the customer. *Management Science, 45*(4), 533-542.

Keil, M., Beranek, P., & Konsynski, B. (1995). Usefulness and ease of use: Field study evidence regarding tasks considerations. *Decision Support Systems, 13*(1), 75-91.

Kolsaker, A., & Payne, C. (2002). Engendering trust in e-commerce: A study of gender-based concerns. *Marketing Intelligence & Planning, 20*(4), 206-214.

Lederer, A. L., Maupin, D. J., Sena, M. P., & Zhuang, Y. (2000). The technology acceptance model and the World Wide Web. *Decision Support Systems, 29*(3), 269-282.

Lee, D., Park, J. & Ahn, J. (2001). On the explanation of factors affecting e-commerce adoption. *Proceedings of the Twenty-Second International Conference in Information Systems,* 109-120.

Lewis-Beck, M. S. (1974). Determining the importance of an independent variable: A path analytic solution. *Social Science Research, 3*(2), 95-107.

Li, C. C. (1975). *Path analysis: A primer*. Pacific Grove, CA: The Boxwood Press.

Liaw, S. S. (2002). Understanding user perceptions of world-wide web environments. *Journal of Computer Assisted Learning, 18*(2), 137-148.

Lin, J. C. C., & Lu, H. (2000). Towards an understanding of the behavioural intention to use a web site. *International Journal of Information Management, 20*(3), 197-208.

Lohse, G. L., Bellman, S., & Johnson, E. J. (2000). Consumer buying behavior on the Internet: Findings from panel data. *Journal of Interactive Marketing, 14*(1), 15-29.

Magal, S. R., & Mirchandani, D. A. (2001). Validation of the technology acceptance model for Internet tools. *Proceedings of the Americas Conference on Information Systems*, 1-16.

Mathieson, K., (1991). Predicting user intentions: Comparing the technology acceptance model with the theory of planned behavior. *Information Systems Research, 2*(3), 173-191.

Moon, J. W., & Kim, Y. G. (2001). Extending the TAM for a world-wide-web context. *Information & Management, 38*(4), 217-230.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research, 2(*3), 192-222.

National Telecommunication and Information Administration, (2002). A nation online: How Americans are expanding their use of the Internet. U.S. Department of Commerce, Washington, DC. Retrieved October 18, 2002, from http://www.ntia.doc.gov/Reports.html

Pew Research Center. (2002). Pew Internet & American Life. Retrieved October 18, 2002, from http://www.pewinternet.org

PR Newswire. (2002, November 21). Online survey by edu.com reveals college students plan to spend $2.2 billion online this holiday season. *PR Newswire Association, Inc.*, p. 2987.

Reichheld, F., & Schefter, P. (2000). E-loyalty: Your secret weapon on the web. *Harvard Business Review, 78*(4), 105-113.

Salanova, M., Grau, R. M., Cifre, E., & Llorens, S. (2000). Computer training, frequency of usage and burnout: The moderating role of computer self-efficacy. *Computers in Human Behavior, 16*(6), 575-590.

Shaw, M. J., Gardner, D. M., & Thomas, H. (1997). Research opportunities in electronic commerce. *Decision Support Systems, 21*(1), 49-156.

Taylor, S., & Todd, P. A. (1995). Understanding information technology usage: A test of competing models. *Information Systems Research, 6*(2), 144-176.

Teo, T. S. H., Lim, V. K. G., & Lai, R. Y. C. (1999). Intrinsic and extrinsic motivation in Internet usage. *Omega, 27*(1), 25-37.

Totty, M. (2001, October 29). Information, please: How three companies are using the web to find out more about their customer-or to let their customers know more about them. *Wall Street Journal*, p. R6.

Venkatesh, V. (2000). Determinants of perceived ease of use: integrating control, intrinsic motivation, & emotion into the technology acceptance model. *Information Systems Research, 11*(4), 342-365.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science, 46*(2), 186-204.

Venkatesh, V., Morris, M. G., & Ackerman, P. L. (2000). A longitudinal field investigation of gender differences in individual technology adoption decision-making processes. *Organizational Behavior and Human Decision Processes, 83*(1), 33-60.

Yoo, B., & Donthu, N. (2001). Developing a scale to measure the perceived quality of an Internet

shopping site (SITEQUAL). *Quarterly Journal of Electronic Commerce, 2*(1), 31-45.

Yoon, S. (2002). The antecedents and consequences of trust in online-purchase decisions. *Journal of Interactive Marketing, 16*(2), 47-63.

Zigurs, I., Buckland, B. K., Connolly, J. R., & Wilson, E. V. (1999). A test of task-technology fit theory for group support systems. *ACM SIGMIS Database, 30*(3-4), 34-50.

Appendix: Variables Measuring the Constructs for the Combined TTF/TAM Model

The variables measuring the constructs for the combined TTF/TAM model were formed from the following items. Unless otherwise noted, these items measured the constructs by asking individuals to agree or disagree with statements using a Likert scale of 1 – 5 with end points of "strongly agree" and "strongly disagree."

Perceived Usefulness

1. Using the Internet enables me to accomplish my shopping tasks more quickly.
2. Using the Internet makes it easier for me to shop.
3. Overall, I find the Internet useful for my shopping activities.

Perceived Ease of Use

4. It is difficult to learn how to use the Internet to do my shopping activities.
5. I took a long time to learn to use the Internet to do my shopping activities.
6. I often become confused when I use the Internet for my shopping activities.

Intention to Use

7. I think it would be very good to use the Internet for my shopping activities in addition to traditional methods.
8. In my opinion it would be very desirable to use the Internet for my shopping activities in addition to traditional methods.
9. It would be much better for me to use the Internet for my shopping activities in addition to traditional methods.
10. Using the Internet for my shopping activities is a good idea.
11. Overall, I like using the Internet for my shopping activities.

Actual Use

12. I use the Internet for my shopping activities very frequently (many times per day).
13. On average, how many different online shopping places do you visit in a given month (Choose only one)?
    A. None
    B. 1-2
    C. 3-5
    D. 6-20
    E. over 20
14. In general, much time do you spend doing online shopping activities per week (Choose only one)?
    A. 0-5 minutes
    B. 6-15 minutes
    C. 16-60 minutes
    D. over 60 minutes
15. On average, how frequently do you use the Internet for your shopping activities (Choose only one)?
    A. once a year
    B. two or three times a year
    C. monthly
    D. daily

Task-Technology Fit

16. Sufficiently detailed product information is maintained on product websites.
17. On the websites I visit, product information is either obvious or easy to find out.
18. I can get product information quickly and easily from a website when I need it.
19. The online product information that I use or would like to use is accurate enough for my purposes.
20. The online product information is up to date enough for my purposes.
21. The online product information that I need is displayed in a readable and understandable form.
22. The online product information maintained at websites is pretty much what I need to carry out my tasks.
23. The product information is stored in so many forms it is hard to know how to use it effectively.