Extending the Technology Acceptance Model: A Field Study of Broker Workstations

Henry C. Lucas, Jr.
Valerie K. Spitler

IS-96-17

Extending the Technology Acceptance Model: A Field Study of Broker Workstations

Henry C. Lucas, Jr.
Department of Information Systems
New York University
Leonard N. Stern School of Business
44 West 4th Street, Suite 9-67
New York, NY 10012-1126
(212) 998-0814
fax: (212) 995-4228
hlucas@stern.nyu.edu

Valerie K. Spitler
Department of Information Systems
New York University
Leonard N. Stern School of Business
44 West 4th Street, Suite 9-181
New York, NY 10012-1126
(212) 998-0827
fax: (212) 995-4228
vspitler@stern.nyu.edu

November 1996

Working Paper Series
Stern #IS-96-17

Extending the Technology Acceptance Model: A Field Study of Broker Workstations[1,2]

by
Henry C. Lucas, Jr.
Valerie Spitler

Stern School of Business
New York University

ABSTRACT

This paper presents a field study of the Technology Acceptance Model. We extended this model to predict the acceptance of a multifunctional, broker workstation with a windowed interface. Brokers and sales assistants in the private client group of a major investment bank use this workstation as an integral part of their jobs. The extended model explains a significant percentage of the variance in usage, but the variables that are most salient in the model differ between brokers and sales assistants. There is evidence that low performing brokers use the workstation more than higher performing brokers; the results also suggest that more training may be needed for sophisticated workstations for professionals than for clerical personnel learning to use transactions processing systems. We believe it is important to predict and understand the acceptance of technology like the workstation in this study if firms are to obtain a return from investing in information technology.

Over 50% of capital investment in the U.S. is for information technology (*The New York Times, December 3, 1995)*; *BusinessWeek* estimates that there are 63 PCs per 100 workers in the U.S. (including machines at home) and others have calculated that one in three U.S. workers uses a computer on the job. One brokerage firm is investing over $100 million in new technology for its brokers. There will be little return from information technology (IT) if workers fail to accept it or to fully utilize its capabilites. How can managers and developers of advanced technology predict its acceptance and likely success when making investment decisions?

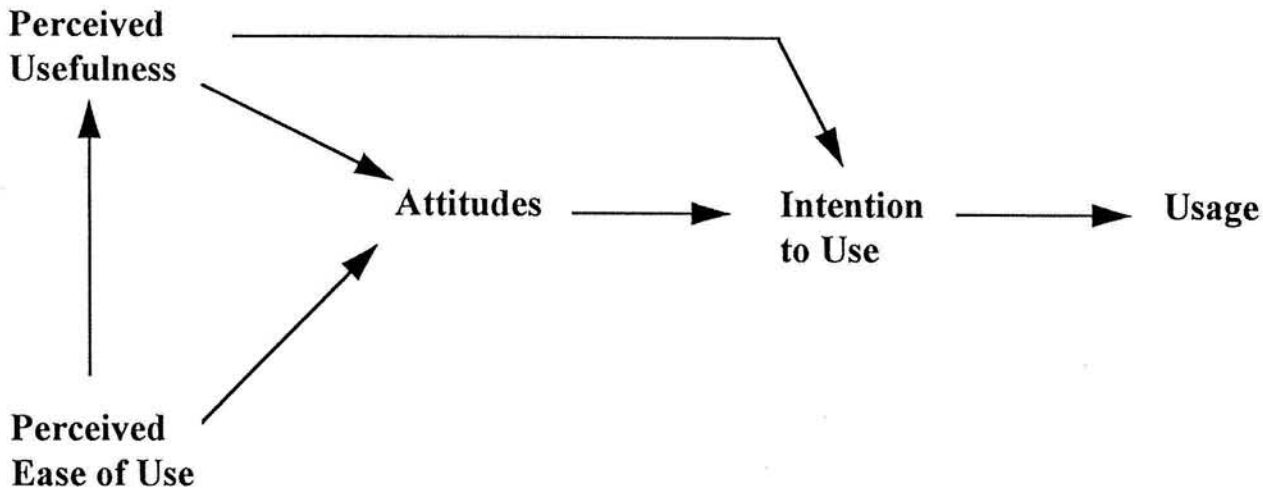
---

[1] The authors wish to thank Professor Fred Davis for his insightful and helpful comments on an earlier draft of this paper.
[2] This research was sponsored in part by National Science Foundation Grant Number IRI-9200205.

Davis has proposed the Technology Acceptance Model for predicting intentions to use and actual use of technological innovations. The purpose of this paper is to present the results of using an extended version of the Technology Acceptance Model (TAM) in a field study of broker workstations. The model was modified and extended to predict the acceptance and use of a workstation designed for private client brokers at a major investment bank. These brokers work with sales assistants to provide investment services for high net worth customers of the bank.

In addition to Davis, there have been a number of studies of implementation and the acceptance of new technology; reviews and summaries of some of these studies may be found in Swanson (1987) and Lucas, Schultz and Ginzberg (1990). Davis' Technology Acceptance Model (TAM) is one of the newest models and is based on the Theory of Reasoned Action developed by Fishbein and Ajzen (1975).

In the original test of the model (Davis 1989), high levels of Perceived Usefulness and Perceived Ease of Use predicted Intentions to Use information technology. See Figure 1. Davis found that Perceived Ease of Use acts primarily through Perceived Usefulness to influence Intentions to Use. Davis' results supported his model (1989); several other studies also provide evidence for TAM. See Table 1. Davis, Bagozzi and Warshaw compared a model based on the Theory of Reasoned Action with TAM and found mixed results for both models, though there was support for the key variables of Perceived Usefulness and Perceived Ease of Use and their positive relationship with behavioral Intentions to Use a system (1989). Mathieson (1991) also compared TAM



The Technology Acceptance Model
Figure 1

with the Theory of Planned Behavior (TPB) and found that both models predicted Intention to Use well, but that TAM was slightly better from an empirical view.

Taylor and Todd (1995) looked at TAM and the Theory of Planned Behavior in a longitudinal study of a resource center; they concluded that a decomposed Theory of Planned Behavior provided more insights than TAM, though TAM received support from their data. In another study drawn from their data (Taylor and Todd 1995a), these same authors found that TAM, modified to include subjective norms and perceived behavioral control, performed well in predicting acceptance for both experienced and inexperienced users. Straub et al. (1995) used TAM to compare self-report and computer monitored voice mail usage in a field setting. Szajna (1996) found that a revised TAM, dropping attitudes from the model and making a slight change for pre versus post-implementation, predicted usage, but that adding an experience component is a worthwhile extension of the model. Szajna also recommends that measures of actual usage may work better than self-report measures, at least when looking at the acceptance of e-mail.

THE RESEARCH MODEL

As Table 1 shows, almost all of the studies of TAM and similar models haved employed college students in experimental or quasi-experimental research designs. One study of a computer system, used primarily for developing scales, included professionals whose daily job involved the use of technology (Davis 1989). Straub, et al. (1995) conducted a field study, but the technology was voice mail and the purpose of the study was to assess agreement between self-report measures of use and computer recorded use

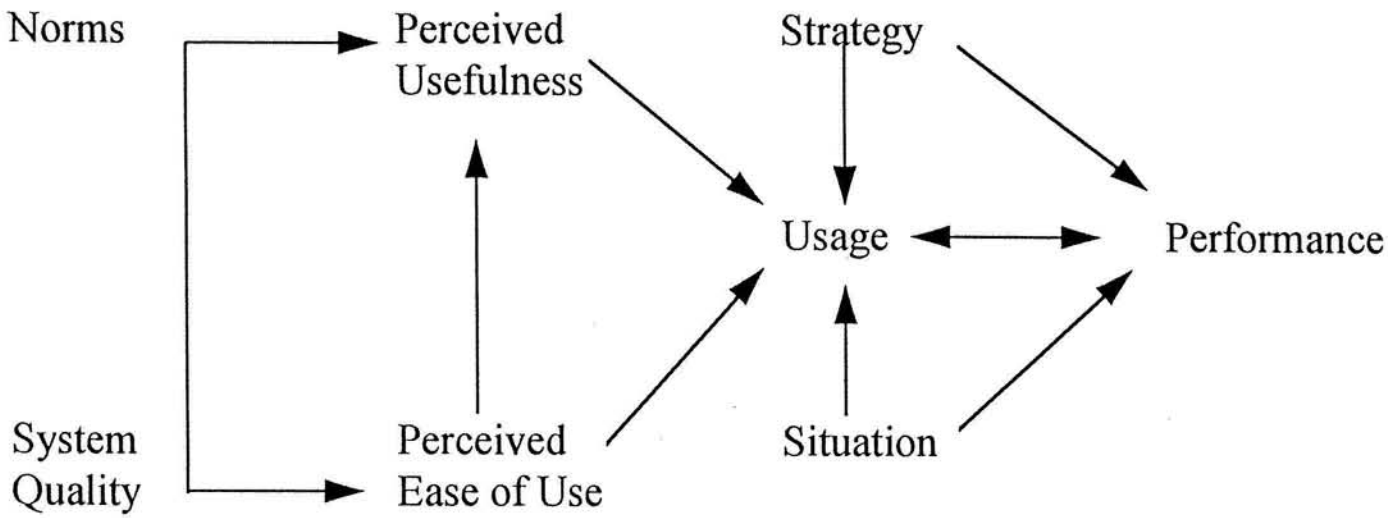
Author	Model/Subjects	Results
Davis (1989)	TAM 1. IBM developers using PROFS, XEDIT 2. MBA students	1. Developed Perceived Ease of Use, Usefulness scales in study 1. 2. Regression showed Usefulness and Perceived Ease of Use associated with self-reported use. Perceived Ease of Use acts primarily through Usefulness 3. Study 2 showed similar results for students in an experiment based on self-reports predicting their own future use of software packages.
Davis, Bagozzi and Warshaw(1989)	TRA, TAM MBA students	1. Perceived Usefulness predicts intentions to use while Perceived Ease of Use is secondary and acts through Perceived Usefulness. 2. Attitudes have little impact mediating between perceptions and intentions to use. 3. Relatively simple models can predict acceptance.
Mathiesson (1991)	TAM, TPB Students	1. Both models predict intentions to use well. 2. TAM is easier to apply, but provides only general information. 3. TPB provides more specific information for developers
Taylor and Todd (1995)	TAM, TPB Students	1. All models performed well based on fit and explanation of behavior. 2. TPB provides a fuller understanding of intentions to use. 3. In TAM attitudes are not significant predictors of intention to use.
Taylor and Todd (1995)	Modified TAM including social influences Students	1. Modified TAM explains usage for both experienced and inexperienced users. 2. Stronger link between behavioral intention and behavior for experienced users 3. Antecendent variables predict inexperienced users' intentions better
Straub, et al., 1995	TAM as a framework for comparing self-reported and actual usage measures	1. Focus on agreement between self-report and computer recorded usage measurements. 2. Field study of voice mail system 3. For voice mail, self-report and computer recorded usage do not have high agreement
Szajna (1996)	Revised TAM Students	1. Looked at pre and post implementation 2. Questions self-report measures versus actual measurement of usage for e-mail system. 3. Experience component may be important in TAM.

Summary of TAM Studies
Table 1

rather than to test TAM directly. The technology in these studies has been single function software (eg. a spreadsheet) or voice mail instead of a more modern, multifunctional managerial workstation with a windowed interface. The objective of the research reported in this paper is to test TAM in a field setting with users who have powerful, multifunction workstations and where *the technology is an integral part of work life.* In this field setting, we believe TAM needs to be extended to include other variables if it is to be successful in predicting usage and acceptance of technology.

We have added several variables and relationships to TAM suggested by the authors in Table 1 and by past studies of implementation in a field setting (Lucas, Schultz and Ginzberg, 1990). The original TAM includes the variables Perceived Usefulness, Perceived Ease of Use, Attitudes, Intention to Use and Usage. Higher levels of Perceived Usefulness and Perceived Ease of Use predict favorable Attitudes which, in turn, predict Intentions to use. Intentions to use predict actual Usage.

Figure 2 contains the revised and extended model used in this study. We have added two individual variables, Norms and System Quality, and three classes of variables to TAM and eliminated several variables because of measurement and collinearity problems. In a pretest we found that attitude scales similar to those used in past studies ("I think it would be (Very good/Very bad) to use the spreadsheet rather than my calculator for the assignment") did not correlate to form a scale for brokers using the workstation (Mathiesson, 1991). It is possible that attitudes are not extremely important in a field setting where some of the functions of the workstation are required in order to



The Research Model
Figure 2

perform one's job. For these reasons, and consistent with Szajna (1996) and Davis et al (1989), we do not include attitudes in the model. We also eliminated the Intention to Use variable from the model. Our survey asked for self-report measures of Usage for a variety of functions of the workstation. At the same time, we asked for Intentions to Use these functions in the future. The correlation between current and intended usage ranged from .78 to 1.0, indicating quite similar responses so we do not include Intentions in the model.

We felt it necessary to extend TAM because of the less controlled and more complex environment of a field study compared to prior experimental tests of the model. Fishbein and Ajzen (1975) include Subjective Norms in the Theory of Planned Behavior. In one empirical study of participation Hartwick and Barki (1994) incorporated norms and found only weak associations with other variables. However, we feel that norms have the potential to be an important explanatory variable in an organizational setting and they are included in our model.

We have also added ratings of System Quality as a variable that influences perceptions of Ease of Use and Usefulness. A high quality interface and high functionality should influence user perceptions of these two TAM variables.

The use of an information system is a complex phenomenon; the model in Figure 2 includes three classes of variables not in the original TAM. The first of these is strategy: individuals may have a number of different strategies for doing their jobs, and these strategies will influence use of a system (Lucas, 1979). Consider an office of stock brokers: one broker may feel she can best serve her clients by doing extensive research and disseminating the results to customers to encourage them to trade. This broker would be

likely to use the features of a workstation that provided access to research information. A second broker might have a strategy of cultivating social ties so that most of his time would be spent at meals, visiting clients and at social functions; he would have less use for the features of a workstation.

The second new class of variables added to TAM is situational. For example, we expect a broker with a large number of accounts to use a workstation more than a broker with fewer accounts (Lucas, 1979).

The third class of variables extending TAM is performance. The relationship between system Use and Performance is complex (Lucas 1975). In some instances, the use of a system could be associated with high levels of performance when the system contributes and supports a worker. In other instances, a person with poor performance may use an information system to diagnose problems and develop a strategy for improving performance. TAM is a model of individual reactions to technology; where it is possible to measure individual performance, we predict there will be a relationship between performance and usage.

THE STUDY

Site, Technology and Sample

The data to test the research model came from a sample of brokers and sales assistants at a major investment bank. Groups of brokers and assistants work with "private clients," customers with a high net worth. The brokers' objective is to help clients manage their assets. This business is valued by the bank because it tends to be

stable compared to the volatility the bank experiences in other activities. Both brokers and sales assistants are highly compensated for their efforts.

The role of the broker is fairly uniform; brokers provide advice and order execution for a group of clients. Brokers are also constantly seeking new clients to replace those lost to attrition or to the competition. Brokers tend to work in groups of two to four, supported by one or more sales assistants. The job of sales assistants is varied; they maintain account information and serve clients in a number of ways. They have frequent phone contact with clients and may take on some of the broker's normal duties when the broker is not available.

Prior to the fall of 1994, brokers and assistants had access to relatively limited information technology. They used a variety of quotation systems and a number worked with their own analytic, word processing and spreadsheet programs on personal notebook and/or home computers. In the last part of 1994, the bank implemented a major new system for the private client brokerage unit. This system includes a Sun workstation for each broker and each sales assistant. The workstation runs a windowed interface with the Unix operating system. The workstations are networked to servers and to the corporate mainframe computer which maintains transactions processing and accounting data.

The workstation has three main applications: market data, office software and mainframe access. Market data includes "snap" stock quotes in real time from the various exchanges, and monitoring functions which signal when an event happens such as a stock hitting a certain price on the NYSE. Market data is a fundamental requirement for brokers and sales assistants who must use it to answer customer queries and execute

orders. The investment bank purchases market data; the market data package includes a series of analytic routines for research, for example, functions to graph stock prices and volumes.

Office applications include three common functions: word processing, spreadsheets and presentation graphics. The bank purchased these applications for Unix; they are similar to Microsoft Office for a PC.

The last major application is access to mainframe data. All information on a client's portfolio is on the mainframe. To access client records and to perform maintenance on them, users must work with existing mainframe applications. Once within the mainframe window, the graphical user interface is no longer active and all work must be done in character mode.

There are approximately 71 brokers and 81 sales assistants in the personal client group. Of these, 54 brokers and all sales assistants completed questionnaires about the variables in the model of Figure 2, except for performance data which came from bank records. The majority of respondents completed the survey in a conference room on one of two days. About 20% of the respondents could not complete the instrument on one of these days and replied later by mail. All respondents completed the survey before the end of 1994. The bank was unable to provide performance data on 5 brokers. Based on the calculations for sales assistants' performance described in the next section, the final sample includes 49 brokers and 58 sales assistants for whom we have mostly complete data.

Variables and Data

We developed an instrument to measure TAM based on the studies in Table 1. It was necessary to alter the wording of some questions to refer to the bank's systems since questions for Perceived Ease of Use and Usefulness refer to a specific system (Davis 1989). Two studies have indicated satisfactory reliability for these two key variables in TAM (Hendrickson, Massey and Cronan, 1993; Segars and Grover, 1993).

We developed a scale for Norms based on Fishbein and Ajzen (1975) and pretested it on several groups of MBAs and on brokers using a workstation in a different firm. Questions for usage and strategy variables were patterned after those used in past studies of implementation (Lucas, Ginzberg and Schultz, 1990). We used correlation and factor analysis to construct scaled variables from individual items.

Table 2 presents the variables in the study, a summary of the items making up each scale, and the reliability coefficient for scales.

This study uses self-report measures of usage for each of the major functions provided by the workstation. Straub, Limayem and Karahanna-Evaristo (1995) caution that under certain conditions, self-report measures may not be valid indicators of use, though their study involved voice mail rather than workstations. Szajna (1996) in a test of a modified version of TAM also argued in favor of actual usage with TAM in a study of students using e-mail. In the case of a modern workstation, indirect measures of use, for example, through a monitor that counts how often a function is invoked, may not provide a more accurate measure than a self-report. Brokers may leave a stock ticker running across their screen all day; there is no way for a software monitor to know if the broker is

looking at the ticker. One broker may graph a stock and study it for some time, while another graphs five stocks in ten minutes. Who has "used" the system more? For a

Class	Scaled Variable	Description	Items	Alpha
Norms	NORMS	Perceived support by management and peers to use workstation, desire to please management and peers by using workstation	4	.77
Quality	QUALITY	Ratings of retrieval, response time,reliability, accessing market data, using mainframe functions	5	.62
Perceived usefulness	USEFUL	Workstation improves performance, revenue, productivity, effectiveness; is valuable, useful	6	.91
Perceived ease of use	PEOU	Sufficient training, easy to use, easy to get workstation to do what is wanted	3	.77
Usage	USAGE	Total use including MARKET, MAINFRM, OFFICE individual survey items	15	.87
	MARKET	Usage of six market data products	6	.83
	MAINFRM	Usage of six mainframe functions	6	.82
	OFFICE	Usage of three office applications: word processing, spreadsheet, presentation graphics	3	.79
	WP	Word processing component of OFFICE	1	
Strategy	MEET	Meet with clients face-to-face	2	.88
	RESEARCH	Does research for clients	2	.71
	LEVERAGE	Leverages technology for accounts, portfolios, clients, contacts, stock selection	5	.57
Situation	QUOTE	Use of prior popular market data system: 0, 1	1	
	NOCLIENTS	Number of active, revenue generating clients	1	
Performance	LNPERF94	Log of 1994 average monthly commission revenue (12 months)	1	
	LNPERF95	Log of 1995 average monthly commission revenue (5 months)	1	
Sample	BRKASST	Dummy, Broker =0, Sales Assistant = 1	1	

Variables in the Study
Table 2

complex system with many possible functions, self-report measures may be the best alternative available.

The three strategy variables come from a correlation analysis of items on the survey. A broker with a high score on MEET follows a strategy of meeting face-to-face with clients; another strategy, RESEARCH, is to conduct research for clients. The variable LEVERAGE represents a respondent's agreement with statements about using technology to leverage his or her work.

There are two situational variables in the study. QUOTE is a binary variable indicating whether or not the respondent used a specific, popular market data services to obtain quotes and other information prior to the new system; it is a measure of prior use of technology. The number of clients, NOCLIENTS, describes the number of active, revenue generating clients and is a measure of transactions and administrative workload.

The bank was able to provide performance data for individual brokers based on their commissions for all of 1994 and the first five months of 1995. Given the timing of implementation, we have defined 1994 as early implementation and 1995 as post-implementation. We computed a monthly average commission for each year and then took the natural log of that average to create a less skewed distribution. There was no comparable measure of sales assistants' performance, so we computed an implied performance for each sales assistant by averaging the commissions of the brokers with whom the sales assistant works. The last variable is an intercept dummy to test for differences in response between brokers and sales assistants.

In general the reliabilities are sufficiently high to use each scale, though the alphas for System Quality and Leverage are low at .62 and .57.

RESULTS

We tested the model in Figure 2 by 1) regressing Perceived Usefulness and Perceived Ease of Use on Norms and System Quality, 2) regressing Usage variables on Perceived Ease of Use, Perceived Usefulness, Situation, Strategy and Performance variables, and 3) Performance on Usage, Strategy and Situation variables. The results showed substantial differences between brokers and sales assistants for many of the equations as indicated by the significance of the dummy variable BRKASST. Therefore, we ran subsample regressions to better understand how an extended TAM predicts acceptance for these two groups. For predicting Perceived Ease of Use and Usefulness, the number of observations in the entire sample is sufficent to include all independent variables. However, for other dependent variable subsample regressions we had to use a stepwise procedure because there are not enough observations to enter all the independent variables in one step.

In the results we present beta weights which represent the change in the dependent variable in standard deviation units caused by a single standard deviation change in an independent variable. Beta weights provide an indication of the relative importance of each independent variable in influencing the dependent variable. Note, however, that this research is cross-sectional. The research model implies causality, but the research design can only indicate support for the associations in the model.

Predicting Perceived Ease of Use and Usefulness

In the original TAM, Davis (1989) did not try to predict Perceived Ease of Use and Usefulness, though he found that Ease of Use acted through Usefulness in predicting behavioral Intentions to Use. In a field setting, we are interested in the influence of Norms and how System Quality impacts perceptions. We predict that favorable Norms and high ratings of Quality will be associated with favorable perceptions. The general forms of the regressions for these two variables are:

(1) PEOU = f(NORMS, QUALITY)
(2) USEFUL = f(NORMS, QUALITY, PEOU)

The results of the regressions are shown in Table 3 and 4. In general, Systems Quality is the best predictor of high levels of Perceived Ease of Use in the full sample and the two subsamples. It is interesting to note that favorable Norms are a significant predictor of Perceived Ease of Use for brokers, but not for sales assistants.

Dependent Variable: *PEOU*	Full sample Beta/(t statistic)	Brokers Beta/(t statistic)	Sales Assistants Beta/(t statistic)
NORMS	.10 (1.10)	.29 (2.69)***	-.08 (-.58)
QUALITY	.52 (5.57)***	.58 (5.37)***	.39 (2.95)**
BRKASST	-.06 (-.67)	NA	NA
Adjusted R^2 (n) F	.28 (107) 15.00***	.45 (49) 27.32***	.11 (58) 4.45**

* p <=.10; ** p<=.05; ***p<=.01

Predicting PEOU
Table 3

Dependent Variable: *USEFUL*	Full sample Beta/(t statistic)	Brokers Beta/(t statistic)	Sales Assistants Beta/(t statistic)
NORMS	.10 (1.47)	.19 (1.65)	-.16 (-.92)
QUALITY	.45 (5.33)***	.25 (1.86)*	.58 (4.56)***
PEOU	.21 (2.62)***	.44 (3.03)**	.08 (.71)
BRKASST	.11 (1.42)	NA	NA
Adjusted R^2 (n) F	.44 (107) 23.18***	.54 (49) 19.51***	.31 (58) 9.39***

* p <=.10; ** p<=.05; ***p<=.01

Predicting USEFUL
Table 4

Quality is an important predictor of Perceived Usefulness in the full sample and two subsamples. Again there are differences between the strengths of the different relationships for brokers and sales assistants; Perceived Ease of Use is an important predictor of Perceived Usefulness for brokers, but not for sales assistants. We shall see later that sales assistants tend to use the system more than brokers; possibly they are familiar with it or dismiss ease of use since the workstation is such an integral part of their jobs.

Norms do not predict Perceived Usefulness for sales assistants. They are almost significant for brokers and are clearly stronger than for sales assistants. For these two variables in the original TAM, it appears that Norms affect brokers far more than they affect sales assistants.

Predicting Use

Overall Usage is a scale consisting of all items asking about the respondent's use of the three main subsystems. We also developed three separate scales for the major functions/windows of the workstation: market data (MARKET), mainframe access

(MAINFR) and office applications (OFFICE). The general form of the equation predicting usage is:

(3) *USAGE* = f(PEOU, USEFUL, *STRATEGY,SITUATION,* LNPERF94)

where italicized terms represent classes of variables. Equation 3 is the general form for regressions on the *usage* variables USAGE (overall usage) and MARKET, MAINFR and OFFICE (workstation functions). Because perceived ease of use and usefulness apply to the workstation as a whole, from a theoretical standpoint, we should not include these two TAM variables in predicting use at the window or functional level. However, we believe that brokers were most focused on their use of the market system when completing the survey while sales assistants were responding to the office automation and mainframe functions which they use extensively. Therefore, we include PEOU and USEFUL in predicting use of the individual components of the workstation, MARKET for brokers, and MAINFR and OFFICE for sales assistants.

The TAM model predicts that high levels of usage are a function of high levels of Perceived Ease of Use and Usefulness. We have added strategy variables, LEVERAGE, MEET and RESEARCH; brokers who leverage technology and conduct research should use the workstation more, while a strategy of meeting the client is likely to lead to lower levels of Usage. Also included are situation variables for use of the prior quotation system and number of accounts. The functions of the prior quote system most often used by brokers are included in the workstation; QUOTE shows a prior history of using IT and should be positively related to usage of the workstation. Brokers with more accounts can use the workstation to service their clients, so we expect a positive relationship between

this variable and usage. Finally, we predict that poorer 1994 performance will encourage the use of these workstation functions to look for problems and ways to improve performance. Table 5 presents the results for estimating Equation (3) for USAGE, MARKET, MAINFRM and OFFICE for the population and subgroups described above.

Usefulness is a predictor of overall USAGE in the second column of Table 5. Number of clients also predicts use and the BRKASST dummy variable shows that sales assistants report a higher overall level of use of the workstation than brokers.

Types of Use

(1)	(2)	(3)	(4)	(5)
Dependent Variable:	*Total USAGE* Full sample Beta/(t statistic)	*MARKET Use* Brokers (stepwise) Beta/(t statistic)	*MAINFRM Use* Sales Assistants (stepwise) Beta/(t statistic)	*OFFICE Use* Sales Assistants (stepwise) Beta/(t statistic)
PEOU	.13 (1.15)			.34 (2.44)**
USEFUL	.23 (2.05)**	.46 (3.75)***		.42 (3.35)***
LEVERAGE	.09 (0.92)	.20 (1.66)*		
MEET	.08 (0.61)			-.38 (-2.81)***
RESEARCH	.07 (0.80)			
NOCLIENTS	.19 (2.07)**		.29 (2.26)**	
QUOTE	.14 (1.59)	.25 (2.03)**	.43 (3.33)***	
LNPERF94	-.03 (-.37)			
BRKASST	.38 (2.67)***	NA	NA	NA
Adjusted R^2 (n)	.29 (95) 5.18***	.31 (48) 8.02***	.24 (47) 8.33***	.33 (47) 8.44***

* p <=.10; ** p<=.05; ***p<=.01

Predicting Usage
Table 5

For brokers and sales assistant subgroups, it was necessary to use step-wise analysis because there are too many variables in Equation 3 for the number of observations in each group. Columns 3-5 in Table 5 show the variables that entered before the stepwise algorithm terminated. The TAM variable USEFUL and the strategy variable LEVERAGE predict use of the market data system by brokers. Use of the previous quotation system also predicts broker use of the market system.

For sales assistants, number of clients and use of the prior quote system predict higher mainframe usage. Having more clients means that there are more accounts to maintain, requiring use of the mainframe functions. For office software, the TAM variables Perceived Ease of Use and Usefulness predict sales assistant use. A strategy of meeting with clients is negatively related to usage.

It is interesting to note that the TAM variables which were measured for the workstation as a whole (PEOU and USEFUL) are significant predictors of usage for two of the functions (MARKET and OFFICE) provided by the workstation. We believe that brokers and sales assistants responded to Perceived Ease of Use and Usefulness thinking about the functions of the system most salient for them. Future research should examine how overall reactions to a workstation are related to its individual components.

These results suggest that strategy and situational variables are important extensions of TAM. Should these variables be included in the category "external variables" in the original model? If so, they would influence usage through Perceived Usefulness and Perceived Ease of Use rather than directly. Regression analysis with different subsets of the variables provided almost no evidence in favor of a model in which

strategy and situation variables act through Perceived Ease of Use and Usefulness. In this study, the evidence supports the research model in Figure 2 in which strategy and situation are associated directly with usage.

Predicting Performance

We expect performance in 1995 to be influenced by prior performance, situation, strategy and workstation usage. The regression equation is:

(4) PERF95 = f(LNPERF94, USAGE, *SITUATION, STRATEGY*)

Strategy includes three variables: leveraging the computer to do one's job, meeting with clients, and doing research for clients. High scores on Usage and strategy variables should be associated with high levels of performance. Situation variables include use of the prior quote system and number of active clients, both of which we predict will be positively associated with performance. The results of testing Equation 4 are found in Table 6.

Dependent Variable: *LNPERF95*	Full sample Beta/(t statistic)	Brokers (stepwise) Beta/(t statistic)	Sales Assistants (stepwise) Beta/(t statistic)
LNPERF94	.89 (16.97)***	.93 (16.80)***	.85 (10.47)***
USAGE	-.02 (-.28)		
MEET	.04 (.63)		
RESEARCH	.06 (1.11)		
LEVERAGE	.07 (1.29)		.23 (2.79)***
NOCLIENTS	-.02 (-.32)		
QUOTE	.03 (.67)		
BRKASST	.07 (.97)	NA	NA
Adjusted R^2 (n) F	.78 (96) 43.54***	.86 (48) 282.36***	.70 (48) 55.30***

* p <=.10; ** p<=.05; ***p<=.01

Predicting LNPERF95
Table 6

Performance in 1994 is the best predictor of performance in 1995; none of the other variables in the model is significant for the full sample. Only the strategy variable, LEVERAGE, is significant for sales assistants in the subsamples. Weill (1992) used a similar model lagging performance one year for firms in the valve industry; he found that type of information system was significant after removing the influence of past performance. Possibly the relative newness of the workstation and the need for users to integrate it with their work has prevented it from having an impact on performance. It is interesting to note that 23% of brokers and 28% of sales assistants thought they had not received sufficient training in the use of the workstation. This finding suggests that more training may be needed for technology to have a positive impact on performance.

Voluntary Use

Hartwick and Barki (1994) have raised a number of interesting issues about voluntary versus mandatory use of information systems. In the private client group, the use of the word processing component of the office applications is largely voluntary. Table 7 shows the results for predicting Equation (3) with the word processing part of the office application as the dependent variable.[3]

[3] Twenty brokers and 21 sales assistants have their own computers. When we created a combined variable representing word processing using the Office software provided by the system or word processing on one's own computer, the results follow roughly the same pattern as above. However, fewer variables are significant in each equation using this more complex dependent variable.

Dependent Variable: *WP*	Full sample Beta/(t statistic)	Brokers (stepwise) Beta/(t statistic)	Sales Assistants (stepwise) Beta/(t statistic)
PEOU	.10 (.96)		.27 (1.80)*
USEFUL	.16 (1.49)		.38 (2.86)***
LEVERAGE	.03 (.35)		
MEET	-.02 (-.16)	.32 (2.52)**	-.37 (-2.55)**
NOCLIENTS	.07 (.85)		
QUOTE	-.11 (-1.32)		
RESEARCH	.07 (.78)		
LNPERF94	-.19 (-2.02)**	-.47 (-3.78)***	
BRKASST	.50 (3.62)***	NA	NA
Adjusted R^2 (n) F	.34 (95) 6.45***	.28 (48) 10.21***	.24 (47) 5.96***

* p <=.10; ** p<=.05; ***p<=.01

Predicting WP
Table 7

These results show that the greatest motivation for brokers to use word processing is relatively poor performance in 1994 followed by a strategy of meeting with clients. The lower performing broker can use word processing to send material to existing clients and to prospect for new clients. For the sales assistants, Perceived Ease of Use and Usefulness are significant predictors of the use of word processing, as is a strategy of *not* meeting with clients. We believe the TAM variables are significant here because the sales assistants had applications like the office software in mind when responding to PEOU and USEFUL.

It is interesting to note in column 4 of Table 5 that PEOU and USEFUL are not significant in predicting sales assistant use of the mainframe function, a function whose use is the least voluntary on the workstation. These results suggest that models like TAM

may have the most predictive power for functions where usage is voluntary rather than mandatory.

Table 7 shows that predicting voluntary use in this setting depends on group membership and tasks. During interviews, managers indicated they wanted brokers phoning existing clients and prospecting for new ones; managers did not want the broker to write letters. The opposite is the typical case for the sales assistant who is asked and encouraged to send information to clients.

DISCUSSION

From a research standpoint, the Extended Technology Acceptance Model works well in a field setting with professionals using a sophisticated workstation. TAM alone, however, does not predict outcomes as well as the extended model. Data from the two subgroups supports the extended model, but different variables are more salient for different groups. Consistent with their tasks, brokers and sales assistants have different patterns of use which can be captured by the extended model. In a field setting we may need more variables to help make up for the control that is possible in laboratory and experimental designs. In particular, systems quality, norms, user strategy, situation and performance variables are useful supplements to the original Technology Acceptance Model in this kind of field setting. Norms are more salient in a field setting in which respondents are in the same environment a significant portion of the day. There is also support for the proposition that a workstation may have greater acceptance and use by

lower performing users who see it as a way to diagnose problems and/or improve performance.

This study has implications for understanding the acceptance and use of a workstation designed for professionals. While the technology is exciting and required a significant investment, the impact of the system has not been revolutionary. We speculate that a system with a large number of functions and access to huge databases will take considerable time for the user to integrate with his or her daily activities. It also may take considerable time for the user to realize that the workstation *makes it possible to perform one's job differently than in the past.*

If our reasoning is correct, then the amount of training and support needed for sophisticated and complex workstations will be much greater than for clerical workers using transactions processing systems. First, it is clear from our results that different groups given the same workstation and functionality in a system will have quite different usage patterns depending on their tasks. Designers who include users in developing a system need to involve a cross section of representatives from different work groups.

The results also have implications for training and education. On one level, education about the system has to address the mechanics; what "clicks" and keystrokes accomplish what functions. It is very tempting to stop training once users understand the mechanics of how to use the workstation. However, to obtain the full benefits from complex technology, organizations should consider training that demonstrates how the user might do his or her job differently, how the technology enables different strategies and different approaches to one's job. In the investment bank, the sales assistants and

brokers knew how to use the mainframe transactions-oriented functions. They can easily learn the mechanics of using analytic routines that come with the market data system, but do they understand how to use the analytics to improve their performance? Have they seen how the most successful brokers use spreadsheets and word processing to contribute to their success?

FURTHER RESEARCH

In general, the Extended TAM receives considerable support from the data in a field setting. However, we have presented the results from only one study and would like to encourage other researchers to consider testing the extended TAM and similar models in field settings. A single study cannot validate a model or the extensions we have made to it.

Our measure of attitudes was not successful. Davis (1989) found that attitudes did not mediate the effect of Perceived Ease of Use and Usefulness on behavior. More research is needed to understand the role of attitudes in TAM and whether or not they should be included in the model. We also experienced problems with Intentions to Use which turned out to be virtually identical to self-reports of usage. Future research should examine the relationship among intentions, self-reports and actual usage. There is also an opportunity to explore the nature of actual usage and how to measure it in a workstation environment where multiple windows may be active all day.

The Extended Technology Acceptance Model predicts user acceptance of technology. Following acceptance, the next question is what kind of impact the

technology has on users and the organization. Can models like this be extended to show how technology enables users to take new approaches to their jobs? Can research estimate the organization's return from investing in information technology?

In conclusion, an extended TAM received support in a field setting of multifunctional broker workstations. The results suggest that the model can predict outcomes, but that the most important variables and relationships differ among subgroups, even though they are using the same system. This extended model and other models can help us understand the acceptance and use of new technologies, two prerequisites for the organization to obtain a return from its investment in information technology.

References

Davis, F., "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology,? *MIS Quarterly*, Vol., 13, No. 3 (September 1989), pp. 319-340.

Davis, F., R. Bagozzi and P. Warshaw, "User Acceptance fo Computer Technology: A Comparison of Two Theoretical Models," *Management Science*, Vol. 35, No. 8 (August 1989), pp. 982-1003.

Fishbein, M. and I. Ajzen, *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research,"* Reading, MA, Addison-Wesley, 1975.

Hartwick, J. and H. Barki, "Explaining the Role of User Paticipation in Information System Use," *Management Science*, Vol. 40, No. 4 (April 1994), pp. 440-465.

Hendrickson, A., P. Massey and T. Cronan, "On the Test-Retest Reliability of perceived Usefulness and Perceived Ease of Use Scales, " *MIS Quarterly,* Vol. 17, No. 2 (June 1993), pp. 227-228.

Lucas, H. C., Jr. "Performance and the Use of an Information Systems," *Management Science*, Vol. 21, No. 8 (April 1975), pp. 908-919.

_____, The Implementation of an Operations Research Model in the Brokerage Industry, *TIMS Studies in the Management Sciences*, Vol 13 (1979), pp. 139-154.

_____, Jr., R. Schultz and M. Ginzberg, *Information Systems Implementation: Testing a Structural Model.* Ablex, 1990.

Mathieson, K., "Predicting User Intentions: Comparing the Technology Acceptance Model with the Theory of Planned Behavior," *Information Systems Research*, Vol 2, No. 3 (September 1991) pp: 173-191.

Segars, A., V. Grover, "Re-Examining Perceived Ease of Use and Usefulness: A Confirmatory Factor Analysis," *MIS Quarterly*, Vol. 17, No. 4 (December 1993), pp. 517-525.

Swanson, E. B., *Information System Implementation: Bridging the Gap Between Design and Utilization,* Homewood, IL: Irwin, 1988.

Straub, D., M. Limayem, E. Karahanna-Evaristo, "Measuring System Usage: Implications for IS Theory Testing," *Management Science*, Vol., 41, No. 8 (August 1995), pp. 1328-1342.

Szajna, B., "Empirical Evaluation of the Revised Technology Acceptance Model," *Management Science*, Vol. 42, No. 1 (January 1996), pp. 85-92.

Taylor, S. and P. Todd, "Understanding Inforamtoin Technology Usage: A Test of Competing Models, " *Information Systems Research*, Vol. 6, No. 2 (June 1995), pp. 144-176.

_____(a), "Assessing IT Usage: The Role of Prior Experience," *MIS Quarterly,* Vol. 19, No. 4 (December 1995), pp. 561-570.

Weill, P., "The Relationship Between Investment in Information Technology and Firm Performance: A Study of the Valve Manufacturing Sector," *ISR*, Vol. 3, No. 4 (December 1992), pp. 307-333.