EXPLAINING PHARMACISTS' INTENTIONS TO USE PERSONAL DIGITAL ASSISTANTS AS CLINICAL RESOURCES DURING PATIENT CARE INTERVENTIONS

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Brent Irby Fox

Certificate of Approval:

_____ Bruce A. Berger, Co-Chair Professor Pharmacy Care Systems	_____ Bill G. Felkey, Co-Chair Professor Pharmacy Care Systems
_____ Anthony J. Guarino Associate Professor Educational Foundations, Leadership and Technology	_____ Kem P. Krueger Associate Professor Pharmacy Care Systems
_____ R. Kelly Rainer Privett Professor Department of Management	_____ Stephen L. McFarland Dean Graduate School

EXPLAINING PHARMACISTS' INTENTIONS TO USE PERSONAL DIGITAL ASSISTANTS AS CLINICAL RESOURCES DURING PATIENT CARE INTERVENTIONS

Brent Irby Fox

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EXPLAINING PHARMACISTS' INTENTIONS TO USE PERSONAL DIGITAL ASSISTANTS AS CLINICAL RESOURCES DURING PATIENT CARE INTERVENTIONS

Brent Irby Fox

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Signature of Author

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Date

Copy sent to:

Name Date

VITA

Brent Irby Fox, son of Larry Fox and Deborah (Andress) Walker, was born June 27, 1974, in Mobile, Alabama. He graduated from Daphne High School in Daphne, Alabama, in 1992. He attended the University of Mississippi for two years before transferring to Auburn University in 1994, where he earned a Bachelor of Science in Pharmacy in 1998. He graduated from Auburn University with a Doctor of Pharmacy in June, 1999. He then worked as a Pharmacy Support Representative with CPSI in Mobile, Alabama, for 13 months before entering the graduate program in the Department of Pharmacy Care Systems at Auburn University. He is engaged to marry M. Georgia Wavra of Ocean Springs, Mississippi, in June, 2005.

DISSERTATION ABSTRACT

EXPLAINING PHARMACISTS' INTENTIONS TO USE PERSONAL DIGITAL ASSISTANTS AS CLINICAL RESOURCES DURING PATIENT CARE INTERVENTIONS

Brent I. Fox

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(B.S., Auburn University, 1998)

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This research project explored the ability of a modified Technology Acceptance Model 2 (TAM2) to explain pharmacists' intentions to use personal digital assistants (PDAs) to document interventions. The Technology Acceptance Model (TAM) has been extensively applied to the explanation of users' intentions to adopt computing technology in non-healthcare settings, consistently explaining approximately 40% of the variance in usage intentions. The TAM2 was developed to provide greater specificity about the factors influencing the primary TAM construct, perceived usefulness. Other research has identified the antecedents of the secondary TAM construct, perceived ease of use. Little published research has applied TAM or TAM2 to healthcare settings and users.

Pharmaceutical Care is a philosophy of pharmacy practice in which pharmacists take heightened responsibility for their impact on patient outcomes. Intervention documentation is one way that pharmacists accept the responsibility defined in pharmaceutical care. Pharmacists use a variety of methods to record interventions; most recently, PDAs have received attention as a potentially useful documentation method.

This study sought to explore a modified TAM2's ability to explain pharmacists' intentions to use PDAs to document interventions. Model fit indices indicated that the TAM2 did not sufficiently describe the data. A bootstrap procedure was then performed due to a small sample size. Model fit indices from the bootstrap procedure indicated that the TAM2 did not fit the data. The modified TAM2 was concluded to not be a useful model for explaining pharmacists' intentions to use PDAs to document interventions.

This study also focused on the relationships between other factors and usage intentions. Specifically, results indicated a non-significant increase in the group's intention to use PDAs from before to after a presentation on PDA use. Other analyses tested for relationships between intentions and five demographic variables: professional position, pharmacy department size, gender, age, and experience. An inverse relationship was identified between pharmacy department size and intentions; intentions to use PDAs to document interventions increased as the size of the pharmacy department decreased.

This research could serve as the initiation point for future research related to pharmacists' intentions to use PDAs (and other technologies). Future research should seek to replicate the present study using a larger sample that is more representative of the profession. Other models of behavior can also be explored using different technologies. Future research should also measure actual usage of the target technology.

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Style manual or journal used Publication Manual of the American Psychological Association, 5th edition

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I. INTRODUCTION

Clinical Pharmacy and Pharmaceutical Care

The profession of pharmacy has been significantly influenced by two movements that occurred in the last 50 years; clinical pharmacy and pharmaceutical care. Clinical pharmacy emerged in the 1960's, but its foundations existed in the profession for many years prior to its emergence (Francke, 1969). In its earliest forms, clinical pharmacy began as a reaction to increased drug utilization, with a focus on cost containment and the quality of medical care (Hatoum, Catizone, Hutchinson, & Purohit, 1986).

An important component of enhancing medical care is to demonstrate improvements that have been achieved through the actions of individuals. Unfortunately, in the 1970's pharmacy as a whole was doing a poor job of evaluating its own ability to demonstrate the value of its clinical practitioners and services (McGhan, Rowland, & Bootman, 1978). Subsequently, Hatoum et al. (1986) conducted an eleven year review of articles published on the topic of clinical pharmacy services. Their goal was to provide pharmacy departments with a departure point for justifying the role of clinical pharmacy in larger healthcare systems and to expand future roles. Their literature review provides a thorough overview of the early years of clinical pharmacy.

Pharmaceutical care is the second re-professionalization movement in the last 50 years that has significantly shaped pharmacy. Pharmaceutical care represents a change in practice from clinical pharmacy. Defined as, "the responsible provision of drug therapy

for the purpose of achieving definite outcomes that improve the patient's quality of life", pharmaceutical care focuses on the patient's overall well-being (Hepler & Strand, 1990). In contrast, clinical pharmacy focuses on services provided. Pharmaceutical care turned pharmacists' foci from clinical services to their responsibility to care for the public relative to drug therapy decision-making (Penna, 1990).

Documentation as a Component of Care

Documentation has been a key component of both clinical pharmacy activities and pharmaceutical care. Documentation has been used as an indicator of pharmacists' contributions to patient care. Documented clinical activities are also assessed as part of quality improvement exercises (Zimmerman, Smolarek, & Stevenson, 1995). The term "intervention" has been closely related to clinical pharmacy and pharmaceutical care. This term has been used to describe pharmacists' clinical pharmacy activities as well as to indicate the actual documentation of these clinical activities by pharmacists. The definition of pharmaceutical care above indicates that pharmacists have a responsibility to work with patients to improve their quality of life. Intervention documentation can be viewed as one way that pharmacists take responsibility for documenting and evaluating the care they provide.

Before the introduction of the personal computer in the 1980s, documentation of interventions began as a manual process using paper forms. Other intervention documentation methods that have been identified include personal organizers, pharmacy and hospital information systems, personal and networked computers, bar-code scanners, and handheld computers (Simonian, 2003). Simonian describes various logistical and

technical issues with these intervention documentation methods. Similarly, others have described common problems with manual documentation of interventions. Manual documentation of interventions is time consuming, pulling pharmacists away from the pharmaceutical care activities they are trying to document. Data from manually documented interventions are also difficult to collate for several reasons. Documentation forms can easily be lost, individuals' handwriting can make it difficult to read what was actually documented, and individuals may document on any available piece of paper, leading to a lack of standardization in what data are captured from one intervention to the next. Additionally, cost calculations can be difficult to perform from manually documented interventions (Zimmerman et al., 1995).

Personal Digital Assistants

One documentation method that has, since the late 1990s, received attention is the use of a specific type of handheld computer to electronically document interventions when and where they occur (Brody, Camamo, & Maloney, 2001; Lau, Balen, Lam, & Malyuk, 2001; Lynx, Brockmiller, Connelly, & Crawford, 2003; Reilly, Wallace, & Campbell, 2001; Vecchione, 1997). Personal digital assistants (PDAs) are handheld computers that weigh roughly 5 – 10 ounces. Personal digital assistants have pressure sensitive display screens. The user often interacts with a PDA by touching the display screen with a stylus, which is a pointed instrument designed specifically for use with PDAs. All personal digital assistants have preloaded personal information management (PIM) software that includes an address book, a calendar, a to-do list, and a memo pad.

Other basic software may include Internet browsers, expense tracking software, and office-type software, depending on the PDA selected.

The two predominant operating systems (OS) for personal digital assistants are the Palm OS (PalmSource, Inc., Sunnyvale, CA) and Pocket PC (Microsoft Corporation, Redmond, WA) (Pettey, 2003). Various hardware manufacturers produce PDAs for each operating system and to date, 275,000 independent software developers have created software for the Palm OS (PalmSource, 2003). There are over 840 clinically-oriented software programs for Palm OS devices. These programs include disease specific references, medication references, patient tracking tools, laboratory test interpretation software, and the list continues (*Healthy PalmPilot*, 2003).

Intervention documentation software also exists for personal digital assistants. These programs can be purchased from commercial developers, or they can be developed by the end user using one of many available database development programs, such as HanDBase (http://www.ddhsoftware.com/handbase.html). Several reports of PDA-based pharmacist interventions have been published. The majority of these reports consist of descriptive accounts of the implementation process followed when introducing this new, portable method of documenting interventions (Brody et al., 2001; Lau et al., 2001; Lynx et al., 2003; Reilly et al., 2001; Vecchione, 1997). Very little has been published on the impact PDA-based intervention documentation has had on the quantity of documented interventions (Clark & Klauck, 2003). No research could be found on the impact PDA-based intervention documentation has had on the quality of documented interventions. Furthermore, no research could be found on the role that user characteristics or

technological factors have on influencing the end user's adoption (or rejection) of this relatively new technology.

Technology Acceptance Model

The Technology Acceptance Model (TAM) has been used as a general, parsimonious model for explaining and predicting users' adoption (or rejection) of new technologies (Davis, Bagozzi, & Warshaw, 1989). The original model, drawn from Ajzen and Fishbein's Theory of Reasoned Action (Ajzen & Fishbein, 1980), uses two key constructs to explain computer usage: perceived usefulness (PU) and perceived ease of use (PEOU). Perceived usefulness is defined as, "the prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context". Perceived ease of use is defined as, "the degree to which the prospective user expects the target system to be free of effort". These two constructs, along with attitude toward use, determine a user's intentions to use a computer system according to TAM (Davis, 1989). Intentions are used to approximate actual system usage in situations where usage can not be directly measured.

Davis et al. developed a theory-based model that has been used in a variety of settings with a variety of end user technologies (1989). Davis et al.'s impetus for developing TAM was to help identify barriers and facilitators to users' adoption of new information technologies within organizational settings. To this end, TAM has been successfully applied to a variety of end users and technologies in settings outside of the healthcare environment (Davis & Venkatesh, 1996; Mathieson, 1991; S. Taylor & Todd, 1995, 2001). In various implementations, TAM has been used to explain from 25% to

69% of the variance in users' intentions to use various technologies (Davis & Venkatesh, 1996; Mathieson, 1991; Szajna, 1996; S. Taylor & Todd, 2001; Venkatesh & Davis, 1996).

Technology Acceptance Model 2

Despite TAM's utility in explaining a significant portion of the variance in usage intentions, it has been criticized for its lack of specificity in identifying factors influencing perceived usefulness and perceived ease of use. The argument is that TAM provides a useful means for identifying broad concepts for explaining usage intentions. It does not, however, provide target areas for individuals interested in modifying usage intentions (Agarwal & Prasad, 1999; Patrick Y. K. Chau, 2001; Magid Igbaria, Guimaraes, & Davis, 1995; M. Igbaria, Zinatelli, Cragg, & Cavaye, 1997; Venkatesh, 2000; Venkatesh & Davis, 1996; Venkatesh & Davis, 2000; Venkatesh & Morris, 2000).

Research has been conducted to identify the antecedents of perceived usefulness and perceived ease of use. In the process of exploring these relationships, this line of research provided further support for TAM's ability to explain usage intentions. The Technology Acceptance Model 2 (TAM2) grew out of the line of research that sought to identify the antecedents of perceived usefulness (Venkatesh & Davis, 2000). The antecedents of perceived ease of use were identified separately fromTAM2. In separate research studies, the antecedents of perceived usefulness and perceived ease of use have been able to explain a significant portion of the variance in their respective constructs. A thorough literature review uncovered no studies simultaneously testing TAM2 and the antecedents of perceived ease of use.

Little published research has applied TAM or TAM2 to healthcare settings (Patrick Y. K. Chau & Hu, 2002; Chismar & Wiley-Patton, 2002). No research published to date could be found that has applied TAM2 to pharmacists' use of personal digital assistants to document clinical interventions.

Research Objective

The purpose of this research is to apply a modified version of the Technology Acceptance Model 2 to pharmacists' intentions to use personal digital assistants to document interventions in acute care and ambulatory care settings. The modified TAM2's ability to explain pharmacists' intentions to use PDAs to document interventions will be analyzed. An important aspect of TAM2 is that its constructs are customarily measured in relation to a training session on the technology in question. This research will utilize a live, 3-hour pharmacy continuing education presentation on PDA-based intervention documentation as the training session. Additional analyses will be conducted to determine if any relationships exist between training and the modified TAM2's explanatory abilities.

II. LITERATURE REVIEW

As stated in the above objectives, the purpose of the present research is to apply a model, developed and validated in the information systems literature, to a group of pharmacists. The goal of this model is to attempt to explain users' behavior, or in this case, their intentions to perform a behavior. The behavior in question for this research is the documentation of patient care interventions by pharmacists using a handheld computer (PDA).

This research draws upon literature from multiple domains. This is reflected in the literature review below, that sets the stage for the changing role of the pharmacist through a brief historical perspective of pharmacy. The documentation of interventions is then discussed, including its role as an indicator of the changes that are occurring in pharmacy. It concludes with a discussion of the Technology Acceptance Model 2 (TAM2). The Technology Acceptance Model (TAM) has been extensively studied in environments external to healthcare, but little research has been published that applies TAM to health professionals. Furthermore, very little research has been published applying TAM2 to healthcare professionals.

Historical Foundations

Significant changes have occurred in pharmacy since 1990. In that year, a new direction was proposed for pharmacy. This new practice paradigm, known as pharmaceutical care, called for a new approach to practice. According to the

pharmaceutical care approach, pharmacists were to accept responsibility for ensuring that patients received optimal medication therapy (Hepler & Strand, 1990). At no time in the history of American pharmacy had the pharmacist's role been so clearly defined in terms of their responsibility to their patients. To begin to understand the importance of changes brought by pharmaceutical care, one must first look at the practice of pharmacy in the decades leading up to 1990, beginning with the mid-1960s.

Clinical Pharmacy

In the mid-1900s, pharmacy emerged from its previous roles focused on medication compounding and the distribution of patent medications. Clinical pharmacy was the term used to describe a new approach to practice that denoted process-oriented activities that utilized an interdisciplinary approach to achieve safe and appropriate use of medications. By definition, clinical pharmacy is a decentralized approach to pharmacy in which the pharmacist moves away from traditional dispensing activities to a practice that, at its core, requires the pharmacist to interact with other healthcare professionals (Francke, 1969; Higby, 2003).

While the term clinical pharmacy has been used to describe various approaches to pharmacy practice dating back to the 1940s and 1950s, as it relates to this discussion, clinical pharmacy began in hospital settings in the 1960s (McLeod, 1976). Ironically, in the 1800s, hospital pharmacists were looked down upon by other pharmacists as individuals who lacked the skills necessary to run a drugstore. However, the uniqueness of their practice allowed hospital pharmacists to come together as a unified group with common goals. As an indicator of their cohesiveness, hospital pharmacists formed a

subsection of the American Pharmaceutical Association (APhA) in 1936. This marked the first time that hospital pharmacists had a voice in the premier national pharmacy association. In 1942, the American Society of Hospital Pharmacists (ASHP) was founded in affiliation with APhA. In 1947, ASHP and APhA jointly established a division focused solely on hospital pharmacy (Bethune, Zellmer, & Sage-Gagne, 2002; Higby, 2003).

Beginning in the 1940s and 1950s, hospital pharmacists took the first steps toward elevating their status as healthcare providers. Pharmacy and Therapeutics (P & T) Committees were established in hospitals to gain more control over the increasing number of medications being used. Pharmacists were key players on P & T Committees, bringing pharmacists into the therapeutic side of practice (Higby, 2003). These committees established formularies, which are institutional-specific lists of preferred medications for use in patients receiving care in the institution.

As the 1960s began, three additional factors contributed to the increasing stature of pharmacists in the hospital setting. The three factors were the development of drug information centers, medication error research, and changes in the medication distribution system (Francke, 1969; Higby, 2003; McLeod, 1976).

Drug information and radiopharmacy have been identified as the first specialty areas of pharmacy (McLeod, 1976). Drug information pharmacists serve as consultants to other practitioners in the retrieval, analysis, and application of information about medications. The American Society of Hospital Pharmacists recognized the importance of drug information specialists through publications and committee actions in the 1950s and 1960s (Francke, 1969). These publications and committee actions were formal

acknowledgements of the Society's recognition that drug information is a practice specialty that requires in-depth training, education, and knowledge and that the individuals who practiced in a drug information role were indeed specialists.

Research published in the 1960s brought national attention to the problem of medication errors (Barker, 1969; Barker, Heller, Brennan, & Sheldon, 1964a). Although numerous definitions exist for medication errors, most definitions indicate that a deviation occurs in the appropriate dispensing of medications. Medication error research identified pharmacists, physicians, and nurses as all potentially being involved in medication errors. It is argued that as a result of this research, pharmacists began to understand the importance of working with other healthcare providers in the interests of the patient (Barker, 1967; Francke, 1969).

Changes in the way medications were distributed also contributed to the changing role of the hospital pharmacist. The unit dose distribution of medications was a new approach in which individual doses were sent from the pharmacy to the nursing station to be administered by the nurse (McConnell, Barker, & Garrity, 1961). This change in distribution methods allowed pharmacists an opportunity to enter direct patient care areas where they interacted with other healthcare professionals, the medical chart, and patients to some extent (McLeod, 1976). Also, as pharmacists began to be more involved with reading and interpreting physicians' orders, they moved into more of an interdisciplinary practice approach (Barker, Heller, Brennan, & Sheldon, 1964b; Francke, 1969).

Clinical Pharmacy into the 1980s

The net effect of these three factors was to move the hospital pharmacist from a centralized role to that of a healthcare practitioner who shares his/her expertise with other providers and patients. The changing role of the hospital pharmacist was heavily influenced by a change in how these acute care specialists applied their knowledge (Higby, 2003). Clinical pharmacists changed their focus from the production of a drug product to the safe and effective use of drugs in patients.

Clinical pharmacy continued to represent the best in institutional pharmacy practice throughout the 1970s and 1980s. During this time, clinical pharmacy services such as pharmacokinetic dosing, antibiotic usage studies, and adverse drug reaction monitoring and reporting enhanced the role of the clinical pharmacist as a more involved provider of care (McLeod, 1976). However, as important as clinical pharmacy is to pharmacy's history, the profession still lacked the necessary focus to bring pharmacy to a fully developed professional direction.

Pharmaceutical Care

Pharmacy's search for a professional direction became more clearly focused in 1990 when Hepler and Strand published their landmark article introducing pharmaceutical care as the future of pharmacy. Defined as, "the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve a patient's quality of life," pharmaceutical care represents a marked change from the clinical pharmacy approach that focused on services provided (Hepler & Strand, 1990).

Pharmaceutical care is a patient-centered approach that focuses on the pharmacist's shared responsibility for the overall well-being of the patient.

At first glance, it may be difficult for those both inside and outside of the profession to distinguish clinical pharmacy from pharmaceutical care. As described above, a clinical pharmacy approach to practice focuses on services that the pharmacist provides to ensure safe and effective use of medications in the care of patients. The key to the pharmaceutical care philosophy is pharmacists' responsibility to their patients. The use of the word "care" emphasizes the pharmacist's responsibility. While clinical pharmacy services of the past focused on functions or activities that pharmacists performed, pharmaceutical care indicates the pharmacist's responsibility for the patient's overall outcomes relative to the use of medications (Penna, 1990).

This is not to say that clinical pharmacy activities are no longer important. These activities can actually still be a major component of pharmaceutical care. The distinction is that the profession no longer defines its role in healthcare in terms of services provided. Instead, pharmacy's role is defined in terms of its responsibility to patients whether or not a medication is dispensed. This responsibility includes a covenant between the pharmacist and each individual patient, in which the patient grants authority to the pharmacist, and in turn, pharmacists pledge their commitment to their patients (Hepler & Strand, 1990). Pharmaceutical care places the patient in the center of pharmacists' interests. Pharmacists' foci are on the outcomes of services provided, not on the services themselves (Penna, 1990).

Pharmaceutical care is a patient-centered philosophy. The sole purpose of pharmaceutical care is to improve patients' well-being through the responsible and

judicious use of medications. A key component of this practice philosophy is the documentation of care provided (Felkey & Fox, 2003). Everyone involved in the care process can benefit from pharmaceutical care activities when these activities are documented. Patients receiving the care benefit because other members of the healthcare team are able to draw upon the pharmacist's activities in their own provision of care. Other patients benefit from the knowledge that pharmacists gain through the analysis and evaluation of countless patient encounters. Pharmacists benefit by being able to provide real world data that demonstrate the positive clinical impact that their approach to care has on patients' lives. Payors benefit by pharmacists' activities that optimize the use of medications to ultimately decrease total healthcare costs.

Other reasons for documenting pharmaceutical care activities include performance evaluation, evidence for financial reimbursement, and to create a documentation trail for tracing responsibility (Penna, 1990). Some authors have devoted entire book chapters to the topic of documenting pharmaceutical care activities (Cipolle, Strand, & Morley, 1998).

According to Penna, part of the responsibility of pharmaceutical care is the pharmacist's obligation to document patient care activities (1990). The term "intervention" has often been used in the context of documentation as it is closely related to the pharmaceutical care philosophy of practice. Although an authoritative definition for intervention in the context of pharmaceutical care remains elusive, the term has been used to describe pharmacists' clinical pharmacy services and pharmaceutical care activities as well as to indicate the actual documentation of these clinical activities (Brown, 1991; Hatoum, Hutchinson, Elliott, & Kendzierski, 1988). If pharmaceutical

care is the future of pharmacy, and if interventions are documented evidence of pharmaceutical care activities, then it follows that interventions are extremely important to the profession of pharmacy. Interventions serve as documented indications of pharmacists' contributions to patient care. A discussion of interventions follows.

Pharmacists' Interventions

Hundreds of articles have been published in the pharmacy and biomedical literature discussing some aspect of the documentation of pharmacists' clinical interventions (Hatoum et al., 1986). For the purpose of this research study, an intervention will be defined as any solicited or unsolicited information provided by a pharmacist to another healthcare professional, or to a patient, in regards to the optimal use of medications for patient care. While many of the articles in the literature do not explicitly use the term intervention to describe pharmacists' activities, examination of these articles reveals that the term intervention does accurately apply in those situations even where it was not used because pharmacists' activities in these situations are focused on ensuring optimal use of medications for patient care.

The literature contains numerous examples of articles published with the intent of serving as resources for clinicians trying to establish intervention programs (Gibson, Hyneck, & Scherrer, 1982; McGhan et al., 1978; Strong & Tsang, 1993). The purpose of this discussion is not to provide a historical review of intervention literature and the contributions that pharmacists have made. Instead, this review will focus on the literature related to the intervention documentation process and activities associated with documenting interventions.

As members of a healthcare team and in keeping with the goals set by pharmaceutical care, considerable attention has been placed on the documentation of pharmacists' interventions. Some authors have even stated that interventions are the direct extension of clinical pharmacy activities (Klinger, 1990). Much literature exists on the evaluation of interventions in terms of their clinical and financial impact on patients and on the healthcare system (Folli, 1987; Hatoum, Hutchinson, Witte, & Newby, 1988; Isetts, Brown, Schondelmeyer, & Lenarz, 2003; Lee, Boro, Knapp, Meier, & Korman, 2002; Mutnick et al., 1997; Slaughter, Erickson, & Thomson, 1994; Strong & Tsang, 1993; C. T. Taylor, Church, & Byrd, 2000). These reports have consistently indicated that pharmacists' interventions significantly improve overall patient care while simultaneously decreasing overall healthcare costs.

Other published literature has focused on peer-review evaluation of pharmacists' interventions (Brown, 1991; Hatoum, Hutchinson, Elliott et al., 1988; Johnson, Brown, & Shea, 2002; Overhage & Lukes, 1999; Zimmerman, Smolarek, & Stevenson, 1997). The peer-review process has been used for a number of reasons: to improve the intervention process, to educate pharmacists, to validate and justify intervention activities, and to ultimately enhance patient outcomes. These activities are part of a larger continuous quality improvement process focused on improving the quality and documentation of pharmacists' interventions (Zimmerman et al., 1997).

Again, documentation of interventions began as a manual process with the use of paper forms. Ironically, the manual processes first used to document pharmacists' clinical activities actually pulled pharmacists away from their clinical activities because manual processes were often very time-consuming and inefficient. Furthermore, the data

collected from manual documentation systems were difficult to summarize and collate (Zimmerman et al., 1995). This made processing, evaluating, and follow-up activities difficult for manually documented interventions (Lynx et al., 2003).

This limitation of manual documentation is important in the area of demonstrating pharmacists' contributions to patient care. This was highlighted in a recent interview with the director of pharmacy at a hospital in Panama City, Florida. He indicated that in his best estimation the pharmacists on his staff documented approximately 50% of the interventions they performed. However, the administrators in his facility did not allow him to extrapolate to an overall impact based on his estimation of the number of interventions that were actually documented (R. Moss, personal communication, September 12, 2003). Situations such as this suggest the need for a more efficient means to document interventions.

Several other methods for documenting interventions have been discussed in the literature. These methods include intranets, bar code scanners, local area networks (LANs), personal computers, pharmacy and hospital information systems (HIS), and electronic medical records (Simonian, 2003). After the implementation of an intranet-based intervention documentation system, the documentation rate doubled and intervention reporting was standardized across multiple hospitals in a health system (Simonian, 2003). In an additional report, a LAN-based intervention documentation system resulted in a 37% increase in documented cost savings over a manual documentation system (Zimmerman et al., 1995).

Comparisons of manual, paper-based data collection to mainframe (i.e., HIS) data collection methods have indicated that users find the mainframe approach to be more

efficient, accessible, and easier to use (Schumock, Guenette, Clark, & McBride, 1993). Another report on hospital information system-based documentation indicated that it allowed intervention information to be easily retrievable on any HIS terminal. This accessibility was reported to increase continuity of care and communication among pharmacists. The primary limitation of the described system was the volume of data that it generated (Mason, Pugh, Boyer, & Steining, 1994).

The common theme among the reports described above is the assertion that existing, alternate documentation methods provide numerous benefits beyond manually documenting interventions on paper. These benefits are consistently found in the areas of access, data collection and collating, and in report capabilities. As with any new process, obstacles related to the user learning new methods are commonly encountered. And while data exist suggesting that alternate documentation methods offer improvements over existing manual methods, other methods have been identified for potential improvements they offer. Personal digital assistants, the subject of the next section, are one such method.

Personal Digital Assistants

Personal digital assistants are handheld computing devices with information storage/retrieval capabilities, usually weighing between five and ten ounces. Users most often use a stylus and/or a keyboard to interact with the device. The current generation of personal digital assistants (PDAs) was first introduced in 1996 when Palm Computing, which was then a division of U.S. Robotics, released the Palm Pilot 1000 and 5000. Prior to that, electronic organizers such as the Sharp Wizard and Apple Newton required third

party software to connect the organizer to a computer. The major advantage of the Palm Pilot and other current generation PDAs over the Wizard and Newton is easy synchronization of information between the PDA and a computer (CNN, 1996).

Users interact with PDAs using a stylus on pressure-sensitive display screens. The information stored on PDAs can be synchronized, or transferred, between the PDA and a personal computer. Standard PDA software is referred to as personal information management (PIM) software. Examples of PIM software include an address book, a calendar, a memo pad, and a to-do list. Figure 1 is an example of a PDA. This unit has two features that are beginning to appear in more PDAs: a 5-way navigation button and flash storage capability.

As PDA technology progresses, additional features have been added to these devices. The majority of PDAs today have memory expansion capabilities. Many PDAs are also being produced that combine the PDA with a mobile phone in a single device. Other features include wireless connectivity using the Wi-Fi (802.11b) protocol. Similarly, Bluetooth is increasingly being incorporated into PDAs. Bluetooth is a personal radio frequency communication protocol that operates in a range of 30 feet.

Figure 1. An example PDA, the PalmOne Tungsten T5

A final point of discussion regarding PDAs focuses on software, both systems software and application software. There are two dominant PDA operating systems in the U.S. that offer storage of health-related applications: the Palm OS (PalmSource, Inc., Sunnyvale, CA) and Pocket PC (Microsoft Corporation, Redmond, WA) (Pettey, 2003). Numerous PDA hardware developers produce devices for each operating system, and some developers produce devices for both operating systems. PalmSource (2003) estimates that there are 275,000 independent software developers and over 10,000 software applications for the Palm OS. In comparison with Pocket PC, the Palm OS is a less complex operating system, leading to the large number of independent software developers for this operating system.

Clinical software has been developed for both operating systems. Over 840 clinical applications currently exist for the Palm OS, and nearly 250 clinical applications are available for the Pocket PC (2003; *Healthy PalmPilot*, 2003). Intervention documentation software exists for both operating systems. This software can be divided

into two broad classes: database development and commercially available documentation software. In broad functional terms, database development software allows the user to build their own documentation application from the ground up, while commercially available documentation software gives the user a fully-functional documentation application out of the box. Some functional variability does exist within classes. Table 1 lists currently available PDA intervention documentation software.

Table 1. Examples of database development and commercially available PDA-based intervention documentation software applications

Name	Platform(s) Supported	Software Type
CliniTrend	Palm OS & Pocket PC	Commercial
dbNow	Palm OS	Development
HanDbase	Palm OS & Pocket PC	Development
HealthProLink	Palm OS	Commercial
Jfile	Palm OS	Development
MAPS	Palm OS	Commercial
MobileDB	Palm OS	Development
Pendragon	PalmOS	Development
Pharmaconomics	Palm OS	Commercial
PIDS	Palm OS	Commercial
Pocket Access	Pocket PC	Development

Note. Palm OS = Palm Operating System; Pocket PC = Microsoft Pocket PC Operating System; Commercial = Commercially available software; Development = Database development software.

PDA-Intervention Literature

Early reports of PDA use for intervention-related activities describe the use of Sharp Wizards as data collection tools to capture intervention information (Bluml & Enlow, 1993; Vecchione, 1997). While these devices are distinguished from the current generation of PDAs as described above, their appearance in the literature is important because it signifies the earliest published attempts at using this technology to capture intervention information. Both reports focus on the advantages of using a PDA documentation system compared to a manual, paper-based system. Personal digital assistant use was reported to be more convenient, to facilitate more complete documentation, and to allow for easier retrieval of intervention information for tracking and trending purposes.

More recently published reports describing PDA use to document interventions discuss differences between PDAs and paper forms as data collection tools. Specifically, Reilly et al. (2001) believed that PDAs offered advantages over paper forms because mandatory fields could be designed, requiring a pharmacist to enter the appropriate information before continuing with the documentation process. Personal digital assistants were preferred for their portability because they allowed interventions to be documented when and where they occurred. The study subjects also believed that PDA use increased the accuracy and efficiency of calculations. Reilly at al. identified user discomfort and fear of breaking the PDA as obstacles to PDA use. Hence, one-on-one training was provided.

Portability of PDAs was also identified as an advantage over paper forms in a report published by Lau et al. (2001) that described the use of a PDA to document

interventions in an intensive care unit. More efficient data entry and the ability to transfer information between devices were also identified as advantages. Conversely, numerous problems related to PDA-based intervention documentation were identified in an article published by Brody et al. (2001). This report described problems with PDA hardware and documentation software. Hardware malfunctions occurred in half of the PDAs used. Users believed there was duplication in the documentation software and that the software was no more efficient than paper forms. Users did indicate that they would consider using PDAs in the future to document interventions.

Clark and Klauck (2003) published a report comparing PDA-based documentation to paper-based documentation. Significantly more interventions per new medication order were documented using PDAs. Also, data collected using a PDA was consistently more complete. The pharmacists indicated via a survey that they preferred documenting interventions on a PDA compared to the use of a paper form.

Lynx et al. (2003) published a report in which PDAs were used to document interventions. Personal Digital Assistant-based intervention documentation was initiated in response to a request by the medical administrative staff of the institution to provide a list of interventions made by pharmacists to physicians as part of the medical staff's recredentialing procedures. Previously, interventions were documented in the notes section of the patient's profile in the pharmacy information system. This approach did not ensure completeness of documentation, and it did not allow reports to be generated to quantify interventions.

Many pharmacists initially resisted the use of PDAs to document interventions because it was faster to enter an intervention into the pharmacy information system.

However, once the pharmacists understood the necessity of using PDAs instead of the pharmacy information system, the problem was resolved. Subsequently, implementation of PDAs to document interventions resulted in more complete documentation and the ability to produce customized reports for the medical administrative staff (Lynx et al., 2003).

The literature regarding pharmacist use of PDAs to document interventions is still in its infancy. All reports identified for this research study consisted of descriptive accounts of implementing PDAs to document interventions. While some of these reports provide preliminary quantitative data on the change in number of interventions documented, no authors used a research methodology to identify what factors influenced pharmacist use of PDAs. Some authors did identify barriers to use, such as discomfort with the PDA, but these issues were discussed as secondary issues in the published reports. Barriers and facilitators to pharmacist use of PDAs to document interventions have not been the focus of any published literature.

Theories of Behavior

From a psychological standpoint, the present research is, at its core, addressing how to change people's behavior. More specifically, the research examines what influences people to behave in certain ways. The activity of interest is pharmacists' use of PDAs to document clinical interventions, and the Technology Acceptance Model serves as the model for exploring determinants of PDA use. The Technology Acceptance Model (TAM) has been used as a general, parsimonious method for explaining and predicting users' adoption of new technologies. In the face of increasing organizational

investment in information technologies, TAM was originally proposed as a means to identify why people accept or reject information technology. The ultimate goal of TAM research was to understand why people reject information technology to be able to target the reasons for rejection, and subsequently increase user acceptance (Davis et al., 1989). The theoretical foundation for TAM is the Theory of Reasoned Action (Ajzen & Fishbein, 1980). While this study focuses on the TAM line of research, it should be noted that TAM and TRA are not the only approaches for modifying behavior.

Indeed, numerous theories and models have been employed in psychotherapy as therapists strive to help their clients facilitate change in their lives. The Transtheoretical Model (TTM) of Change is one approach that has been the subject of much research targeted at changing people's health behaviors. It is discussed below, followed by a more thorough discussion of TAM research.

Transtheoretical Model

A goal of psychotherapy is to change behavior using psychological techniques such as counseling. In the 1970s and 1980s, the field of psychotherapy was being confronted with an overabundance of therapeutic approaches. Students and practitioners were faced with deciding between many approaches to therapy, all with apparently high success rates, many similarities, and obvious differences. As more therapeutic approaches were continually being introduced, the need for convergence across theories was identified as the most important trend (of the time) in psychotherapy. The Transtheoretical Model (TTM) of Change, first introduced in 1979, represented a

significant step towards convergence in psychotherapy (Prochaska, 1979; Prochaska & DiClemente, 1984).

The TTM was developed from a comparative analysis of 18 leading therapeutic approaches. It takes a comprehensive view of intentional behavioral change, focusing on how people change themselves and how change is facilitated through therapeutic relationships. The initial studies of TTM in the early 1980s involved comparing smokers who quit on their own to smokers participating in treatment programs (Prochaska, 1984). Since then, the TTM has been the subject of considerable research targeted at changing health behaviors, including weight control, alcohol abuse, exercise, condom use, use of sunscreens, and psychiatric disorders. Results from this line of research have indicated that the TTM is useful in modifying health behaviors (Center, 2002; Hudmon & Berger, 1995).

The TTM takes a step-wise approach to the intentional modification of behavior. Specifically, change is divided into five Stages of Change (Table 2) that capture the evolving nature of a decision to change and the implementation of that decision. Ten Processes of Change (Table 3) are the covert and overt activities that move people through the Stages. The Processes occur within individuals and are extremely important because they serve as the motivators for progression from precontemplation to maintenance (Center, 2002; Hudmon & Berger, 1995; Prochaska & DiClemente, 1984).

Table 2. The Transtheoretical Model's Stages of Change (Center, 2002)

Stage	Description
Precontemplation	The individual does not plan to take action (i.e., change their behavior) in the next six months.
Contemplation	The individual intends to change their behavior in the next six months.
Preparation	The individual plans to take action (i.e., change their behavior) in the next month.
Action	The individual has made overt changes in their lifestyle within the past six months.
Maintenance	The individual is working to prevent a relapse in the behavior and has maintained the target behavior for more than six months.

An important aspect of the TTM is the relationship between the Stages and Processes (Prochaska & DiClemente, 1984). An initial step in using the TTM to modify behavior is the identification of the individual's current stage of change, usually using a questionnaire or a discussion (Prochaska, 1984). Research has demonstrated that certain Processes are generally most productive in certain Stages. For example, the first five Processes in Table 3 are primarily used in the early Stages. The latter five Processes are most often used in later Stages (Center, 2002). Specific interventions based on the Processes of Change categories can then be identified and applied to help move individuals through the Stages (Prochaska, 1984; Prochaska & DiClemente, 1984).

Table 3. The Transtheoretical Model's Processes of Change (Center, 2002; Hudmon & Berger, 1995)

Process	Description
Consciousness Raising	The individual's knowledge about their particular problem increases.
Dramatic Relief	The individual becomes emotional due to information about their behavior.
Environmental Reevaluation	The individual examines the impact of their behavior on their social environment.
Social Liberation	The individual becomes aware of available social opportunities or alternatives due to changing the behavior.
Self Reevaluation	The individual evaluates their self-image in terms of their behavior.
Stimulus Control	The individual alters their environment to remove cues that promote the unhealthy behavior and introduce cues to promote the behavior change.
Helping Relationships	The individual becomes aware of support for the behavior change from others
Counter Conditioning	The individual identifies and implements healthy behavior(s) to replace the problem behavior(s).
Reinforcement Management	The individual rewards themselves, or others reward them, for modifying the behavior.
Self Liberation	The individual believes that they can change and are committed to the change based on their belief.

The practical application of the TTM to a research setting involves identifying an individual's Stage of Change and interventions for each Process based on the behavior in question. Interventions for health behaviors such as smoking have been identified and validated through extensive TTM research in this area (Prochaska & DiClemente, 1984). Use of the TTM in smoking cessation and other health behaviors supports its use as a reliable way to motivate change in health behaviors that are intentional (Center, 2002).

While the TTM does appear to be an attractive model for studying behavioral change, possibly even the use of PDAs, it was not chosen for the present research for several reasons. The goal of the present research was not to stage pharmacists' readiness to change, i.e., start using PDAs to document interventions. The goal was to test a model for its ability to explain pharmacists' intentions. Furthermore, the TTM has traditionally been applied to the study of health behaviors, which were not the focus of the present research. In contrast, the TAM is specifically designed for studying technology, which was the focus of the current research. Lastly, the researcher's familiarity with the TAM contributed to it being selected as the theoretical framework for the present research.

Theory of Reasoned Action

The Theory of Reasoned Action (TRA) is based on the general idea that humans are rational and that they make systematic use of the information available to them in making decisions. According to TRA, a decision to perform a behavior is ultimately determined after consideration of the implications of the behavior. Most behavior is under volitional control, and is not automatic. As such, behavior can be predicted once the determinants of the behavior are identified (Ajzen & Fishbein, 1980).

Ajzen and Fishbein's (1980) Theory of Reasoned Action states that a person's intention to perform a volitional behavior is the best indicator of the eventual performance of the behavior. In turn, intentions are a function of an individual's attitude towards the behavior and of a subjective norm component regarding behavior. Intentions are defined as a measure of the likelihood that a person will engage in a behavior. Attitude is defined as an individual's positive or negative feelings of performing the behavior. Subjective norm is defined as an individual's perceptions of social expectations from significant others that they perform the behavior. The Theory of Reasoned Action is depicted in Figure 2, which illustrates that attitudes and subjective norms are functions of an individual's beliefs.

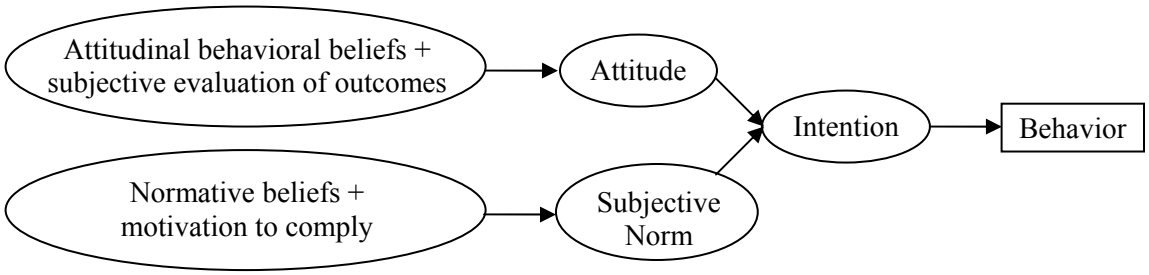


Figure 2. Ajzen and Fishbein's Theory of Reasoned Action

Attitude Formation

An individual's attitude toward a behavior is determined by a set of salient beliefs regarding that behavior. Specifically, attitudes are a function of an individual's positive or negative evaluation of the consequences of a behavior. An additional component of attitude is an individual's subjective evaluation of the outcomes of the behavior, or his/her strength of belief that the behavior will lead to the outcome (Ajzen & Fishbein, 1980).

The first step in determining an attitude is to elicit a modal set of salient beliefs from a representative sample of the target population. Salient beliefs in this context are the expected consequences of the behavior under study. Individuals then rate each expected consequence on, for example, a seven-point, good-bad scale (+3 to -3), indicating the individual's evaluation of the consequence of the behavior (Ajzen & Fishbein, 1980).

The second step in determining attitude is to assess how confident an individual is that the behavior does lead to each of the expected consequences. This is the individual's likelihood, or subjective probability, that performance of the behavior will result in the given consequence. A four-point scale with 0 (not at all certain) and 4 (extremely certain) has been suggested (Ajzen & Fishbein, 1980) and subsequently used (Ajzen & Fishbein, 1980; Davis et al., 1989).

Attitude, then, is predicted by multiplying an individual's evaluation of a behavior's consequence with the strength of the belief that performing the behavior will lead to the consequence. The summation of these products across all beliefs results in an attitude score. This expectancy-value model of attitude demonstrates that individuals with the same expected consequences of a behavior can have different attitudes toward the behavior. Alternatively, individuals with different expected consequences of a behavior can have similar attitudes toward the behavior (Ajzen & Fishbein, 1980).

Subjective Norm Formation

An individual's subjective norm toward a behavior is determined by a set of salient beliefs regarding that behavior. Specifically, subjective norms are a function of an

individual's normative beliefs, which are the individual's perception that most people who are important to him/her think he/she should or should not perform the behavior in question. An additional component of subjective norm is an individual's motivation to comply, which is an individual's willingness to comply with their perceptions of the beliefs of significant others about the behavior (Ajzen & Fishbein, 1980).

The first step in determining subjective norm is to identify a modal set of salient referents for the behavior in question from a representative sample of the target population. Next, individuals use a seven-point, should-should not scale (+3 to -3), to indicate their perception of each salient referent's opinion of whether or not the behavior should be performed. This is the normative belief component of subjective norm (Ajzen & Fishbein, 1980).

Individuals then identify their general motivation to comply with their perception of each referent's opinion. A four-point scale with 0 (not at all motivated) and 4 (strongly motivated) has been suggested. This is the motivation to comply component of subjective norm (Ajzen & Fishbein, 1980).

Subjective norm for a behavior is then predicted by multiplying an individual's normative beliefs with their motivation to comply with these beliefs. The summation of these products across all beliefs results in a subjective norm score for the behavior. The motivation to comply component of subjective norms is very important. Because motivation to comply attaches a weight to each normative belief, individuals with the same set of referents can have different subjective norms, and individuals with different referents can have the same subjective norms (Ajzen & Fishbein, 1980).

Relationship of Attitude and Subjective Norm to Intentions. Multiple regression is used to determine the relative weights of attitude and subjective norm on intentions (Ajzen & Fishbein, 1980).

Measuring Intentions

Figure 2 illustrates the relationship between intentions and behavior. Specifically, intention is the immediate determinant of a behavior, and when measured appropriately, is the single best indicator of behavior. Intentions are determined by asking the subjects their likelihood of engaging in the behavior. The situational context determines how behaviors are measured. Ajzen and Fishbein identified the specificity of the intention measure as a key component in increasing the correlation between intentions and behavior. Specifically, the intention should correspond to the behavior as closely as possible (1980).

Components of Intentions and Behavior. Intentions and behavior will correspond to the extent that the elements of action, target, context, and time are identical. Action is the behavior in question. The target is the object of the action. The context is the situational surroundings for the action. The time component indicates that the action should be defined in terms of when it will occur (Ajzen & Fishbein, 1980).

As an example, consider the intention question, "Will Tim and Claudia go to the Iron Bowl on Auburn University's campus with Matt on November 22, 2003?" Compare that question with, "Will Tim and Claudia go to the Iron Bowl?" The action is going and the target is the Iron Bowl. The context is Auburn University's campus, and the time

component indicates when, in this case November 22, 2003. Intention measures from the first question are expected to correlate more highly with the behavior than the second intention question due to the level of specificity of the first intention question. As a final point, the Theory of Reasoned Action also requires that the behavior in question is under volitional control (Ajzen & Fishbein, 1980).

Technology Acceptance Model

The Technology Acceptance Model (TAM) is an adaptation of the Theory of Reasoned Action, designed specifically for modeling the use of information systems. The overall goal of TAM is, "to provide an explanation of the determinants of computer acceptance that is general, 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" (Davis et al., 1989). The Technology Acceptance Model, as it was originally proposed, is depicted in Figure 3.

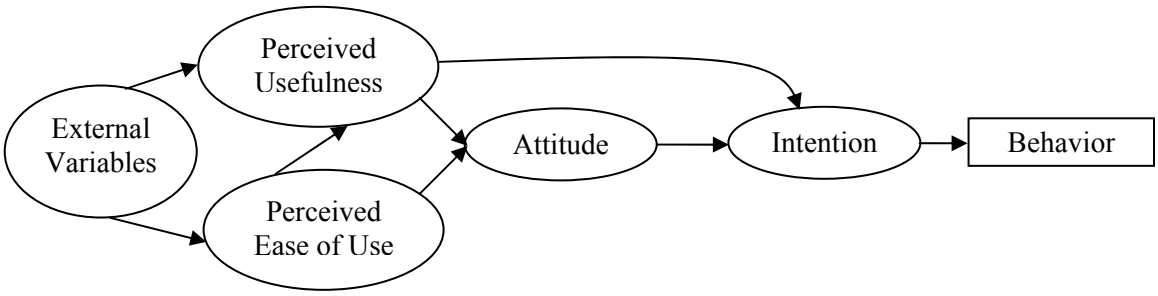


Figure 3. The Technology Acceptance Model

Similar to the TRA, the Technology Acceptance Model posits that intentions are the single best indicators of the eventual performance of a behavior. Unlike TRA,

intentions in TAM are determined by perceived usefulness, in addition to attitude. The Technology Acceptance Model also proposes that attitudes are determined by perceived usefulness and perceived ease of use. Finally, perceived usefulness and perceived ease of use are influenced by external variables. Both TAM and TRA research utilize regression (or similar analytical procedures) to determine the relative weights of each construct. In both approaches, external variables are believed to act on intentions through each model's constructs (Ajzen & Fishbein, 1980; Davis et al., 1989).

Technology Acceptance Model Components

The components of TAM are perceived usefulness, perceived ease of use, attitude, intentions, and behavior. Attitude, intentions, and behavior are defined as in the TRA. As in TRA, the correlation between intentions and behavior in TAM is dependent upon the level of specificity of the intention and behavior statements. If the intention statements contain all four elements of the behavior (action, target, context, and time), intentions are expected to be better predictors of behavior. Unlike TRA, TAM proposes that attitudes are determined by perceptions of usefulness and ease of use (Davis et al., 1989).

Perceived Usefulness. Davis et al. (1989) defined perceived usefulness as, "the prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context". Based on previous research demonstrating links between use and variables similar to usefulness such as

perceptions of performance impact, relevance, and importance, TAM suggests that a relationship will exist between perceptions of usefulness and attitude.

TAM proposes that a direct link exists between perceived usefulness and intentions to use over and above attitude. The Technology Acceptance Model is intended to explain individuals' usage of information systems within organizational contexts. The direct link between perceived usefulness and intentions is based on the belief that individuals, within their job settings, will form intentions toward behaviors over and above the influence of attitudes because enhanced performance is seen as instrumental to achieving various rewards that are extrinsic to the content of the work, such as pay raises or promotions. Intentions toward such behaviors are largely based on cognitive processes to improve performance and supersede general feelings (i.e., attitudes) about the behavior (Davis et al., 1989).

Intention-based behaviors that are higher in one's goal hierarchy (beyond pay raises or promotions) activate more of an affective component in the intention-behavior decision process. Davis et al. (1989) suggest in TAM that the attitude component will not fully capture the influence of perceived usefulness on intentions due to this difference in activation of cognitive versus affective processes. Accordingly, a direct relationship is proposed to exist between perceived usefulness and intentions, as well as an indirect effect of perceived usefulness on intentions through attitude.

Perceived Ease of Use. Davis et al. (1989) defined perceived ease of use as, "the degree to which the prospective user expects the target system to be free of effort". All things being equal, higher ease of use perceptions should result in stronger intentions to

use. Self-efficacy and instrumentality are the two proposed mechanisms through which ease of use is proposed to act. Self-efficacy, or an individual's belief that they can carry out the steps of behavior necessary to operate the system, is theorized to be one of the major factors underlying intrinsic motivation. The direct relationship between ease of use and attitude is meant to capture this intrinsically motivating aspect of ease of use.

Ease of use improvements may also be instrumental in nature. These instrumental improvements can contribute to increased performance, where for example, effort saved due to increased ease of use can be redeployed elsewhere to allow a person to accomplish more work for the same amount of effort. Accordingly, to the extent that instrumental improvements in ease of use can contribute to improved performance, there is an expected direct relationship between ease of use and usefulness (Davis et al., 1989).

Comparing TAM and TRA

Davis et al. (1989) conducted a study to compare the Technology Acceptance Model and the Theory of Reasoned Action in an information technology context. Their research questions were:

- How well do intentions predict usage?
- How well do TRA and TAM explain intentions to use a system?
- Do attitudes mediate the effect of beliefs on intentions?

The study sample included 107 full-time MBA students in the first of four semesters of the MBA program at the University of Michigan. A word processing software application, WriteOne, was selected as the test application. According to the requirements for TRA and TAM, the use of WriteOne was voluntary.

A questionnaire was created to measure the TRA and TAM variables. The subjective norm and attitudinal components of TRA were operationalized according to Ajzen and Fishbein's guidelines (discussed above). For TAM, perceived usefulness and perceived ease of use were each operationalized using the responses to 4-item scales. Intentions were measured in both behavioral models using responses to two items. According to the authors, the four components of behavior specification that are necessary to ensure correspondence between intentions and behavior are present in the statements, as recommended by Ajzen and Fishbein (1980) above. Use is the behavior, the target is WriteOne, the context is the MBA program, and the time component is implied by the length of the course. All constructs except attitude were measured with 7-point scales having likely-unlikely endpoints. Table 4 presents these constructs with their measurement items (Davis, 1993; Davis et al., 1989).

Table 4. Items for perceived usefulness, perceived ease of use, and intentions

Construct	Construct Operationlization (Questions)
Perceived Usefulness	1. Using WriteOne would improve my performance in the MBA program.
	2. Using WriteOne in the MBA program would increase my productivity.
	3. Using WriteOne would enhance my effectiveness in the MBA program.
	4. I would find WriteOne useful in the MBA program.
Perceived Ease of Use	1. Learning to operate WriteOne would be easy for me.
	2. I would find it easy to get WriteOne to do what I want it to do.
	3. It would be easy for me to become skillful at using WriteOne.
	4. I would find WriteOne easy to use.
Intentions	1. Assuming that I had access to WriteOne, I intend to use it.
	2. Given that I had access to WriteOne, I predict that I would use it.

Attitude was measured using four, 7-point semantic differential scales. Although the scales were not explicitly spelled out by Davis et al. (1989), subsequent publications by Davis (1993) indicated that the following scales were used: "My using WriteOne in the MBA program is" Harmful – Beneficial, Good – Bad, Rewarding – Punishing, and Unpleasant – Pleasant.

WriteOne use was measured by responses to two questions regarding the frequency of current WriteOne usage. One question used a 7-point scale with frequent and infrequent as the endpoints. The second question used a "check the box" approach in which participants indicated their current level of use: not at all, less than once a week, about once a week, 2 or 3 times a week, 4 to 6 times a week, about once a day, or more than once a day (Davis et al., 1989).

Data were gathered at two points during the semester. At the beginning of the semester, the students were given a one-hour introduction to WriteOne. At the end of this introduction (T1), a questionnaire was administered to measure the TRA and TAM variables. The second questionnaire was administered 14 weeks later at the end of the semester (T2). It contained the same TRA and TAM measures as well as a 2-item measure of self-reported usage (Davis et al., 1989).

The data were analyzed using linear regression. Reliabilities for the measurement scales all exceeded .7 and are presented in Table 5. Intentions correlated with use .35 ($p < .001$) at T1 and .64 ($p < .001$) at T2. The TRA explained 32% of the variance in intentions at T1 and 26% at T2 ($p < .001$ at both points). The TAM explained 47% of the variance in intentions at T1 and 51% at T2 ($p < .001$ at both points). Table 6 depicts the

individual determinants of intentions for both models. Table 7 depicts the variance in attitude explained by each model at both measurement points (Davis et al., 1989).

Table 5. Reliabilities for the TAM and TRA measurement scales

Construct	T1 (after 1-hr introduction)	T2 (after a 14 week semester)
Intentions	.84	.9
Attitude	.85	.82
Perceived Usefulness	.95	.92
Perceived Ease of Use	.91	.9
Use		.79

Table 6. Standardized regression weights for individual determinants of intentions

Model	Construct	T1 (after 1-hr introduction)	T2 (after a 14 week semester)
TRA			
	Attitude	.55**	.48**
	Subjective Norm	.07	.1
TAM			
	Perceived Usefulness	.48**	.61**
	Perceived Ease of Use	.2*	-.11
	Attitude	.27**	.16

*$p < .01$
**$p < .001$

Table 7. Explained variance (percentage) in attitude by each model

Model	T1 (after 1-hr introduction)	T2 (after a 14 week semester)
TRA	79*	30**
TAM	37**	36**

*$p < .01$
**$p < .001$

The results indicate that, in this context, intentions and use are highly correlated, especially after some level of experience with the behavior. Both models explained a significant portion of the variance in intentions at both measurement points. However, the Technology Acceptance Model consistently explained more variance in intentions. Looking specifically at TAM, perceived usefulness was a strong determinant of intentions at both measurement points. The significant effect of attitude on intentions appears to have attenuated over the 14-week semester. Finally, both TRA and TAM explained a significant amount of variance in attitude at both measurement points (Davis et al., 1989).

The authors noted the apparent significant direct effect perceived ease of use had on intentions over perceived usefulness and attitude at T1 ($\beta = .2$, $p < .01$). They also noted that, at T2, this direct effect of ease of use becomes indirect through usefulness. They further noted that the attitude-intentions link becomes nonsignificant. Factor analysis was conducted to further examine these relationships. From the factor analysis, the authors concluded that (Davis et al., 1989):

- Attitude only partially mediates the effects of perceived usefulness and perceived ease of use on intentions.
- Perceived usefulness is a strong determinant of intentions at T1 and T2.
- Perceived ease of use had a significant effect on intentions at T1 only.
    - This effect became a significant indirect effect through perceived usefulness at T2.

Using the factor analysis data, a new model was developed. This model is depicted in Figure 4.

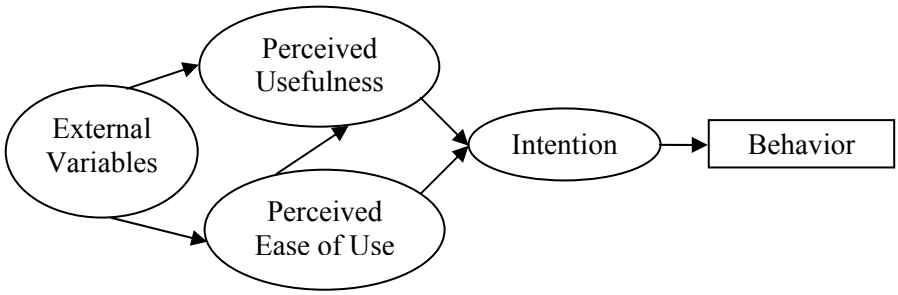


Figure 4. The Revised Technology Acceptance Model

From the results of the research study, the authors reached three conclusions: (1) people's computer use can be predicted reasonably well from their intentions; (2) perceived usefulness is a major determinant of people's intentions to use computers; and (3) perceived ease of use is a significant secondary determinant of people's intentions to use computers (Davis et al., 1989).

Validation and Comparison Studies

Due to their low success rates, information systems implementations have been the subject of extensive research since the 1970s. The goal of this line of research has been to identify the factors that can facilitate information systems integration into the business world. Accordingly, Davis et al. published the Technology Acceptance Model (TAM) in 1989 as a method for identifying the mediating role of perceived usefulness and perceived ease of use between external variables and intentions to use a system (Legris, Ingham, & Collerette, 2003). Since Davis et al.'s publication, TAM has been the subject of extensive research in the information systems field. This line of research sought to validate TAM in other settings with different users as well as to compare TAM to other models of behavior.

Validation Studies

The Technology Acceptance Model is intended to be a general method for explaining technology use across a wide range of technologies and end user populations (Davis et al., 1989). The ability to identify factors that can influence the success of a new information system is critical as research indicates that less than 30% of all management information systems projects are completed on time and within budget, and nearly one-third of all projects are cancelled (Legris et al., 2003). As such, numerous studies have been published that have sought to apply TAM to different user groups and different technologies.

One month after Davis et al.'s 1989 publication, Davis (1989) published additional research results that further supported the role of perceived usefulness and

perceived ease of use in explaining intentions and actual system usage. In two studies, one using 112 professionals and managers and the other using 40 part-time MBA students, Davis developed and refined the perceived usefulness and perceived ease of use scales in the context of software use (Davis, 1989).

Study one was conducted to assess the reliability and validity of 10-item perceived usefulness and perceived ease of use scales. The study used 112 subjects and two software packages. The dependent variable was actual software use as indicated by self-report. Both scales exhibited acceptable reliability and construct validity. For both software packages, the effect of perceived usefulness on usage was significant ($p < .001$), and the effect of perceived ease of use was nonsignificant. Davis concluded that ease of use perceptions affect usage through their influence on perceived usefulness (Davis, 1989).

Study two was conducted to evaluate 6-item perceived usefulness and perceived ease of use scales derived from study one. The study used 40 part-time MBA students and two software packages. The dependent variable was intended software use as indicated by self-report. Both scales exhibited acceptable reliability and construct validity. For both software packages, the effect of perceived usefulness on usage was significant ($p < .001$), and the effect of perceived ease of use was nonsignificant. As in study one, Davis concluded that ease of use perceptions affect usage through their influence on perceived usefulness (Davis, 1989).

Davis reached several conclusions from these studies. First, he concluded that the perceived usefulness and perceived ease of use scales exhibited excellent psychometric properties. Second, Davis concluded that a strong relationship existed between perceived

usefulness and usage and that this relationship was consistently stronger than the relationship between perceived ease of use and usage. Finally, Davis concluded that perceived ease of use may actually be an antecedent of perceived usefulness (Davis, 1989). Attitude towards use was not included in these studies.

Further support for TAM has been provided in other published research. These research studies vary in their application of TAM as set forth by Davis et al. (1989), but this line of research has resulted in empirical support for TAM in explaining intentions and/or usage. A study of 118 business professionals supported the reliability and validity of the perceived usefulness and perceived ease of use scales. The results of this study also supported the relationship between perceived usefulness and usage (Adams & Nelson, 1992). Another TAM study using two software packages and a sample of 123 undergraduate business students found that the perceived usefulness and perceived ease of use scales exhibited a high degree of test/retest reliability (Hendrickson, Massey, & Cronan, 1993).

The Technology Acceptance Model has been the subject of extensive information systems research since its introduction in 1989. The majority of published research varies at least slightly from the original TAM publications. Often, these differences are due to omission or inclusion of attitude and/or intentions in the model. Additionally, some researchers, including Davis (1989) use different scales for perceived usefulness and perceived ease of use. Despite these differences, TAM has consistently been found to explain approximately 40% of users' intentions to use an information system (Venkatesh & Davis, 2000). A final note is that the large majority of published TAM research has used business students or business professionals as the study sample.

Comparison Studies

As discussed above, Davis et al. (1989) compared TAM to the Theory of Reasoned Action (TRA) in a group of MBA students using a word processing program, Write One. The Technology Acceptance Model consistently explained more variance in intentions than TRA. The results of this research study led to the development of TAM depicted in Figure 4 above.

Other researchers have compared TAM to the Theory of Planned Behavior (TPB). Like TAM, the Theory of Planned Behavior is an intention-based model founded in the Theory of Reasoned Action (Figure 2, above). The Theory of Planned Behavior goes beyond TRA in that it adds an additional determinant of intentions, perceived behavioral control (PBC), which is a person's perception of, "the presence or absence of requisite resources and opportunities" to perform the behavior in question (Mathieson, 1991; S. Taylor & Todd, 1995). The Theory of Planned Behavior is depicted in Figure 5.

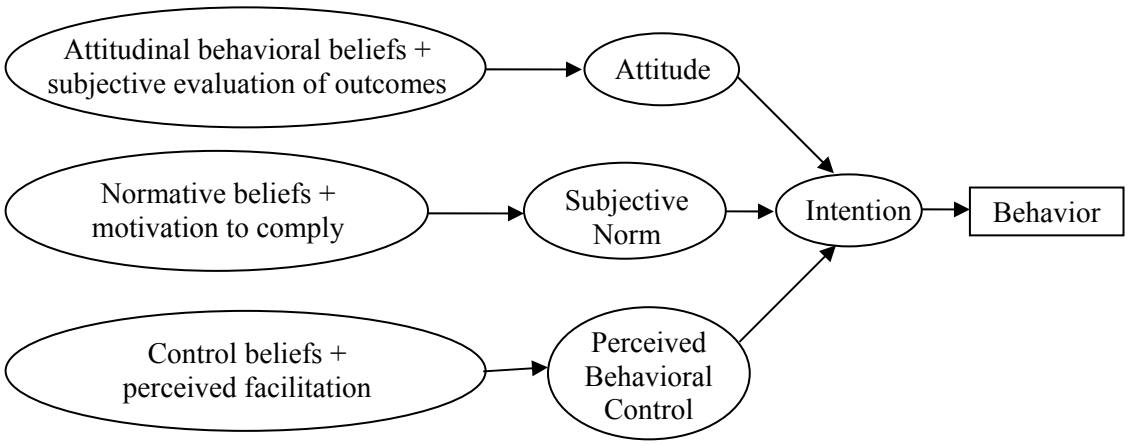


Figure 5. Ajzen's Theory of Planned Behavior (TPB)

The Theory of Planned Behavior extends TRA in that it accounts for situations where individuals do not have complete control over their behavior. The perceived behavioral control component is analogous to the expectancy-value model of attitude discussed above, where control beliefs are perceptions about the presence (or absence) of factors that facilitate or impede behavior performance. Perceived facilitation is the power attributed to each factor, by the individual, to facilitate or impede the behavior. As with attitudes and subjective norm in TRA, the relative importance of perceived behavioral control on intentions is determined using multiple regression (or similar analytical procedures) following salient belief elicitation and weighting (Ajzen, 2002).

Study One. The first TAM – TPB study to be discussed compared the two models on three attributes: their ability to explain intentions, the amount of valuable information provided by the models, and how difficult the models were to apply. The sample was comprised of junior and senior level college students in an introductory management course who were given the opportunity to choose between two methods (a spreadsheet or a calculator) of completing an assignment (Mathieson, 1991).

In this particular study, TAM explained 69% of the variance in usage intentions, while TPB explained 60% of the variance in usage intentions. The authors concluded that both models were very effective in explaining usage intentions, noting that both models explained more than the original TAM research and that the difference in explained usage intentions was not enough to warrant selection of one model over the other (Mathieson, 1991).

Regarding the second comparison point, the authors concluded that the salient belief elicitation process in TPB lends to a more specific explanation of factors influencing usage intentions than the general perceived usefulness and perceived ease of use constructs found in TAM. Finally, the authors concluded that the standard instruments used in TAM research make this model easier and less costly to use than TPB (Mathieson, 1991).

The authors' overall conclusion was that the research situation should dictate which model to select. The Technology Acceptance Model can be used to quickly gather general information, while TPB is more labor-intensive to apply, but it provides more specific information (Mathieson, 1991).

Study Two. Unlike the study discussed above, the second study comparing TAM to TPB measured both usage intentions and actual usage of the target technology. The sample was comprised of 786 undergraduate and graduate business students who were considered to be potential users of a business school computing resource center (CRC). Use of the CRC was voluntary (S. Taylor & Todd, 1995).

In this particular study, TAM explained 52% of the variance in usage intentions and 34% of actual usage. The Theory of Planned Behavior explained 57% of the variance in usage intentions and 34% of actual usage. The authors concluded that the two models were comparable in their ability to explain actual usage behavior. The authors went on to say that TPB provided an improvement in explanatory power when considering intentions (S. Taylor & Todd, 1995).

The authors of this study reached similar conclusions to Mathieson (1991). That is, the research setting and objectives should be considered when selecting a model of behavior. If the goal is simply to predict intentions, then a more parsimonious model, i.e. TAM, is probably a better choice. However, if the goal is to gain a fuller understanding of the determinants of intentions, a more complex model, i.e. TPB, may be preferred. Researchers must make these decisions on a case-by-case basis (S. Taylor & Todd, 1995).

In summary, TAM has performed as good as or better than competing models of behavior in explaining intentions to use technology. An advantage of TAM is that it uses a parsimonious model with standard items to gather intention information. A weakness of TAM is that the generalness of the model's constructs limits its utility in identifying specific factors influencing intentions and usage.

Development of TAM2

An identified strength of TAM has been its applicability in a variety of situations due to the use of two constructs that are measured the same way regardless of the situation. However, this has also been identified as a weakness of TAM because the use of general constructs such as perceived usefulness and perceived ease of use does not provide specific diagnostic information that can be used to create interventions to influence usage of the target system. Accordingly, numerous researchers have suggested the need for further exploring and identifying the external factors that act on perceived usefulness and perceived ease of use (Agarwal & Prasad, 1999; Patrick Y. K. Chau, 2001; Magid Igbaria et al., 1995; M. Igbaria et al., 1997; Venkatesh, 2000; Venkatesh &

Davis, 1996; Venkatesh & Davis, 2000; Venkatesh & Morris, 2000). A revised TAM (TAM2) was developed from this line of research in an attempt to identify the antecedents of perceived usefulness. Additionally, separate research has also attempted to identify the antecedents of perceived ease of use. This research is discussed immediately below, and TAM2 research follows.

Antecedents of Perceived Ease of Use. To test their hypotheses that computer self-efficacy (CSE) and objective usability were important antecedents of perceived ease of use, Venkatesh and Davis (1996) conducted two experiments using four different software applications on a sample of 68 college students. Computer self-efficacy was defined as an individual's belief that he/she has the ability to complete a task using a computer. It was measured using a previously published scale by (Compeau & Higgins, 1995). Objective usability was defined as an objective measurement of a technology's usability characteristics, such as its efficiency and ease of learning. In this case, the objective usability measurement was a keystroke method comparing the amount of time experts needed to complete a task with the amount of time novice users required to complete the same task using the same technology. Objective usability is computed as a ratio with higher ratios indicating increased ease of use (Venkatesh, 2000; Venkatesh & Davis, 1996). The studies described below use the model depicted in Figure 6.

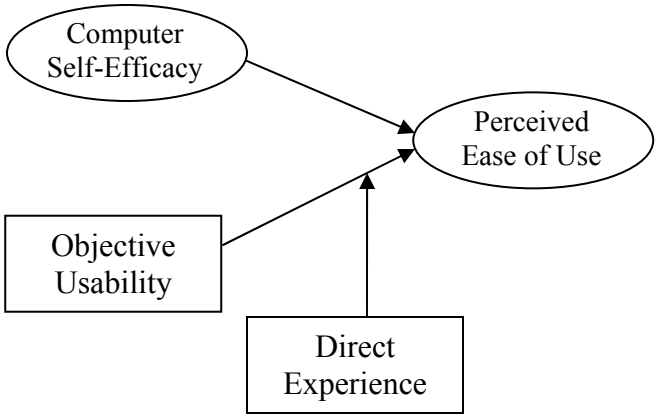


Figure 6. Antecedents of perceived ease of use

Two studies were conducted, each using two different software applications. The primary purpose of the first study was to determine if computer self-efficacy had an effect on ease of use perceptions for specific applications. Subjects were 36 undergraduate college students. The subjects were given the study questionnaire twice: once immediately after reading a one-page handout describing the two study software applications, and a second time five weeks later in which subjects spent a total of 15 hours using the study software. This study design used hands-on experience to determine if computer self-efficacy continued to be a determinant of ease of use perceptions after extensive direct experience with the software applications (Venkatesh & Davis, 1996).

Analysis indicated that the scales for computer self-efficacy and perceived ease of use were reliable and exhibited acceptable construct validity. Objective usability was determined using the keystroke method as described above. Results indicated that computer self-efficacy was a significant determinant ($\beta = .57$, $p < .001$) of ease of use perceptions prior to direct experience and that objective usability (scaled to a score of -3 to +3) was not a significant determinant ($\beta = .04$) of ease of use perceptions prior to

direct experience (R^2 Ease of Use = .33). After direct experience, computer self-efficacy continued to be a significant determinant ($\beta = .51$, $p < .001$) of ease of use perceptions, and the relationship between objective usability and ease of use perceptions reached significance ($\beta = .25$, $p < .001$; R^2 Ease of Use = .32) (Venkatesh & Davis, 1996).

A test for moderation effects of direct experience was conducted by combining the questionnaire responses from before and after direct experience. Results indicated that the effect of objective usability on perceived ease of use was moderated by direct experience (computer self-efficacy: $\beta = .48$, $p < .001$; direct experience: $\beta = .23$, $p < .001$; R^2 Ease of Use = .29) (Venkatesh & Davis, 1996).

The primary purpose of the second study was to determine if the observed significant relationship between computer self-efficacy and perceived ease of use in the first study was a result of individuals' lack of procedural knowledge of the software. In other words, were general feelings of computer self-efficacy a determinant of ease of use perceptions early on because individuals lacked sufficient system-specific knowledge? To address this question, the non-interactive stimulus from study one (i.e., a one-page handout) became a 3-hour lecture in study two that also included an extensive handout (Venkatesh & Davis, 1996).

Subjects were 32 part-time MBA students who all held positions in industry. The subjects were given the study questionnaire twice: once immediately after the 3-hour lecture regarding the two study software applications, and a second time five weeks later in which subjects spent a total of 15 hours using the study software. This study design also used hands-on experience to determine if computer self-efficacy continued to be a

determinant of ease of use perceptions after extensive direct experience with the software applications (Venkatesh & Davis, 1996).

Analysis indicated that the scales for computer self-efficacy and perceived ease of use were reliable and exhibited good construct validity. Objective usability was determined using the keystroke method as described above. Results indicated that computer self-efficacy was a significant determinant ($\beta = .49$, $p < .001$) of ease of use perceptions prior to direct experience and that objective usability (scaled to a score of -3 to +3) was not a significant determinant ($\beta = .00$) of ease of use perceptions prior to direct experience (R^2 Ease of Use = .24). After direct experience, computer self-efficacy continued to be a significant determinant ($\beta = .56$, $p < .001$) of ease of use perceptions, and the relationship between objective usability and ease of use perceptions reached significance ($\beta = .23$, $p < .001$; R^2 Ease of Use = .37) (Venkatesh & Davis, 1996).

A test for moderation effects of direct experience was conducted by combining the questionnaire responses from before and after direct experience. Results indicated that the effect of objective usability on perceived ease of use was moderated by direct experience (computer self-efficacy: $\beta = .47$, $p < .001$; direct experience: $\beta = .28$, $p < .001$; R^2 Ease of Use = .30) (Venkatesh & Davis, 1996).

In summary, the results of these two studies indicate that, prior to experience, users base their ease of use perceptions on general computer self-efficacy, regardless of the extent of information provided about the specific software. After direct experience with the software, computer self-efficacy continues to be a significant determinant of ease of use perceptions. However, the relationship between objective usability and ease

of use perceptions became significant through moderation effects only after direct experience.

Additional work has identified other antecedents of perceived ease of use, adding four more constructs (perceptions of external control, computer anxiety, computer playfulness, and perceived enjoyment) to explain twice as much (i.e., 60%) of the variance in perceived ease of use. This research measured the relationship of perceived ease of use and six constructs at three points in time: immediately after initial training (T1), one month after use (T2), and three months after use (T3). At T1, four constructs had significant relationships with perceived ease of use and explained 40% of the variance in perceived ease of use (computer self-efficacy, perceptions of external control, computer anxiety, and computer playfulness) (Venkatesh, 2000). Compared with the findings discussed above (Venkatesh & Davis, 1996), the addition of perceptions of external control, computer anxiety, and computer playfulness explained approximately 10% more of the variance in perceived ease of use at T1 by the use of more than 21 additional questionnaire items (Venkatesh, 2000).

Antecedents of Perceived Usefulness (TAM2). In numerous TAM publications, perceived usefulness has consistently been a stronger determinant of usage intentions than perceived ease of use (Legris et al., 2003; Venkatesh & Davis, 2000). The standardized regression coefficient of the relationship between perceived usefulness and usage intentions is usually around .6. With TAM research usually explaining about 40% of the variance in usage intentions, the antecedents of perceived usefulness are very

important in identifying the determinants of end-users' intentions to use a new technology (Venkatesh & Davis, 2000).

Accordingly, Venkatesh and Davis (2000) developed and tested a theoretical extension of TAM to identify the key determinants of perceived usefulness. This extension of TAM is known as the Technology Acceptance Model 2 (TAM2). Six additional constructs were added to TAM. Three were drawn from social influence processes: subjective norm, voluntariness, and image. The other three constructs were drawn from cognitive instrumental processes: job relevance, output quality, and result demonstrability. The definitions for each construct are presented in Table 8 and the model is depicted in Figure 7 (Venkatesh & Davis, 2000).

Table 8. Definitions of additional constructs found in the proposed TAM2

Constructs	Definition
Social Influence Processes	
Subjective Norm	a person's perception that people who are important to them think they should or should not perform the behavior question
Voluntariness	the extent to which potential adopters perceive the adoption decision to be non-mandatory
Image	the degree to which use of an innovation is perceived to enhance one's status in one's social system
Cognitive Instrumental Processes	
Job Relevance	an individual's perception regarding the degree to which the target system is applicable to their job
Output Quality	an individual's consideration of how well a technology performs tasks over and above considerations of the technology's job relevance
Result Demonstrability	The tangibility of the results of using the innovation (i.e., technology)

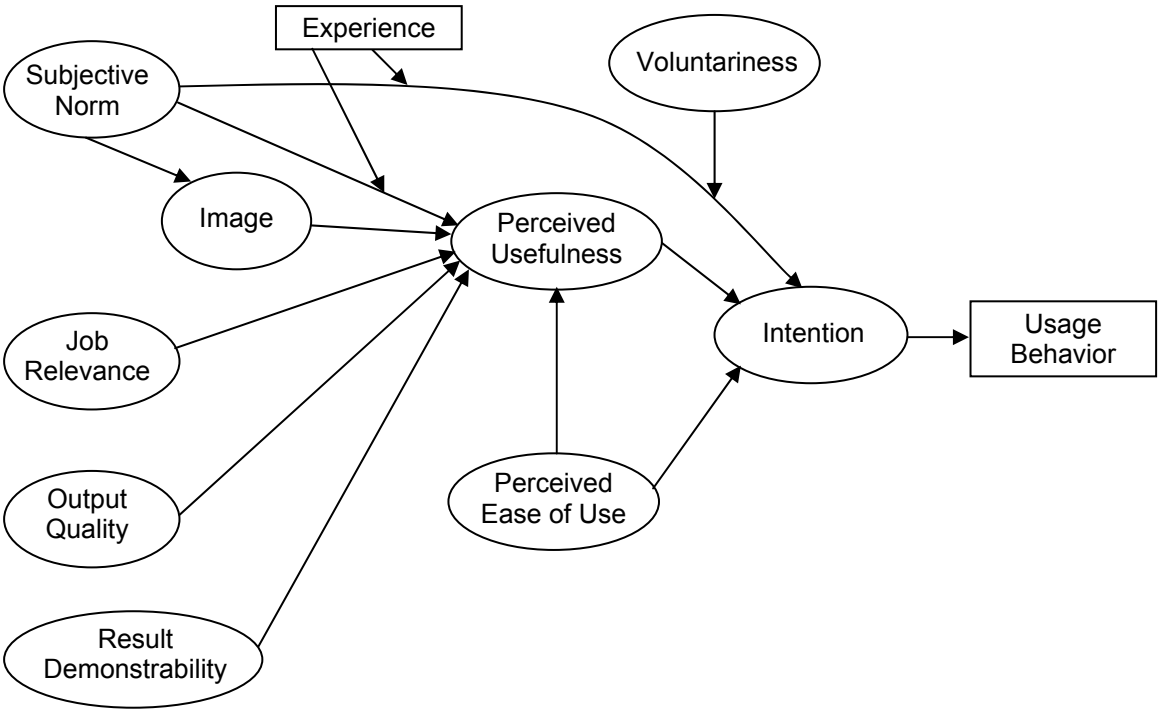


Figure 7. The proposed TAM2

The social influence processes are expected to exhibit relationships with intentions and perceived usefulness because of the social forces that act on an individual as they face the opportunity to use a new system. Venkatesh and Davis (2000) hypothesized that subjective norm would have a positive, direct affect on intentions when system use was perceived to be mandatory. The underlying process of this relationship is termed compliance, and it occurs when an individual perceives that an important referent wants the individual to perform a behavior, and the referent has the ability to reward the behavior or punish nonbehavior. In non-mandatory situations, Venkatesh and Davis hypothesized that subjective norm would have no significant direct effect on intentions. They further hypothesized that voluntariness would moderate the effects of subjective norm on intentions.

Internalization is the process whereby an individual incorporates an important referent's belief into their own belief structure. Through this process, subjective norm was hypothesized to have a significant indirect effect on intentions through perceived usefulness. Subjective norm was also hypothesized to positively influence perceived usefulness through image and a process called identification. The basis for identification is referent power, where heightened standing within a work group (i.e., improved image) is the basis for power and influence within the work setting. According to subjective norm, image can be enhanced by performing (or not performing) behaviors that important referents think should be (or not be) performed. Therefore, subjective norm is expected to positively influence image, and image is hypothesized to positively influence perceived usefulness (Venkatesh & Davis, 2000).

Experience with the target system was also hypothesized to play a role in intentions because, prior to system use, individuals are expected to base their intentions on the opinions of others (subjective norm) because they have no direct knowledge of the system. However, as individuals gain more experience with the system, the direct effect of subjective norm on intentions and perceived usefulness is expected to decrease due to users' development of their own opinions about the system (Venkatesh & Davis, 2000).

The cognitive instrumental processes are an individual's way of comparing what a system can do with what they want it to do. In other words, can the system help me achieve my job-related goals? Job relevance perceptions are hypothesized to positively influence perceived usefulness. The output quality of a system is related to job relevance, but it goes beyond simply assessing a system's compatibility of achieving a goal. Output quality assesses how well a system achieves the goal. The hypothesized relationship

states that output quality perceptions are positively related to perceived usefulness. Finally, individuals will have higher usefulness perceptions for systems that are able to concretely demonstrate their ability to achieve the work-related goal. Result demonstrability is expected to positively influence perceived usefulness (Venkatesh & Davis, 2000).

The Technology Acceptance Model 2 was tested on four different systems in four different organizations with a sample of 156 business professionals. Use of two systems was mandatory, and use of the other two systems was voluntary. A questionnaire containing items for the six constructs in Table 8 plus items for perceived usefulness, perceived ease of use, and usage intentions was administered three times: once immediately after training (T1), one month after training (T2), and three months after training (T3). At T2, T3, and T4 (5 months after training) self-reported usage was measured. Self-reported usage was the only measurement at T4. Intentions measured at T1 were used to predict usage at T2, intentions measured at T2 were used to predict usage at T3, and intentions measured at T3 were used to predict usage at T4.

Psychometric analysis indicated that the items exhibited acceptable reliability and construct validity. The voluntariness measures indicated that the subjects' perceptions of system use were consistent with reality across companies and time periods. Using a 7-point scale (where 1 = mandatory and 7 = voluntary), the mean voluntariness ratings for the subjects in the voluntary group were 6.2 – 6.7 with standard deviations ranging from 0.4 – 0.6. The mean voluntariness ratings for the subjects in the mandatory group were 1.2 – 1.5 with standard deviations ranging from 0.3 – 0.6. Table 9 presents the effects of

perceived usefulness, perceived ease of use, and subjective norm on intentions (Venkatesh & Davis, 2000).

Table 9. Regression results of perceived usefulness, perceived ease of use, and subjective norm on intentions

		Voluntary Settings				Mandatory Settings			
Time		Study 1, n=38		Study 2, n=39		Study 3, n=43		Study 4, n=36	
	Construct	R^2	β	R^2	β	R^2	β	R^2	β
T1		.39		.37		.44		.52	
	PU		.58***		.51***		.48***		.52***
	PEU		.18*		.27**		.13*		.18*
	SN		.11		.1		.31**		.28**
T2		.44		.34		.47		42	
	PU		.55***		.5***		.54***		.44***
	PEU		.17*		.21*		.15*		.11*
	SN		.06		.08		.26**		.24**
T3		.42		.42		0.39		.39	
	PU		.63***		.64***		.57***		.5***
	PEOU		.14*		.16*		.17*		.22*
	SN		.11		.02		.1		.08

Note. PU = Perceived Usefulness; PEOU = Perceived Ease of Use; SN = Subjective Norm
*$p < .05$
**$p < .01$
***$p < .001$

The results indicate that perceived usefulness was a strong primary determinant of intentions and perceived ease of use was a strong secondary determinant of intentions across all four studies and all three times of measurement. In mandatory situations,

subjective norm was a strong determinant of intentions. This relationship weakened over time as users developed their own opinions about the system by T3. In voluntary situations, subjective norm had no direct effect on intentions over and above perceived usefulness and perceived ease of use. Across all four studies and all three time periods, TAM2 explained between 34% and 52% of the variance in intentions. This was consistent with previous TAM research. Also, the correlations between intentions and self-reported usage behavior were in the range of .44 – .57 for all four studies at all measurement points (Venkatesh & Davis, 2000).

In examining the antecedents of perceived usefulness, an interaction was discovered between output quality and job relevance. The interaction was significant across all four studies and all measurement points at $p < .01$ or $p < .001$. This interaction was not expected, but the authors concluded that usefulness perceptions are based upon job relevance and output quality, but users place greater emphasis on output quality in proportion to job relevance. The interaction term was included in the model in estimating the relationship between perceived usefulness and its antecedents, Table 10 (Venkatesh & Davis, 2000).

Table 10. Regression results of the antecedents of perceived usefulness

		Voluntary Settings				Mandatory Settings			
Time		Study 1, n=38		Study 2, n=39		Study 3, n=43		Study 4, n=36	
	Construct	R^2	β	R^2	β	R^2	β	R^2	B
T1		.6		.6		.51		.5	
	SN		.5***		.47***		.38***		.31**
	I		.19*		.21*		.31**		.36***
	JR x OQ		.4***		.38***		.32**		.33**
	RD		.27**		.3**		.3**		.22**
	PEOU		.23**		.24**		.23**		.2**
T2		.48		.55		.51		.46	
	SN		.39***		.34***		.27**		.21*
	I		.22*		.18*		.28**		.27**
	JR x OQ		.32**		.38***		.3**		.33***
	RD		.24*		.26**		.3**		.3**
	PEOU		.26**		.35***		.38***		.29**
T3		.44		.4		.43		.4	
	SN		.2*		.08		.16*		.1
	I		.17*		.19*		.27**		.25**
	JR x OQ		.38***		.36***		.36***		.32**
	RD		.34**		.26**		.21°		.3**
	PEOU		.28**		.34***		.35***		.35***

Note. SN = Subjective Norm, I = Image; JR = Job Relevance; OQ = Output Quality; RD = Result Demonstrability; PEOU = Perceived Ease of Use
*$p < .05$
**$p < .01$
***$p < .001$

Table 10 illustrates that TAM2 explained between 40% and 60% of the variance in perceived usefulness. Subjective norm (internalization) exhibited a strong relationship to perceived usefulness at T1 and T2. The strength of this relationship weakened over time to T3 for all studies. Both within and across studies, the relationships between the other antecedents of perceived usefulness remained significant and strong. The data for all studies and time points were then pooled to estimate the summary model depicted in Figure 8 (Venkatesh & Davis, 2000).

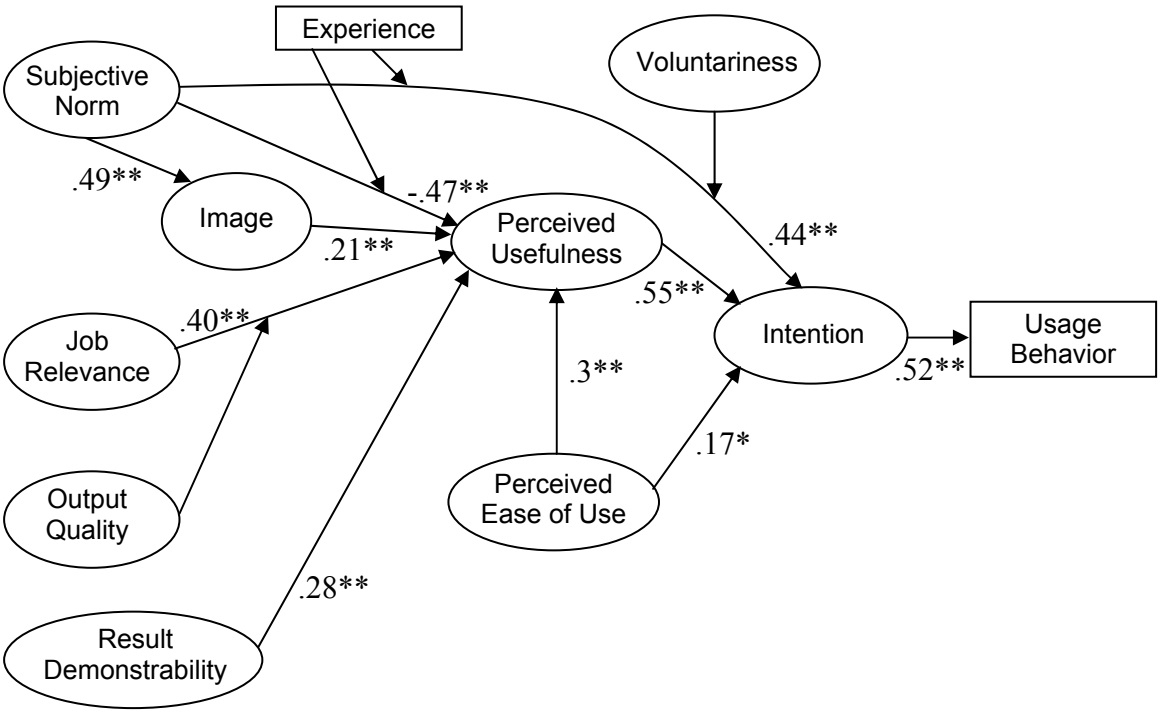


Figure 8. Summary regression model of pooled data for TAM2
R^2 for PU = .51: R^2 for Intentions to Use = .49
*$p < .01$
**$p < .001$

The authors concluded that TAM2 was strongly supported across all four studies and three measurement points. From the summary model, the authors concluded that the original TAM received further support. The subjective norm-intentions relationship was moderated by experience and voluntariness, and the subjective norm-perceived usefulness relationship (internalization) was moderated by experience. The effect of job relevance and output quality was interactive (Venkatesh & Davis, 2000).

Furthermore, TAM2 demonstrated that subjective norm influences intentions over and above perceived usefulness in mandatory usage situations. Subjective norm also exhibited indirect effects on intentions through perceived usefulness (internalization). This effect decreased as users gained experience with the system. Subjective norm exhibited an indirect effect on perceived usefulness through image (identification). This effect was not influenced by experience. The cognitive instrumental processes (job relevance, output quality, and result demonstrability) exhibited significant relationships with perceived usefulness across all four studies and measurement points with an interactive effect between job relevance and output quality. Among many suggestions for future research, the authors suggested combining TAM2 with research that has identified the antecedents of perceived ease of use (Venkatesh & Davis, 2000).

TAM Applications in Healthcare

The Technology Acceptance Model (TAM) has been applied to numerous research settings and a variety of information systems, consistently explaining about 40% of the variance in intentions to use. Perceived usefulness has consistently been a stronger predictor of usage intentions than perceived ease of use. The majority of TAM research

has used software as the usage intention target (Legris et al., 2003; Venkatesh & Davis, 2000). The vast majority of TAM research has used students or business professionals as study subjects. Very little published research has applied TAM or TAM2 to healthcare clinicians. The section below addresses applications of TAM to healthcare settings and clinicians.

TAM Applied to Healthcare

A study of 400 physicians (24% response rate) in Hong Kong applied TAM (Figure 3 minus the Behavior construct) and the Theory of Planned Behavior (TPB, Figure 5) to intentions to use telemedicine technology. Telemedicine technology was operationalized as "the use of information technology to support healthcare services and activities via electronic transmission of information or expertise among geographically dispersed parties … in order to improve service effectiveness and resource allocation/utilization efficiency". The authors did not indicate if efforts were made to further define the target element of intentions, as recommended by Ajzen and Fishbein (1980). Actual usage was not measured (Patrick Y. K. Chau & Hu, 2002).

Using a structural equation modeling approach to compare TAM with TPB, both models achieved adequate fit to the data. The Technology Acceptance Model explained more variance in intentions than TPB, 42% for TAM and 37% for TPB. The TAM paths from perceived usefulness to attitude and to intentions were both significant ($\beta = .43$ for attitude and $\beta = .44$ for intentions, $p < .001$ for both). The attitude – intentions path in both models was significant ($\beta = .36$ for TAM and $\beta = .57$ for TPB, $p < .001$ for both).

Perceived ease of use was not significantly related to perceived usefulness or attitude (Patrick Y. K. Chau & Hu, 2002).

Chau and Hu (2002) concluded that TAM appeared to be a better model than the TPB for explaining physicians' intentions to use telemedicine technology. Additionally, perceived usefulness was the strongest determinant in intentions to use. The authors speculated that the nonsignificant relationships of perceived ease of use with perceived usefulness and attitude may be due to physicians having a higher intellect than previous subjects in TAM research. They also speculated that physicians may place less importance on ease of use perceptions due to the presence of a strong support staff for assisting with technology usage (Patrick Y. K. Chau & Hu, 2002). This research also demonstrated that attitude may play an important role in intention formation for a subset of healthcare professionals. This relationship has not been consistently studied in TAM research because Davis et al. (1989) dropped attitude from the original TAM.

Modified TAM Applied to Healthcare

A study of current PDA users tested a modified TAM's ability to explain PDA use by a diverse group of healthcare professionals. Based on previously published research, the authors added four constructs to the original TAM. These constructs and their definitions can be found in Table 11. Previously published definitions for perceived usefulness and perceived ease of use were employed in this study. The dependent variable was actual PDA use, indicated through a 5-item self-report scale. The other constructs were operationalized using previously published instruments. A point to note is that perceived usefulness and perceived ease of use were operationalized using 7-item

scales whereas previously published reports of TAM have used four, six, and 10-item scales (Liang, Xue, & Byrd, 2003).

Table 11. Additional constructs added to TAM by Liang et al. (2003)

Construct	Definition
Compatibility	degree to which an IT is perceived as being consistent with the existing values, needs, and past experiences of potential adopters
Job Relevance	a user's perception regarding the degree to which the target IT is applicable to his or her job
Support	degree to which necessary resources and supports are provided to users upon request
Personal Innovativeness	willingness of an individual to try out any new information technology

Using a direct mail and a Web-based survey, the authors collected 173 usable responses out of a possible 1222 (14% response rate). Seventy-seven respondents came from the mail survey. Sixty-seven percent of all respondents were pharmacists, physicians, or nurses. No indication was given to actual numbers from each category. The other 33% of respondents were approximately equally distributed between top management (12%), management (11%), and other (10%) categories (Liang et al., 2003).

All scales reached acceptable reliability and validity. Partial Least Squares (PLS) was used to test the model depicted in Figure 9. All paths indicate hypothesized positive relationships. For example, the path between Compatibility and Perceived Usefulness indicates that Compatibility will have a positive relationship with Perceived Usefulness. The study results indicated that all hypothesized relationships were positive and significant. The authors did not indicate if path weights were reported as standardized or unstandardized values. Compatibility, job relevance, and perceived ease of use explained 72% of the variance in perceived usefulness. Support and personal innovativeness explained 39% of the variance in perceived ease of use. Perceived usefulness, perceived ease of use, and personal innovativeness explained 62% of the variance in usage behavior (Liang et al., 2003).

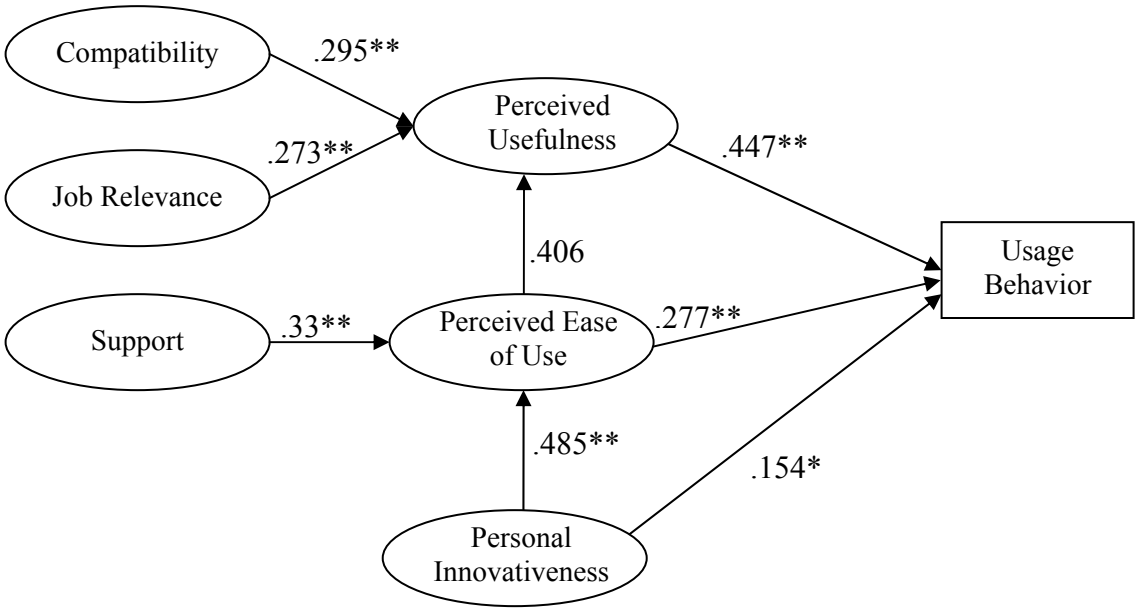


Figure 9. Results of testing a modified TAM

Liang et al. (2003) concluded that, as seen in previous TAM research, perceived usefulness had the strongest relationship with use. They also noted that their model explained more variance in usage than seen in most previous TAM research. They went on further to conclude that their study extended TAM by adding additional constructs to the model and by applying a modified TAM to a new technology and user group (Liang et al., 2003).

The external validity of this study, as it pertains to the present research, is questionable because Liang et al. did not indicate the exact make-up of their sample. The data indicate that clinicians made up the majority of their sample, but the number of each type of clinician was not provided. Furthermore, Liang et al.'s study focused on general PDA use, whereas the current study focuses on PDA use to perform a specific task. These are believed to be important differences between these two studies.

TAM2 Applied to Healthcare

A study of 89 (43% response rate) pediatricians in Hawaii applied a modified TAM2 to the use of the Internet in healthcare. Using the TAM2 model depicted in Figure 7, the authors dropped two constructs: Experience and Voluntariness. Experience was dropped because, according to the authors, it is intended for use when subjects have worked with the system. Voluntariness was dropped because Internet use in their study was not mandated, nor was its use expected to be mandatory in the future (Chismar & Wiley-Patton, 2002).

The model explained 62% of the variance in perceived usefulness and 54% of the variance in usage intentions. Standardized regression coefficients were only reported for

paths observed to reach significance ($p < .05$). The specific, significant relationships were Job Relevance – Perceived Usefulness (β = .58), Result Demonstrability – Perceived Usefulness (β = .336), and Perceived Usefulness – Intentions (β = .666) (Chismar & Wiley-Patton, 2002).

The nonsignificant relationship between perceived ease of use and perceived usefulness is consistent with Chau and Hu's findings (2002). The authors suggested that this may be due to the overall competency level of physicians or to physicians' willingness to form usage intentions even if they perceive the technology not to be easy to use. The nonsignificance of the social influence processes (social norm, image, and voluntariness) suggests, according to the authors, that social pressures may not play a role in physicians' usage intentions (Chismar & Wiley-Patton, 2002). It should be pointed out that voluntariness was dropped from the model even though the voluntariness construct in TAM2 assesses individuals' perceptions of voluntary use, not the actual state of reality (Venkatesh & Davis, 2000). Overall, the authors concluded that a modified TAM2 would be useful in explaining physicians' intentions toward Internet use (Chismar & Wiley-Patton, 2002).

Summary of Literature Review

In 1990, Hepler and Strand proposed pharmaceutical care as the new practice philosophy for pharmacy. Over the years, the profession formally adopted pharmaceutical care as its mission. A primary component of pharmaceutical care is documentation of clinical activities that pharmacists perform. Documentation is a method for taking responsibility for the care pharmacists provide. Personal digital

assistants (PDAs) have been identified as potential tools that can improve the process of documenting the interventions that pharmacists perform. In a similar time frame, research in the information systems literature identified the Technology Acceptance Model as an effective and efficient model in explaining individuals' intentions to use new technologies.

The Technology Acceptance Model (TAM) has been favorably tested against competing models of behavior. Based on two constructs, perceived usefulness and perceived ease of use, TAM has been applied to many organizational contexts, technologies, and users, usually explaining about 40% of usage intentions. A criticism of TAM research has been that its use of these two general constructs limits its diagnostic ability in identifying specific potential target areas for increasing usage intentions, and ultimately, usage behavior.

Subsequent research has been conducted to identify the antecedents of perceived usefulness and perceived ease of use. While exploring the relationships between these two constructs and their antecedents, this research provided further support for TAM's explanatory ability. The result of this research was to develop the Technology Acceptance Model 2 (TAM2), which adds the antecedents of perceived usefulness to TAM. Very little research has been published applying TAM or TAM2 to healthcare users. Of the research that has been published, results are consistent with TAM and somewhat consistent with TAM2.

An important distinction to make is that TAM2 does not include the antecedents of perceived ease of use, and a thorough literature review identified no published research that has combined the antecedents of perceived ease of use with TAM2 in any user group

or information system. Although modified versions of TAM and TAM2 have been sparingly used in healthcare, no published research has applied TAM or TAM2 to pharmacists' use of personal digital assistants to documenting interventions.

III. THEORETICAL FRAMEWORK

This study was designed to assess the ability of a modified Technology Acceptance Model 2 (TAM2) to explain pharmacists' intentions to use personal digital assistants (PDAs) to document interventions in acute care and ambulatory care facilities. Specifically, the relationships between perceived usefulness, attitude, subjective norm, and intentions to use PDAs to document clinical interventions comprise the theoretical framework of this study.

Although little published research has described the impact of PDA use on intervention documentation, PDAs have been identified as tools that can potentially improve pharmacists' ability to document clinical interventions (Brody et al., 2001; Clark & Klauck, 2003; Lau et al., 2001; Lynx et al., 2003; Reilly et al., 2001; Vecchione, 1997). Intervention documentation is one way that pharmacists can demonstrate responsibility for their patient care activities. This is a core component of pharmaceutical care. Accordingly, if pharmacists truly desire to practice pharmaceutical care, then they must take responsibility for their actions (Hepler & Strand, 1990; Penna, 1990). Intervention documentation is one way to accept this responsibility.

This study is important because it was the first attempt to identify factors that may influence pharmacists' use of PDAs to document interventions. By identifying these factors, it is hoped that methods can be developed to influence PDA use among

pharmacists. Research needs to be conducted regarding the impact of PDA use on the quantity and quality of documented interventions.

The Technology Acceptance Model (Davis et al., 1989) is derived from the Theory of Reasoned Action (Ajzen & Fishbein, 1980). Previous applications of TAM to non-healthcare groups have demonstrated that TAM explains from 25% to 69% of users' intentions to use new technologies in their specific work settings (Davis & Venkatesh, 1996; Mathieson, 1991; Subramanian, 1994; Szajna, 1996; S. Taylor & Todd, 2001; Venkatesh & Davis, 1996). This wide range in explained variance is possibly due to differences in use of the original instrument in subsequent applications, to the use of small sample sizes, and to the use of the instrument in existing users of the technology under study (Doll, Hendrickson, & Deng, 1998).

In attempts to increase the utility of TAM, subsequent research has separately identified the antecedents of perceived usefulness and perceived ease of use. The Technology Acceptance Model 2 (TAM2) adds antecedents for perceived usefulness: subjective norm, image, job relevance, output quality, result demonstrability, and voluntariness (Venkatesh & Davis, 2000). Other published research has identified antecedents for perceived ease of use: computer self-efficacy and objective usability (Venkatesh, 2000; Venkatesh & Davis, 1996). Experience with the target technology has also been identified as a contributing factor to the development of usage intentions (Venkatesh & Davis, 2000). The present research built upon these published findings to develop and apply a modified TAM2 to a new user group and a new target technology.

Several modifications were made to TAM2 to produce the model under study (Figure 10). The experience construct was dropped because subjects who had previous

experience with PDAs to document interventions were not included in the study sample. The computer self-efficacy antecedent for perceived ease of use (Figure 6) was added to TAM2 for this study (Venkatesh & Davis, 1996). The objective usability construct was dropped because this research setting did not allow for direct user experience with the target technology in the context of the training session.

The attitude construct was added to the modified TAM2. Attitude was dropped from the original TAM research because it did not appear to be a significant determinant of usage intentions (Davis et al., 1989). However, results from subsequent research have suggested that attitude may be an important determinant of usage intentions for healthcare professionals (Patrick Y. K. Chau & Hu, 2002). Furthermore, according to Davis et al. (1989), attitude may play a more important role in intention formation in situations where individuals are motivated by goals that are higher in one's goal hierarchy than goals such as a pay raise. In summary, this research utilized a modified TAM2 instrument in a sample of users with no prior experience using PDAs to document clinical interventions. Five research questions and 23 hypotheses guided the research. The specific research questions and alternate hypotheses can be found below the following figure.

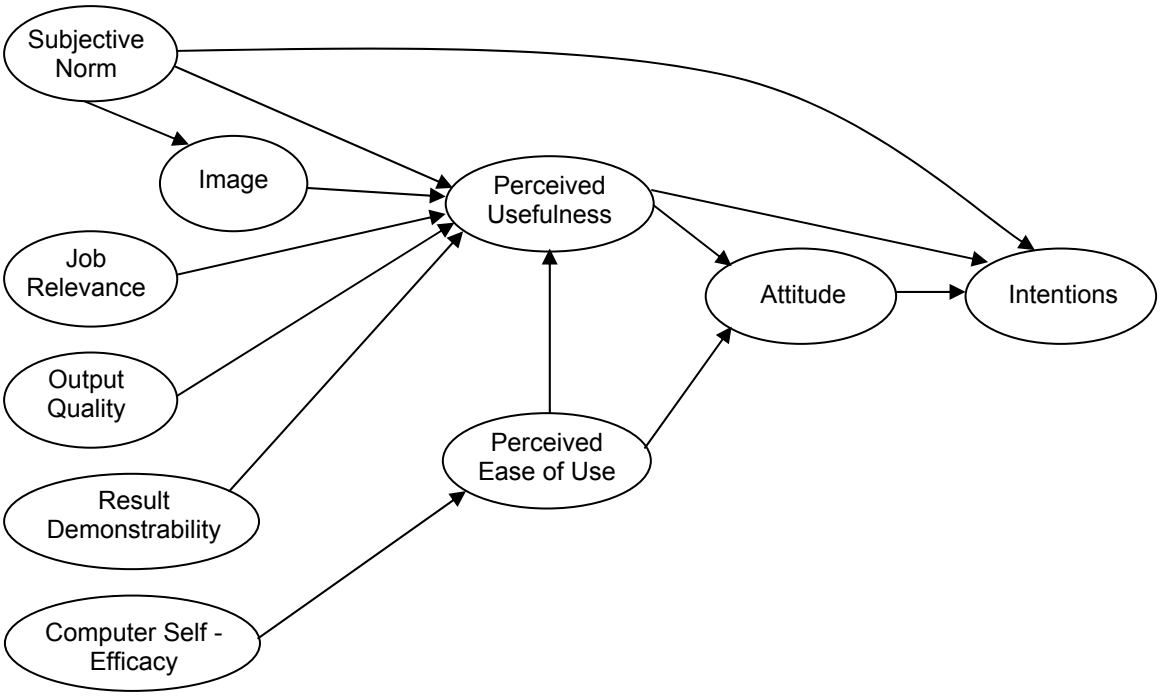


Figure 10. Modified Technology Acceptance Model 2

Research Questions and Alternate Hypotheses

1. How well does a modified TAM2 explain pharmacists' intentions to use PDAs to document interventions in acute care and ambulatory care settings?

   H_{1a} – A relationship will exist between perceived usefulness and intentions.

   H_{1b} – A relationship will exist between subjective norm and intentions.

   H_{1c} – A relationship will exist between perceived ease of use and perceived usefulness.

   H_{1d} – A relationship will exist between perceived ease of use and attitude.

H_{1e} – A relationship will exist between perceived usefulness and attitude.

H_{1f} – A relationship will exist between attitude and intentions.

H_{1g} – Together, perceived usefulness, attitude, and subjective norm will account for $\geq$40% of the variance in intentions.

2. How well do previously identified antecedents of perceived usefulness and perceived ease of use explain their respective constructs?

H_{2a} – A relationship will exist between computer self-efficacy and perceived ease of use.

H_{2b} – Computer self-efficacy will account for $\geq$30% of the variance in perceived ease of use.

H_{2c} – A relationship will exist between result demonstrability and perceived usefulness.

H_{2d} – A relationship will exist between output quality and perceived usefulness.

H_{2e} – A relationship will exist between job relevance and perceived usefulness.

H_{2f} – A relationship will exist between image and perceived usefulness.

H_{2g} – A relationship will exist between subjective norm and image.

H_{2h} – A relationship will exist between subjective norm and perceived usefulness.

H_{2i} – Together, subjective norm, image, job relevance, output quality, result demonstrability, and perceived ease of use will account for $\geq$50% of the variance in perceived usefulness.

3. Is there a difference in the variance in pharmacists' intentions to use PDAs to document interventions explained by a modified TAM2 before and after a 3-hour training session on PDA use?

   H_3 – There will be a difference in the explained variance in pharmacists' intentions to use PDAs before and after a 3-hour training session on PDA use.

4. Will pharmacists' intentions to use PDAs to document interventions change after a 3-hour training session on PDA use to document interventions?

   H_4 – There will be a difference in pharmacists' intentions to use PDAs to document interventions after a 3-hour training session on PDA use.

5. Are there differences in pharmacists' intentions to use PDAs to document interventions based on demographic characteristics?

   H_{5a} – A relationship will exist between position and intentions.

H_{5b} – A relationship will exist between pharmacy department size and intentions.

H_{5c} – A relationship will exist between gender and intentions.

H_{5d} – A relationship will exist between age and intentions.

H_{5e} – A relationship will exist between experience and intentions.

Operational Definitions

Pharmacists – For the purpose of this study, individuals who attend a presentation on the use of PDAs to document interventions, are specially trained and licensed in the appropriate use of medications for use in the provision of care to humans, and indicate that they are currently practicing pharmacy in the United States; pre-presentation questionnaire item 44 (Appendix A)

Acute Care Setting – For the purpose of this study, institutions (such as hospitals) where people receive short term medical care as inpatients; pre-presentation questionnaire item 46 (Appendix A)

Ambulatory Care Setting – For the purpose of this study, institutions (such as clinics) where people receive short term medical care as outpatients; pre-presentation questionnaire item 46 (Appendix A)

Personal Digital Assistant (PDA) – For the purpose of this study, handheld, pen-based computing device with information storage/retrieval capabilities,

including the ability to access clinical information and document clinical activities such as interventions and as defined in the workshop on the top of the pre-presentation and post-presentation questionnaires

Intervention – For the purpose of this study, any solicited or unsolicited information provided by a pharmacist to another healthcare professional, or to a patient, in regards to the optimal use of medications for patient care

Perceived Ease of Use – the degree to which the pharmacist expects the PDA to be free of effort; as measured by the answers to four items on a 7-point Likert-type scale from Strongly Disagree to Strongly Agree; pre-presentation questionnaire items 4, 7, 10, and 25 (Appendix A); post-presentation questionnaire items 15, 22, 25, and 30 (Appendix B)

Perceived Usefulness – the pharmacist's subjective probability that using a PDA to document interventions will increase his or her job performance within their organization; as measured by the answers to four items on a 7-point Likert-type scale from Strongly Disagree to Strongly Agree; pre-presentation questionnaire items 14, 17, 20, and 22 (Appendix A); post-presentation questionnaire items 23, 26, 29, and 36 (Appendix B)

Intentions – the likelihood that the pharmacist will engage in PDA use to document interventions; as measured by the answers to two items on a 7-

point Likert-type scale from Strongly Disagree to Strongly Agree; pre-presentation questionnaire items 1 and 2 (Appendix A); post-presentation questionnaire items 11 and 12 (Appendix B)

Attitude – the pharmacist's positive or negative feelings about performing the target behavior; as measured by the answer to item 27 on the pre-presentation questionnaire (Appendix A) and item 37 on the post-presentation questionnaire (Appendix B)

Subjective Norm – the pharmacist's perception that people who are important to them think they should or should not use a PDA to document interventions; as measured by the answers to two items on a 7-point Likert-type scale from Strongly Disagree to Strongly Agree; pre-presentation questionnaire items 19 and 26 (Appendix A); post-presentation questionnaire items 20 and 27 (Appendix B)

Image – the pharmacist's perception of the degree to which use of a PDA to document interventions will enhance their status in their social system; as measured by the answers to three items on a 7-point Likert-type scale from Strongly Disagree to Strongly Agree; pre-presentation questionnaire items 8, 13, and 23 (Appendix A); post-presentation questionnaire items 19, 28, and 33 (Appendix B)

Job Relevance – the pharmacist's perception regarding the degree to which a PDA documentation tool is applicable to their job; as measured by the answers to two items on a 7-point Likert-type scale from Strongly Disagree to Strongly Agree; pre-presentation questionnaire items 9 and 12 (Appendix A); post-presentation questionnaire items 17 and 31 (Appendix B)

Output Quality – the pharmacist's consideration of how well a PDA performs documentation tasks over and above considerations of the PDA's job relevance; as measured by the answers to two items on a 7-point Likert-type scale from Strongly Disagree to Strongly Agree; pre-presentation questionnaire items 6 and 15 (Appendix A); post-presentation questionnaire items 13 and 21 (Appendix B)

Result Demonstrability – the pharmacist's perceptions of the tangibility of the results of using a PDA documentation tool; as measured by the answers to four items on a 7-point Likert-type scale from Strongly Disagree to Strongly Agree; pre-presentation questionnaire items 3, 11, 18, and 24 (Appendix A); post-presentation questionnaire items 16, 18, 32, and 35 (Appendix B)

Computer Self-Efficacy – the pharmacist's belief that they have the ability to complete a task using a computer; as measured by the answers to 10 items (28 – 37) on the pre-presentation questionnaire (Appendix A); 1 – 10 on

the post-presentation questionnaire (Appendix B) using the instrument developed by Compeau and Higgins (1995)

Position – employment category within the pharmacist's place of work that defines the responsibilities of individuals within each category; as measured by the answer to item 47 on the pre-presentation questionnaire (Appendix A)

Department size – the number of full-time equivalent (FTE) pharmacist positions within the pharmacist's place of work; as measured by the answer to item 48 on the pre-presentation questionnaire (Appendix A)

Experience – the number of months the pharmacist has practiced pharmacy in the US; as measured by the answer to item 45 on the pre-presentation questionnaire (Appendix A)

IV. METHODS

The research used a pretest-posttest design to analyze the ability of a modified Technology Acceptance Model 2 (TAM2) to explain acute care and ambulatory care pharmacists' intentions to use personal digital assistants to document patient care interventions. All data were gathered in conjunction with a presentation entitled, "Turning the Corner: PDA-based Clinical Documentation" on December 7, 2003, by the principal investigator and Bill G. Felkey, M.S., at the American Society of Health-System Pharmacists Midyear Clinical Meeting in New Orleans, Louisiana, USA. The presentation was sponsored by an unrestricted grant from Roche Laboratories.

Study Design and Sample

Study Design

This study utilized a pretest-posttest study design to test the hypothesized relationships. The intervention was a 3-hour presentation at a national pharmacy meeting with over 650 individuals expected to attend. The presentation focused on pharmacists' use of personal digital assistants (PDAs) to document interventions in acute care and ambulatory care settings.

Due to the use of human subjects in this study, a protocol was submitted to the Auburn University Institutional Review Board (IRB) on the use of Human Subjects in

Research. The protocol was granted approval under exempt status because data were collected anonymously. A copy of the approval letter can be found in Appendix C.

The IRB required that an information letter be provided to all participants. The information letter can be found in Appendix D. This letter informed the participants of the objective of the research project, the investigators conducting the research, why the participant was selected for participation, any risks/benefits the participant may anticipate from participation, and who to contact with questions now and in the future.

Sample

A convenience sample of the attendees of the presentation, "Turning the Corner: PDA-based Clinical Documentation", delivered at the American Society of Health-System Pharmacists (ASHP) Midyear Clinical Meeting (MCM) in New Orleans, LA, on December 7, 2003, comprised the study subjects. The attendees were given the opportunity to volunteer to participate in the research study. The presentation was delivered by the principal investigator and Bill G. Felkey, M.S. An estimated 600 – 700 individuals were expected to participate in this session based on attendance figures for similar presentations given during the previous two MCMs by the same presenters.

The MCM is an annually held national meeting. It focuses on the needs of health system pharmacists and pharmacy technicians. Practitioners from a variety of pharmacy practice areas attend the MCM. These areas include academia, industry, hospitals of all sizes, managed care, inpatient and outpatient clinics, and home care as well. The overall goal of the meeting is to provide attendees with "information and instruction on a variety

of topics to enable pharmacy practitioners to provide quality pharmaceutical care" (ASHP, 2003).

On average, the MCM is attended by 20,000 individuals. It is the largest gathering of pharmacists in the world (S. Cantrell, personal communication, November 10, 2003). As described above, these individuals represent many facets of pharmacy practice. For the purposes of this research study, individuals who attended the presentation had to meet the following inclusion criteria to be selected as subjects for the study: willingly volunteer to participate by submitting both questionnaires; currently practice pharmacy in an acute care or ambulatory care setting as indicated on the pre-presentation questionnaire; must not currently use or have used a PDA to document interventions as indicated on the pre-presentation questionnaire; and must complete and submit both the pre-presentation and post-presentation questionnaires.

Personal digital assistant use for purposes other than documenting interventions did not exclude pharmacists from participation. Personal digital assistants have a variety of uses, such as maintaining a contact and task list, calendar and scheduling, clinical reference storage, and email and Internet surfing capabilities. These activities were not the focus of this investigation, which was directed exclusively at explaining pharmacists' intentions to use PDAs to document interventions. Data were recorded regarding participant use of PDAs for nonintervention activities, but this did not exclude a pharmacist from participating in the investigation.

Sample Size

Structural equation modeling (SEM) was the primary data analytic procedure. Various recommendations have been made for the minimum sample size required for SEM (Gefen, Straub, & Boudreau, 2000; Klem, 2002; Thompson, 2002). The most conservative of these requirements suggests that the ratio of number of people (n) to observed or measured variables (v) should be at least 10:1, or as much as 20:1. Others have recommended that the sample size should be at least 100, if not 200. Still others have suggested that the sample size be the minimum of either 100 – 200 people or an n:v ratio of at least 10:1 or 15:1 (Hair, Anderson, Tatham, & Black, 1998; Thompson, 2002).

This research utilized 33 measured variables. Using an n:v ratio of 10:1, a minimum sample size of 333 people would be required. A sample of 333 (out of a possible 650) was not considered to be realistically achievable. However, using the recommendation of the minimum of 100 – 200 people, or an n:v ratio of at least 10:1, a sample size of 150 was required. This sample of 150 subjects was expected to be obtained.

Procedures

Questionnaire Development

Two questionnaires were developed to gather the research data. These are the pre-presentation and post-presentation questionnaires found in Appendices A and B, respectively. The pre-presentation questionnaire consisted of a total of 50 items: comprised of 27 TAM items (including the attitude construct) and TAM2 items (antecedents of perceived usefulness) (Davis et al., 1989; Venkatesh & Davis, 1996;

Venkatesh & Davis, 2000). Ten computer self-efficacy items (perceived ease of use antecedent) were also included in the study questionnaires (Compeau & Higgins, 1995). Thirteen demographic items were included in the pre-presentation questionnaire, items 38 – 50.

The post-presentation questionnaire was made up of 37 items. It included the same 27 TAM and TAM2 items, as well as the same 10 computer self-efficacy items. The post-presentation questionnaire did not contain demographic items as described above.

The pre-presentation questionnaire was arbitrarily selected to be printed on canary-colored paper along with the information letter found in Appendix D. The Information letter was printed on Auburn University letterhead. The Information letter was stapled on top of the pre-presentation questionnaire. The post-presentation questionnaire was arbitrarily selected to be printed on light green-colored paper. A questionnaire set, composed of the Information letter, the pre-presentation questionnaire, the post-presentation questionnaire, and single piece of paper were printed for each potential attendee for the presentation. The single piece of paper had a sentence in large font (56 point) instructing the attendees to be sure to return to the presentation after the planned break for the awarding of door prizes (Appendix E).

The purpose of this piece of paper was to conceal the post-presentation questionnaire, which was placed under the piece of paper in the folder. The sentence, "Door prizes will be awarded after the break" was printed on the concealing piece of paper and was centered in a text box on the top half of the page. The pre- and post-presentation questionnaires were intended to gather information regarding pharmacists'

perceptions of PDAs both before and after the presentation. The concealing piece of paper was used to hide the post-presentation questionnaire so the attendees would not answer until they were asked to do so, after the presentation was given.

The mail merge feature of Microsoft Word was used to assign sequential numbers, beginning with 0001 to the questionnaires. Each questionnaire set had the same number on all pages (except the concealing sheet and the information letter) in order to match the pre- and post-presentation questionnaires after data collection, as well as to match any pages that may have separated during questionnaire administration and/or collection.

Technology Acceptance Model 2

Items 1 – 27 on the pre-presentation questionnaire were used to gather technology acceptance data. The items for this section of the questionnaire were developed using procedures previously described (Davis, 1989; Davis et al., 1989; Venkatesh & Davis, 1996; Venkatesh & Davis, 2000). The modified TAM2 constructs to be analyzed were subjective norm (two items), image (three items), job relevance (two items), output quality (two items), result demonstrability (four items), computer self-efficacy (ten items), perceived usefulness (four items), perceived ease of use (four items), attitude (one item), and intention to use (two items).

The subjects responded to the subjective norm, image, job relevance, output quality, result demonstrability, perceived usefulness, perceived ease of use, and intention to use items using a 1 – 7 Likert-type scale, where 1 indicated Strongly Disagree and 7 indicated Strongly Agree. These items and scale were drawn from published studies

demonstrating acceptable reliability and validity. The subjects indicated their attitude toward using a PDA to document interventions using a single item (with four scales) on the questionnaires. This semantic differential item contained four adjective pairs. The adjective pairs were Good/Bad, Unfavorable/Favorable, Harmful/Beneficial, and Negative/Positive. Computer self-efficacy estimates were measured using a 10-item instrument previously published by Compeau and Higgins (1995).

A key attribute of the statements used to measure the constructs in the modified TAM2 is that they describe the use of a specific technology to achieve a specific outcome in a specific context (Davis et al., 1989). Therefore, the TAM2 statements were subsequently modified to reflect the use of personal digital assistants to document clinical interventions as part of the responsibilities of a pharmacist. This met three of the four elements of intentions as defined by Ajzen and Fishbein (1980): action (use), target (personal digital assistant), and context (part of a pharmacist's job responsibilities). The time element was not specifically included in the questionnaires because the attendees were expected to be a broad group of pharmacists who were anticipated to have varying goals, obstacles, and time frames for implementing a new documentation system. These differences could cause someone who was truly planning on implementing PDA-based documentation to indicate that they did not intend to use PDAs because the specified time frame did not fit their situation. The principal investigator's goal was to determine general intentions without respect to the time period.

Demographics

For the purpose of data analysis, the pre-presentation questionnaire contained 13 items intended to gather demographic information about the participants. A list of desirable demographic information was created through a thorough review of the literature as well as through a brainstorming session by the principal investigator and his advisers. The demographic information was divided into three categories on the pre-presentation questionnaire: General Personal Digital Assistant Demographics, Intervention Demographics, and General Demographic questions. Certain items in these three categories were also used to screen attendees for inclusion in the research study.

The General Personal Digital Assistant Demographic questions, items 38 - 41, were used to gather general PDA usage data as it related to the participant's work setting. These items focused on the participant's use of PDAs in their professional practice. Specifically, item 40 asked if the participant's work setting required PDA use to document interventions. Individuals who answered "Yes" on this item were excluded from the research study because the Technology Acceptance Model was designed for use in situations where usage of the technology under study is voluntary (Davis et al., 1989). Furthermore, item 41e asked about the participants' current daily usage of PDAs to document interventions. Any participants who indicated current usage of PDAs for this activity were excluded from data analysis.

The Intervention Demographic questions, items 42 and 43, were used to gather information about the status of intervention documentation at the participant's work setting. This information was used in the data analysis phase to collectively identify the past and current status of intervention documentation at the participants' work settings.

Item 43 was used to screen participants for data analysis. Individuals who indicated on item 43 that they have used, or were currently using a PDA to document interventions were excluded from data analysis.

The General Demographic questions, items 44 – 50, were used to collect various types of data about the participants. Items 44 and 46 were used to screen individuals for participation in the research study. Individuals who were not currently practicing pharmacy in an acute care or ambulatory care setting in U.S. were not included in the final data analysis. The remaining general demographic questions were used as independent variables in the final data analysis to identify any existing relationships between the participants' demographics and their intentions to use PDAs to document interventions.

Questionnaire Refinement

The pre-presentation questionnaire was reviewed by three individuals in addition to the principal investigator. Two of the reviewers were faculty members of a social and administrate pharmacy department in a southeastern land-grant university. A professor in the Department of Management in the College of Business at the same university also reviewed the pre-presentation questionnaire. The faculty members were asked to review the questionnaire for input on research methodology issues, confusing items, and any general suggestions to improve the questionnaire.

The reviewers facilitated the development of the demographic questions, including combining several items into a single item. The reviewers' comments also led to the inclusion of negatively worded questions to prevent response bias. One of the

reviewers' comments resulted in the addition of units of time in question 39. Additionally, the reviewers identified typographical errors. These comments were used in developing the pre-presentation questionnaire that was then subjected to pre-testing procedures, described below.

Pretest of Pre-presentation Questionnaire

The refined pre-presentation questionnaire was then pre-tested to identify any potential problem items, to elicit feedback on its clarity, and to gain estimates of the time required to complete the questionnaire. The post-presentation questionnaire did not undergo a pretest procedure because it is a shortened version of the pre-presentation questionnaire, and it was expected that any problems found in the post-presentation questionnaire would be uncovered during a pretest of the pre-presentation questionnaire.

Twelve individuals comprised the pretest group. The pretest group was composed of an associate professor from a social and administrate pharmacy department in a southeastern land-grant university, three Doctor of Philosophy students from this same department who had all completed undergraduate professional pharmacy education, six staff pharmacists from a southeastern children's and women's hospital, the pharmacy director of this hospital, and one sales representative from an international pharmaceutical company with operations in the United States.

The pretest group was asked to take the pre-presentation questionnaire by starting at the beginning and answering all questions to the best of their ability. They were also asked to record any difficulties with the questionnaire or suggestions for improvement after completing the questionnaire. The reviewers were not provided with a standard set

of questions designed to gather targeted feedback. The principal investigator hand delivered the questionnaire to the pharmacy faculty member and the pharmacy doctoral students. The principal investigator emailed the questionnaire to the pharmacy director who then printed out and distributed copies to the staff pharmacists and a pharmaceutical sales representative. Comments from the university-based pretest subjects were collected by the principal investigator. The pharmacy director collected comments from the staff pharmacists and the sales representative. These comments were then verbally given to the principal investigator by the pharmacy director.

Based on information provided by the pretest subjects, additional changes were identified to further refine the questionnaires. The pretest group identified questionnaire administration issues such as the need for clarification in the instructions. Specifically, the Computer Self Efficacy instructions were shortened and clarified based on their comments. They identified typographical errors that were not identified in the refinement stage. They identified the need for an "other" category in question 46. The pretest group also identified numbering problems due to the automated numbering feature of Microsoft Word. Their comments were instrumental in creating the final version of the questionnaire.

It should be noted that the pretest group included a wide range of individuals beyond practicing pharmacists. The questionnaire was used to gather data at a national pharmacy meeting. This meeting is traditionally attended by a wide range of individuals related to pharmacy practice including practicing pharmacists, pharmacists in the academy, pharmacy students, pharmaceutical sales representatives, and companies that provide services to the pharmacy profession, such as information technology companies.

Although only individuals who practiced in acute care and ambulatory care settings were used for data analysis purposes, a varied group of individuals was selected for the pretest to gather the broadest possible set of input regarding the questionnaire.

A final point to make regarding the pretest is related to the time required to take the pre-presentation questionnaire. All pretest subjects were asked to record the time required to complete the pre-presentation questionnaire. All but one of the pretest subjects required between 8 and 12 minutes to complete this questionnaire. The single exception was one of the graduate students who took 20 minutes to complete the questionnaire. After discussion with this individual, it was discovered that he did not complete the questionnaire before going back and providing comments. Instead, he provided written comments on the questionnaire as he answered the questions. While his comments provided valuable information about the questionnaire, it is believed that his time requirement was not representative of what would have been required had he answered all questions before providing written comments.

Data Collection Procedures

A sufficient number (650) of questionnaire sets were printed prior to the meeting using registration data for the presentation (collected by ASHP Advantage) and the attendance figures for similar presentations given by the principal investigator and Bill G. Felkey the last two years at the same meeting. These registration figures were provided to the principal investigator by Susan Cantrell, Senior Director of Operations, ASHP Advantage, the event organizer. No identifiable information about the participants was provided to the principal investigator.

Prior to the meeting, the principal investigator created questionnaire sets equal to the number of expected attendees (650). Each questionnaire set contained an Information letter, a copy of the pre-presentation and post-presentation questionnaires, and a single piece of paper to conceal the post-presentation questionnaire. The Information letter was stapled on top of the pre-presentation questionnaire and both were placed in the left hand pocket of a black, bi-fold two pocket portfolio. The post-presentation questionnaire and the concealing piece of paper were placed in the right hand pocket of the black, bi-fold two pocket portfolios mentioned above.

The questionnaires sets were delivered by the principal investigator and a colleague to the ASHP Advantage staff work room at the meeting hotel on December 6, 2003. Between the time of questionnaire set drop off and the beginning of the presentation the next afternoon, the ASHP Advantage staff members placed the questionnaire sets (i.e., portfolios) into the meeting handouts. The meeting handouts were spiral-bound and produced by ASHP Advantage. Each meeting handout contained printed copies of the following (in the order listed below):

- program title page
- program agenda and listing of the program faculty (the principal investigator and Bill G. Felkey)
- program objectives
- faculty biographies
- program PowerPoint slides

- single page stating in large (48 point) font: “Please be sure to complete the green survey and turn it in at the conclusion of the program. Thank you!”
- self-assessment questions
- faculty disclosure statements
- program evaluation form.

The ASHP Advantage staff prepared and brought 650 handouts to New Orleans for the presentation. The principal investigator prepared and brought 650 questionnaires sets to New Orleans as well. All 650 questionnaire sets were delivered to the ASHP Advantage work room where they were then inserted into the spiral-bound handouts.

Approximately 1.5 hours prior to the start of the presentation, the ASHP Advantage staff placed the handouts (with inserted folders) on a table immediately outside the meeting room doors on December 7, 2003. At least one member of the ASHP Advantage staff was at the table from this point until the end of the program. The ASHP Advantage staff provided a handout to individuals when they approached the table outside of the meeting room. The room opened one hour prior to the beginning of the presentation.

The presentation began promptly at 1pm when the principal investigator and Bill G. Felkey welcomed those in the audience to the program. Audience members were invited to participate in the research study. During the introduction to the presentation, Bill G. Felkey briefly described the research study and instructed the attendees to read the Information letter found in the left pocket of their portfolios. Those who elected to participate were asked to answer the canary-colored pre-presentation questionnaire to the

best of their ability. Approximately 12 minutes were then allotted for the pre-presentation questionnaire to be completed. At the end of this time period, audience members were then instructed to tear the Information letter off of the pre-presentation questionnaire and pass the completed pre-presentation questionnaire to the center of their row. A colleague of the principal investigator collected the completed pre-presentation questionnaires.

The audience members were then instructed to keep the Information letter in their portfolio in the event that they wanted to contact the principal investigator after the presentation. The subjects were instructed to close their portfolios and open their handouts for the start of the presentation.

The presentation was then delivered. At approximately 3:40pm (20 minutes prior to the end of the designated program time), the presentation was concluded. Bill G. Felkey then asked the audience to complete the light-green colored post-presentation questionnaire and leave it on their chairs. Approximately 10 minutes later, the presenters opened the program up to questions from the audience. The presentation session was concluded at 4pm, and the audience was thanked for their participation in the presentation and in the research study.

The principal investigator then walked around the room to collect all presentation materials left by the audience members. The principal investigator's colleague and an ASHP Advantage staff member also collected questionnaires from audience members as they exited the room. This was not planned, but the staff member and colleague realized that not all audience members left their questionnaires on their chairs. Accordingly, they improvised to make sure as many questionnaires were collected as possible. All

questionnaires (completed and uncompleted) were given to the principal investigator, who then took the materials back to Auburn University for data analysis.

Data Analysis

Unless otherwise stated, data presented in the Results chapter are for the pre-presentation questionnaire only. Problems with the theoretical model identified during the data analysis stage obviated the need to perform data analysis on the post-presentation data. Specifically, the model did not fit the sample data, as discussed below.

This study assessed hypothesized relationships between the constructs of a modified Technology Acceptance Model 2 (TAM2), depicted in Figure 10, in the context of pharmacists' use of personal digital assistants (PDAs) to document clinical interventions. This study also assessed the modified TAM2's ability to explain pharmacists' intentions to use PDAs to document interventions. This study was designed to determine if a 3-hour training session on PDA use could change pharmacists' intentions to use PDAs to document interventions. Finally, this study attempted to assess the relationships between demographic variables and intentions to use PDAs to document interventions.

Data were analyzed using SPSS v12 and AMOS v5 for Windows. All hypotheses were tested at an a priori .05 level of significance, which is consistent with previous TAM and TAM2 literature. Frequency distributions were created for all variables to perform descriptive statistics such as means, standard deviations, and ranges. Structural equation modeling (SEM) was used to test the relationships between the modified TAM2 constructs and intentions. A paired t-test was used to assess any changes in intentions

after training. Correlations were used to assess relationships between demographic variables and intentions.

Psychometric Analysis

Reliability

Reliability is concerned with the consistency with which all items in a measuring instrument that are intended to measure the same construct actually measure the same construct (Ary, Jacobs, & Razavieh, 2002; Hair et al., 1998). In the model studied here, each construct in the model had at least two items intended to measure that construct. A reliability analysis was conducted on the items intended to measure a single construct.

Reliability values can range from 0 to 1, with 1 indicating perfect reliability. Cronbach's alpha is a widely used measure of reliability. High reliability is a requirement for useful scientific results, but disagreement exists regarding what constitutes high reliability. Many researchers have used .7 as the minimum-cut off for acceptable reliability. However, other authors have stated that the acceptable level of reliability is dependent upon how the measure is intended to be used (Ary et al., 2002; Hair et al., 1998; Kerlinger & Lee, 2000). For the purposes of this research study, a Cronbach's alpha of .7 was used as the minimum required for reliability (Nunnally, 1978).

Validity

Validity is often defined as an assessment of an instrument's ability to measure what it is intended to measure (Ary et al., 2002). While this definition does capture some

of the essence of validity, a more accurate definition of validity is an evaluative judgment of the researcher's ability to make accurate inferences about a construct based on theoretical rationales and on an instrument's operationalization of the construct. Furthermore, validity must be considered in the context in which an instrument is used. Validation of inferences from an instrument in one circumstance does not necessarily translate into validation in another circumstance (Bryant, 2002).

There are three types of validity: content, criterion-related, and construct. Construct validity is arguably the most important form of validity from a research perspective, therefore, it was assessed for this instrument (Kerlinger & Lee, 2000). Construct validity is an assessment of whether an operational definition of a construct actually indicates, or assesses that construct. The two primary forms of construct validity are convergent validity and discriminant validity (Bryant, 2002; Kerlinger & Lee, 2000).

Convergent Validity. Convergent validity can be defined as the level of agreement between multiple measures of the same construct, often assessed using a bivariate correlation. Higher correlations indicate that the items converge on a single construct (Bryant, 2002). Beyond looking at bivariate correlations, factor analysis allows the researcher to assess interrelationships among variables and to explain these relationships in terms of their common underlying constructs (factors). Confirmatory factor analysis (CFA) is a specific type of factor analysis that allows the researcher to test specific theoretical relationships expected in a set of measures. Factor loadings are weights indicating the correlation between a construct and the variables intended to indicate that construct. A unique feature of SEM is that it allows the researcher to

perform a factor analysis while simultaneously conducting hypothesis testing (Byrne, 2001; Gefen et al., 2000). For the purposes of establishing convergent validity in this research study, factor loadings were required to be $\geq$0.3, indicating that at least 10 percent of the variance was captured by the latent construct. This value is a heuristic that is commonly used in social sciences research.

Discriminant Validity. Discriminant validity is a measure of the distinctiveness of constructs as measured by different items. Discriminant validity can also be thought of as the ability of an item (or group of items) to measure distinct components of one or more constructs. Good discriminant validity is evidenced by low correlations between distinct constructs. For example, if an instrument is supposed to measure four different constructs individually, the six correlations between the constructs should all be low. An interconstruct correlation of $\leq$0.84 has been recommended as the maximum allowable that indicates adequate discriminant validity (Kline, 1998). For the purposes of this research study, good discriminant validity was considered to have been achieved with interconstruct correlations <0.85.

Structural Equation Modeling (SEM)

Structural equation modeling is a second generation data analytic technique that was used to test the hypotheses for research question one, two, and three. As a second generation data analytic technique, SEM can be used to assess structural and measurement models in a single analysis. Unlike regression, SEM allows the testing of

multiple hypotheses, or *structural* paths in a single analysis. These structural paths are often referred to as "causal" paths (Gefen et al., 2000).

An additional aspect of SEM that makes it useful in measuring latent variables (such as perceived usefulness, perceived ease of use, and intentions) is that *measurement* models can be assessed at the same time as structural models. Essentially, as part of an SEM approach, a confirmatory factor analysis can be conducted simultaneously with the structural model to determine if individual items load on the latent variables they are intended to indicate. This simultaneous assessment of structural and measurement models is considered to be a more rigorous analysis of the research model. Thus, structural equation modeling is more suited for modeling complex processes (like behavior) than first generation data analytic techniques because it can be used to simultaneously assess multiple causal relationships that are characteristic of real-world phenomena (Gefen et al., 2000).

Fit Indices

Goodness of fit indices were used to assess the overall fit of the structural equation model to the empirical data. Fit indices provide an indication of how well a proposed model reflects reality (the study sample). Fit indices are similar to omnibus tests in that adequate fit of the proposed model to the observed data is required before sustentative conclusions can be drawn from the paths measured in the model (Byrne, 2001; Gefen et al., 2000; Hair et al., 1998; Kline, 1998).

Model fit was assessed using the chi square (x^2) statistic, the Goodness of Fit Index (GFI), the Comparative Fit Index (CFI), and the Root Mean Square Error of

Approximation (RMSEA). The x^2 statistic is an absolute fit measure of the likelihood that the relationships proposed by the model are valid. A non-significant x^2 statistic value is desired because it indicates that the model fits the data. However, the x^2 statistic is sensitive to large samples (which are necessary in SEM) and to large numbers of indicator variables, often reaching significance as a result of the research sample. Accordingly, other measures have fit have been developed (Byrne, 2001; Gefen et al., 2000; Hair et al., 1998; Kline, 1998).

The Goodness of Fit Index (GFI) is a measure of the relative amount of variance in the sample data that is explained by the hypothesized model. As such, it is analogous to a squared multiple correlation. The GFI is not sensitive to sample size. Desired values for GFI are >0.9. The GFI, like the x^2 statistic, is considered to be an absolute measure of fit because it compares the hypothesized model to no model at all (Byrne, 2001; Hair et al., 1998; Kline, 1998).

Conversely, the Comparative Fit Index (CFI) is known as an incremental measure of fit because it compares the hypothesized model to a null model. The null model is typically a model in which the observed correlations are assumed to be uncorrelated. The CFI value, then, is an indication of the hypothesized model's improvement in overall fit compared to the null model. For example, a CFI value of .5 indicates that the hypothesized model fits the data 50% better than the null model (using the same sample data). The CFI has been identified as being relatively stable with small sample sizes. Recommended values for CFI are >0.95 (Byrne, 2001; Kline, 1998).

The Root Mean Square Error of Approximation (RMSEA) is an indication of how well the model could be expected to fit the population. It is a standardized summary of

the average differences between the observed and model-implied covariances. As such, desired values are small: <0.08 indicates a reasonable approximation of the population, .08 – .1 indicates mediocre fit, and >0.1 indicates poor fit (Byrne, 2001; Kline, 1998). Desired values for all fit indices are presented in Table 12 (Byrne, 2001; Hair et al., 1998; Kline, 1998).

Table 12. Goodness of fit indices and their desired values

	x^2 statistic	GFI	CFI	RMSEA
Desired Value	Nonsignificant	> .9	> .95	< .1 (< .08)

Research Questions and Hypotheses

Research Question One

Research question one asked: How well does a modified TAM2 explain pharmacists' intentions to use PDAs to document interventions in acute care and ambulatory care settings? Structural equation modeling was used to answer this question with responses to the pre-presentation questionnaire. The path coefficients between the constructs defined in the relationship statements below had to reach significance (t-value >1.96) to indicate the presence of a relationship. For H_0^{1g}, the squared multiple correlation (Coefficient of Determination) was required to equal or exceed 40%. The associated alternate and null hypotheses are as follows:

H_0^{1a} – No relationship will exist between perceived usefulness and intentions.

H_{1a} – A relationship will exist between perceived usefulness and intentions.

Independent Variable: Perceived usefulness

Dependent Variable: Intentions

H_0^{1b} – No relationship will exist between subjective norm and intentions.

H_{1b} – A relationship will exist between subjective norm and intentions.

Independent Variable: Subjective norm

Dependent Variable: Intentions

H_0^{1c} – No relationship will exist between perceived ease of use and perceived usefulness

H_{1c} – A relationship will exist between perceived ease of use and perceived usefulness. .

Independent Variable: Perceived ease of use

Dependent Variable: Perceived usefulness

H_0^{1d} – No relationship will exist between perceived ease of use and attitude.

H_{1d} – A relationship will exist between perceived ease of use and attitude.

Independent Variable: Perceived ease of use

Dependent Variable: Attitude

H_0^{1e} – No relationship will exist between perceived usefulness and attitude.

H_{1e} – A relationship will exist between perceived usefulness and attitude.

Independent Variable: Perceived usefulness

Dependent Variable: Attitude

H_0^{1f} – No relationship will exist between attitude and intentions.

H_{1f} – A relationship will exist between attitude and intentions.

Independent Variable: Attitude

Dependent Variable: Intentions

H_0^{1g} – Together, perceived usefulness, attitude, and subjective norm will account for <40% of the variance in intentions.

H_{1g} – Together, perceived usefulness, attitude, and subjective norm will account for $\geq$40% of the variance in intentions.

Independent Variables: Perceived usefulness, attitude, subjective norm

Dependent Variable: Coefficient of Determination for intentions

Research Question Two

Research question two asked: How well do previously identified antecedents of perceived usefulness and perceived ease of use explain their respective constructs? Structural equation modeling was used to answer this question with responses to the pre-presentation questionnaire. The path coefficients between the constructs defined in the relationship statements below had to reach significance (t-value >1.96) to indicate the presence of a relationship. For H_0^{2b}, the squared multiple correlation was required to equal or exceed 30%. For H_0^{2i}, the squared multiple correlation (Coefficient of Determination) was required to equal or exceed 50%. The associated alternate and null hypotheses are as follows:

H_0^{2a} – No relationship will exist between computer self-efficacy and perceived ease of use.

H_{2a} – A relationship will exist between computer self-efficacy and perceived ease of use.

Independent Variable: Computer self-efficacy

Dependent Variable: Perceived ease of use

H_0^{2b} – Computer self-efficacy will account for <30% of the variance in perceived ease of use.

H_{2b} – Computer self-efficacy will account for ≥30% of the variance in perceived ease of use.

Independent Variable: Computer self-efficacy

Dependent Variable: Coefficient of Determination for perceived ease of use

H_0^{2c} – No relationship will exist between result demonstrability and perceived usefulness.

H_{2c} – A relationship will exist between result demonstrability and perceived usefulness.

Independent Variable: Result demonstrability

Dependent Variable: Perceived usefulness

H_0^{2d} – No relationship will exist between output quality and perceived usefulness.

H_{2d} – A relationship will exist between output quality and perceived usefulness.

Independent Variable: Output quality

Dependent Variable: Perceived usefulness

H_0^{2e} – No relationship will exist between job relevance and perceived usefulness.

H_{2e} – A relationship will exist between job relevance and perceived usefulness.

Independent Variable: Job relevance

Dependent Variable: Perceived usefulness

H_0^{2f} – No relationship will exist between image and perceived usefulness.

H_{2f} – A relationship will exist between image and perceived usefulness.

Independent Variable: Image

Dependent Variable: Perceived usefulness

H_0^{2g} – No relationship will exist between subjective norm and image.

H_{2g} – A relationship will exist between subjective norm and image.

Independent Variable: Subjective norm

Dependent Variable: Image

H_0^{2h} – No relationship will exist between subjective norm and perceived usefulness.

H_{2h} – A relationship will exist between subjective norm and perceived usefulness.

Independent Variable: Subjective norm

Dependent Variable: Perceived usefulness

H_0^{2i} – Together, subjective norm, image, job relevance, output quality, result demonstrability, and perceived ease of use will account for <50% of the variance in perceived usefulness.

H_{2i} – Together, subjective norm, image, job relevance, output quality, result demonstrability, and perceived ease of use will account for ≥50% of the variance in perceived usefulness.

Independent Variables: subjective norm, image, job relevance, output quality, result demonstrability, perceived ease of use

Dependent Variable: Coefficient of Determination for perceived usefulness

Research Question Three

Research question three asked: Is there a difference in a modified TAM2's ability to explain pharmacists' intentions to use PDAs to document interventions if given before and after a 3-hour training session on PDA use? A structural equation modeling multigroup invariance procedure was planned for use to assess any changes in explained variance after the training session. This procedure was intended to compare the entire model prior to training (pre-presentation questionnaire) to the entire model after training (post-presentation questionnaire).

H_0^3 – There will not be a difference in the explained variance in pharmacists' intentions to use PDAs before and after a 3-hour training session on PDA use.

H_3 – There will be a difference in the explained variance in pharmacists' intentions to use PDAs before and after a 3-hour training session on PDA use.

Independent Variable: Training

Dependent Variable: Coefficient of Determination for intentions

Research Question Four

Research question four asked: Will pharmacists' intentions to use PDAs to document interventions change after a 3-hour training session on PDA use to document interventions? Participants' summed intention scores were matched from the pre-presentation and post-presentation questionnaires. A paired t-test was used to measure any change in the paired intentions scores from before after the training session.

H_0^4 – There will not be a difference in pharmacists' intentions to use PDAs to document interventions after a 3-hour training session on PDA use.

H_4 – There will be a difference in pharmacists' intentions to use PDAs to document interventions after a 3-hour training session on PDA use.

Independent variable: Training

Dependent Variable: Change in intention score

Research Question Five

Research question five asked: Are there differences in pharmacists' intentions to use PDAs to document interventions based on demographic characteristics? Five demographic characteristics were the subject of this analysis. Correlational analysis of pre-presentation data was used to answer this question. The associated alternate and null hypotheses are as follows:

H_0^{5a} – No relationship will exist between position and intentions.

H_{5a} – A relationship will exist between position and intentions.

Independent Variable: Position

Dependent Variable: Intentions

H_0^{5b} – No relationship will exist between pharmacy department size and intentions.

H_{5b} – A relationship will exist between pharmacy department size and intentions.

Independent Variable: Pharmacy department size

Dependent Variable: Intentions

H_0^{5c} – No relationship will exist between gender and intentions.

H_{5c} – A relationship will exist between gender and intentions.

Independent Variable: Gender

Dependent Variable: Intentions

H_0^{5d} – No relationship will exist between age and intentions.

H_{5d} – A relationship will exist between age and intentions.

Independent Variable: Age

Dependent Variable: Intentions

H_0^{5e} – No relationship will exist between experience and intentions.

H_{5e} – A relationship will exist between experience and intentions.

Independent Variable: Pharmacy experience

Dependent Variable: Intentions

Modifications to Planned Data Analysis

Reliability Calculations

Ipsatization is a procedure for producing an exact mirror image of a data set. This is accomplished by creating a mirror image of the entire response set for each subject. The mirrored observations are then added to the original data set, which doubles the size of the data set (Villaume & Weaver, 1996). In the present study, for example, a response of two on the 7-point Likert-type TAM and TAM2 scales was mirrored by a response of six. A response of eight on the 10-point self-efficacy scale was mirrored by a response of three. After the initial reliability assessment, ipsatization was performed on the pre-presentation questionnaire items 1 – 37, excluding item 27.

The ipsatization procedure has been suggested as a method for exploring the cause of poor reliability when a ceiling effect appears to be present in a data set (W. A.

Villaume, personal communication, April 7, 2004). By definition, reliability is the proportion of true variance to total variance in a measuring instrument. Variance in a data set is a requirement of reliability determinations (Kerlinger & Lee, 2000). The presence of a ceiling effect in a data set can reduce variability because the ceiling effect limits the range of possible scores. If poor reliability is due to a ceiling effect, reliability values after ipsatization should increase. However, if reliability values after ipsatization do not increase, the ceiling effect can be ruled out as the cause of poor reliability (W. A. Villaume, personal communication, April 7, 2004). Ipsatization was performed in the present study due to poor reliabilities that were obtained for two TAM2 constructs, Result Demonstrability and Output Quality.

Research Questions One, Two, and Three

Bootstrapping is a nonparametric statistical approach for making inferences about population parameters from sample data. However, unlike parametric approaches to statistical inference, bootstrapping is based on the belief that it is sometimes better to draw conclusions about a population from the available sample data than from assumptions about the population (Mooney & Duval, 1993). This advantage of the bootstrap technique is based on its ability to provide parameter estimates when assumptions of normality may not have been achieved. In structural equation modeling, bootstrapping has been identified as a preferred data analysis method when sample sizes are moderately small (Byrne, 2001). Specific numbers were not given to distinguish between moderate and extremely small sample sizes.

In a bootstrap procedure, the original sample is considered to represent the population from which it was drawn. Multiple subsamples are randomly drawn with replacement from this pseudo-population. These data are then used for parameter estimation and calculation of fit indices (Byrne, 2001). In the present research, 300 subsamples were created for data analysis purposes. This number was chosen based on Byrne's (2001) use of similar subsample sizes.

V. RESULTS

The ASHP Advantage staff provided a handout to individuals when they approached the table outside of the meeting room. Those individuals who received a handout and proceeded into the meeting room are referred to as attendees throughout the remainder of this document. A 10 minute break was provided approximately halfway through the presentation. At this time, the principal investigator's colleague counted the number of handouts remaining on the table outside the meeting room. The total number of handouts remaining on the table was 128. A headcount conducted by the ASHP Advantage staff a few minutes prior to the break indicated that there were 475 attendees in the audience. Forty-seven handouts were unaccounted for considering that 650 handouts were available for the session, 128 handouts remained on the table at the break, and that 475 attendees were present.

This discrepancy has several potential causes. While the ASHP Advantage staff indicated that they made every effort to provide all attendees with a handout, the possibility does exist that not everyone who entered the room received a handout. Similarly, because the principal investigator was not present when the questionnaire sets were placed in the handouts, there is no guarantee that all handouts had a questionnaire set inserted. However, the ASHP Advantage staff did not indicate that they had more handouts than questionnaire sets. Another possible explanation is that attendees could have inadvertently received multiple handouts, although this seems unlikely. The

principal investigator's colleague also observed three individuals within a five-minute time span who approached the table, received a handout, and continued down the hallway. The possibility does exist that an unknown number of handouts were picked up by individuals who did not attend the presentation. Having considered these issues, the headcount number of 475 was used as the maximum number of questionnaires that could have been received.

Response Rate

A questionnaire set was composed of two questionnaires: a pre-presentation and a post-presentation questionnaire. Each attendee was asked to fill out and return both questionnaires at the appropriate times during the presentation. Two hundred three pre-presentation questionnaires were returned, and 199 post-presentation questionnaires were returned. Using 475 as the maximum number of questionnaires to be returned, the response rates were 42.7% and 41.9% respectively. The questionnaires varied in completeness from a response for a single item to responses for all items.

Inclusion in the study sample was predicated upon completion of the modified TAM2 and computer self-efficacy (CSE) items on both questionnaires and upon meeting the study inclusion criteria. Individuals were not included if they did not complete the modified TAM2 and CSE items on both questionnaires, did not meet the inclusion criteria, or if the information provided on the pre-presentation questionnaire did not provide a clear indication that the attendee met the inclusion criteria. Sixty-nine attendees completely filled out both questionnaires, submitted the questionnaires, and met the inclusion criteria.

Five more attendees were identified for inclusion in the study sample because they completed the questionnaires, except for a small number of items. Specifically, three of the five attendees skipped a single modified TAM2 or CSE item on the pre-presentation questionnaire. Another attendee skipped a single modified TAM2 item on the pre-presentation questionnaire, one CSE item on the post-presentation questionnaire, and one modified TAM2 item on the post-presentation questionnaire. A final attendee skipped a single modified TAM2 item on the pre-presentation questionnaire and a single CSE item on the post-presentation questionnaire. In all 5 cases, the attendees answered at least half of the items for the construct it represented. Therefore, the usable response rate was 74 of 475, or 15.6%.

One item was dropped from the questionnaire prior to data analysis. A review of the submitted questionnaires identified an apparent problem with the item. Specifically, item 28 on the pre-presentation questionnaire (37 on the post-presentation questionnaire) was left blank, or was partially answered by 16 of the attendees included in the final sample of 74. This represents 21.6% of the sample. Due to the already low number of usable responses, this item was dropped from the model. This item was the Attitude construct from the original TAM. Hypotheses affected by deletion of this item included: H_{1d}, H_{1e}, H_{1f}, and H_{1g}.

Demographic Variables

Thirteen items on the pre-presentation questionnaire (38-50) were used to gather demographic information in three broad categories: General Personal Digital Assistant questions, Intervention questions, and General Demographic questions. These questions

focused on PDA use, experience documenting interventions, pharmacy practice experience of the attendees, and information about the attendees themselves. The data gathered from these 13 questions are presented in the following section.

General Personal Digital Assistant Questions

Question 38 asked attendees if they currently used a PDA for work-related activities. Fifty-nine (79.7%) indicated that there were currently using a PDA for work-related activities. Question 39 asked all attendees to indicate how long (in months) they had personally used a PDA for work-related activities. Both current and previous PDA users were instructed to indicate the number of months of usage. Attendees who did not have any experience using a PDA for work-related activities were instructed to write "N/A" in the blank. One attendee apparently misread the question and wrote "yes" in the blank.

The highest number of months of work-related PDA usage was 60 (1 attendee). The lowest number of months of work-related PDA usage was zero, or N/A (13 attendees). The most frequent response for the number of months of work-related PDA usage was 24 (14 attendees). The average number of months of work-related PDA usage was 18.6 (standard deviation = 15.5). Appendix F provides a complete listing of responses to question 39.

Question 40 asked if the attendees' institutions required the use of PDAs to document interventions. Attendees indicated their answer by circling "Yes", "No", or "N/A". Attendees who indicated "Yes" were excluded from the study sample. Two of the sample of 74 (2.7%) indicated "N/A" to this question and were included in the study

sample. The remaining 72 (97.3%) indicated “No” and were also included in the study sample.

Question 41 asked attendees to indicate their daily PDA use in eight usage categories, including an "Other" category. This category allowed the attendee to write in a usage that did not fit in one of the other seven categories. Attendees indicated their daily usage for each category by circling 0, 1-2, 3-4, or ≥5 for the appropriate category. Additionally, item 41e was used to identify attendees who were currently using a PDA to document interventions. These individuals were excluded from the study sample. Table 13 presents the responses to this question.

Table 13. Frequency of responses for each PDA usage category with percentage of total

	Uses per Day (Percentage)				
Category of Usage	**0**	**1-2**	**3-4**	**≥5**	**Total**
Personal Information Management	18 (24.3)	20 (27)	15 (20.3)	21 (28.4)	74 (100)
Drug Information Access	17 (23)	16 (21.6)	15 (20.3)	26 (35.1)	74 (100)
Patient Tracking	72 (97.3)	1 (1.4)	0 (0)	1 (1.4)	74 (100)
Formulary Information	57 (77)	11 (14.9)	4 (5.4)	2 (2.7)	74 (100)
Intervention Documentation	74 (100)	0 (0)	0 (0)	0 (0)	74 (100)
Calculations and/or Conversions	28 (37.8)	20 (27)	10 (13.5)	16 (21.6)	74 (100)
Wireless Communications	71 (95.9)	3 (4.1)	0 (0)	0 (0)	74 (100)
Other	73 (98.6)	0 (0)	0 (0)	1 (1.4)	74 (100)

Note. The one attendee who indicated usage in the Other category wrote “games”.

Intervention Questions

The items (42 and 43) making up this section of the pre-presentation questionnaire were used to gather general information about intervention documentation in the attendees' work settings. Item 42 gathered data regarding the current status of intervention documentation, i.e., were the attendees' pharmacy departments currently documenting interventions. Possible responses were "Yes", "No", and "N/A". Sixty-three (85.1%) attendees indicated that their pharmacy department was currently documenting interventions. Ten (13.5%) attendees indicated that their pharmacy department was not currently documenting interventions. One (1.4%) attendee indicated that this question was not applicable.

Item 43 asked the attendees to indicate all methods they were using (or had used in the past) to document interventions. Attendees were presented with a list of eight intervention documentation methods and were instructed to circle all methods they had personally used. Attendees could also circle "None" or "Other". A blank space was provided for attendees to write in other methods, when appropriate. Attendees who circled personal digital assistants as an intervention documentation method were excluded from the sample and are not presented here. Alternatively, attendees who had no prior experience documenting interventions were expected to indicate that they had used none of the documentation methods listed. The responses to item number 43 are presented in Table 14.

Table 14. Frequency of responses for usage of intervention documentation methods

Documentation Methods	Frequency of Responses (Percentage)		
	Experience with this Method	No Experience with this Method	Total
Direct Chart Notation	38 (51.4)	36 (48.6)	74 (100)
Paper-based Documentation	48 (64.9)	26 (35.1)	74 (100)
Mainframe Computer	32 (43.2)	42 (56.8)	74 (100)
Desktop Computer	35 (47.3)	39 (52.7)	74 (100)
Notebook Computer	4 (5.4)	70 (94.6)	74 (100)
Subnotebook Computer	0 (0)	74 (100)	74 (100)
Tablet PC	0 (0)	74 (100)	74 (100)
Personal Digital Assistant	0 (0)	74 (100)	74 (100)
None	5 (6.8)	69 (93.2)	74 (100)
Other	0 (0)	74 (100)	74 (100)

General Demographic Questions

The seven items (44 – 50) making up this section of the pre-presentation questionnaire were used to gather general demographic data about the attendees. This included data about their practice setting, practice experience, and personal demographic data, such as gender. Two of the items in this section (44 and 46) were used to identify attendees for inclusion in the study sample. To be included in the study sample, attendees had to indicate that they currently practiced pharmacy in United States (item

44) in an acute care or ambulatory clinic setting (item 46). All of the attendees included in the data analysis indicated that they currently practice pharmacy in the United States. Sixty-six (89.2%) attendees classified their primary work setting as acute care. The remaining eight (10.8%) attendees classified their primary work setting as an ambulatory clinic.

Item 45 was used to gather data about the attendees' pharmacy practice experience. The mean number of months of experience was 220, with a standard deviation of 122 months. Twelve months was the minimum number of months of experience, as indicated by two attendees. One individual had practiced pharmacy for 504 months. This was the largest number of months of experience. Ninety-six was the most frequently indicated number of months of experience, as indicated by the responses of four attendees. Appendix G contains a complete listing of all responses to item 45. Table 15 contains information comparing the number of months of experience for the study sample and the ASHP membership in 2003, $x^2(4, N = 1234) = 3.02$, $p > .05$ (C. Bush, personal communication, April 4, 2005).

Table 15. Pharmacy Practice Experience Comparison

Months of Experience	**2003 ASHP Membership (%)**	**Study Sample (%)**
≤59	10	9
60-119	10	15
120-179	12	15
180-239	12	14
≥240	56	47

Item 47 was used to gather data about the specific practice positions of the attendees within their individual work settings. The attendees were presented with four options from which to choose: pharmacy director, supervisor, staff pharmacist, or other. Of the 40 attendees listed as staff pharmacists in Table 16, seventeen classified themselves as clinical pharmacists or clinical coordinators in the "other" category. These individuals were classified as staff pharmacists for data analysis purposes. Additionally, two of the staff pharmacists were pharmacy residents. Two of the attendees indicated that their specialty positions were drug information within the acute care or ambulatory clinic setting. These two attendees were classified as staff pharmacists. Table 16 also includes practice position information for ASHP's 2003 membership and the individuals who attended the 2003 Midyear Clinical Meeting (C. Bush, personal communication, April 4, 2005). The "other" category was not included in the chi-square analysis because it was primarily composed of individuals from industry, $x^2(4, N = 1883) = 3.9, p > .05$.

Table 16. Attendees' professional position within their primary work setting

	2003 ASHP Membership (%)	**2003 ASHP Midyear Clinical Meeting (%)**	**Study Sample (%)**
Pharmacy Director	32	35	32
Supervisor	10	10	11
Staff Pharmacist	35	36	54
Other	23	20	3

Note. Other indicates drug information specialty

Item 48 was used to gather data about the size of the pharmacy department at the attendee's primary practice location. Attendees were asked to write in the number of full-time equivalents (FTEs) at their practice location. The minimum number of FTEs was one, and the largest was 60. Eight attendees indicated that their practice location had 20 FTEs, making this the most frequently occurring number. The mean number of FTEs was 19.6, and the standard deviation was 15.4. Appendix H contains a complete listing of all responses to item 48.

The last two items on the pre-presentation questionnaire (49 and 50) were used to gather data about the gender and age of the attendees. Thirty-two (43.2%) attendees were female. Females composed 49 per cent of ASHP's membership in 2003 (C. Bush, personal communication, April 4, 2005). Twenty-five (33.8%) attendees indicated that their age was less than or equal to 39 years of age. Forty-two (56.8%) attendees indicated that their age fell between 40 and 54 years of age. The remaining seven (9.5%) attendees indicated that they were 55 years of age or older.

Reliability Assessment

A reliability assessment was performed on the modified TAM2 and CSE items for both the pre-presentation and post-presentation questionnaires. Specifically, Cronbach's Alpha was used to assess the internal consistency among the items making up each construct. All constructs reached acceptable reliabilities ($\geq$0.7) except for Output Quality and Result Demonstrability. The reliabilities for these constructs were less than 0.7 on both the pre-presentation and post-presentation questionnaires. These two constructs

were dropped from the final model. Reliabilities are presented in Table 17. Figure 11 depicts the final version of the modified Technology Acceptance 2 Model that was tested.

Table 17. Reliabilities for each construct on both questionnaires

	Cronbach's Alpha	
Construct	Pre-presentation	Post-presentation
Subjective Norm	.77	.8
Job Relevance	.8	.78
Output Quality	.56	.29
Result Demonstrability	.02	-.14
Computer Self-Efficacy	.93	.93
Image	.88	.91
Perceived Usefulness	.89	.81
Perceived Ease of Use	.76	.89
Intentions	.94	.85

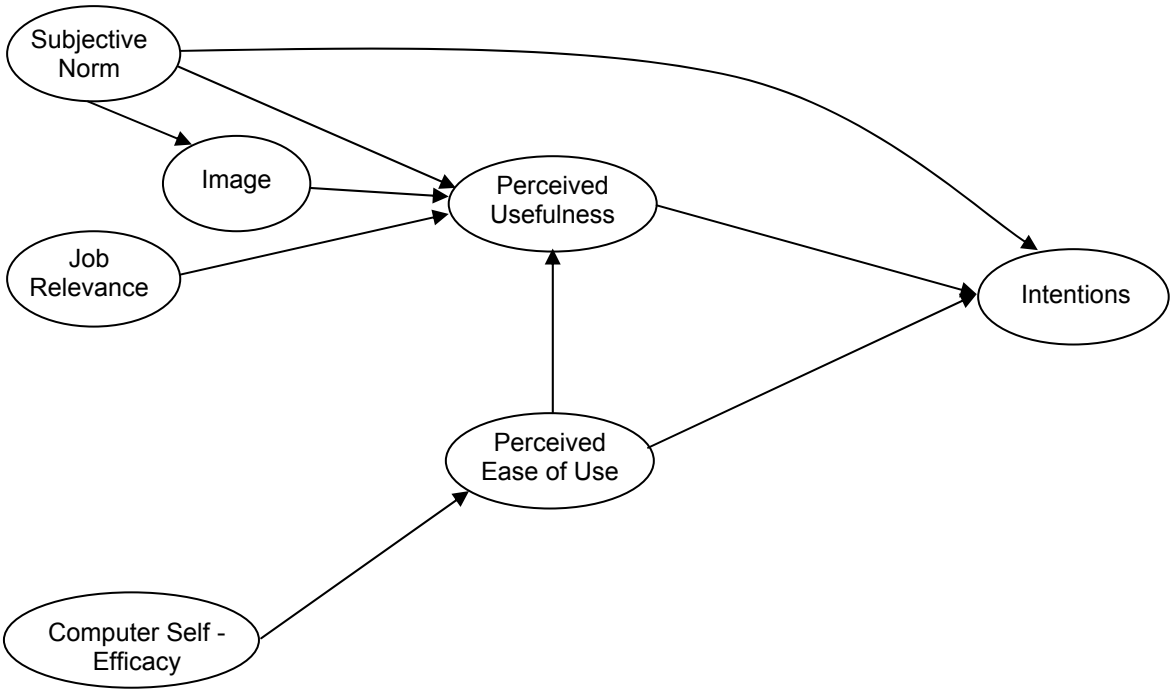


Figure 11. Final modified Technology Acceptance Model 2 tested

Validity Assessment

Convergent Validity

As described in the Methods section, convergent validity was assessed by examining the factor loadings of each pre-presentation item on its respective construct. Twenty-seven items remained in the model after removal of two Output Quality items and four Result Demonstrability items. Factor loadings $\geq$0.3 indicated acceptable convergent validity. All item factor loadings exceeded the minimum acceptable value and are presented in Appendix I.

Discriminant Validity

As described in the Methods section, discriminant validity was assessed by examining the interconstruct correlations between the different constructs comprising the

modified TAM2 and CSE instruments. Seven constructs remained in the model after removal of Output Quality and Result Demonstrability. Twenty-one interconstruct correlations were obtained. Interconstruct correlations were required to be <0.85 to indicate adequate discriminant validity. All interconstruct correlations were in the acceptable range (see Appendix J), except for the correlation of Intentions with Job Relevance (r = .91).

In this study, the primary concern with discriminant validity is the correlation between variables that are serving as independent variables in the model. For example, Subjective Norm, Perceived Usefulness, and Perceived Ease of Use (Figure 11, above) are independent variables in the explanation of the dependent variable, Intentions. Here, the three correlations between these independent variables should be <0.85 to exhibit adequate discriminant validity in the explanation of the dependent variable, Intentions. Figure 11 depicts the absence of a direct relationship between Intentions and Job Relevance. Because there is no direct link in the model between these two constructs, the discriminant validity correlation of .91 is not a concern.

Hypothesis Testing

Figure 11 depicts the final model under study after the removal of the Attitude, Output Quality, and Result Demonstrability constructs. Removal of these three constructs resulted in the elimination of seven hypotheses. Table 18 contains the hypotheses that were eliminated from the study.

Table 18. Hypotheses removed from the model

Hypotheses	Variables
H_{1d}	Perceived Ease of Use and Attitude
H_{1e}	Perceived Usefulness and Attitude
H_{1f}	Attitude and Intentions
H_{1g}	Subjective Norm, Perceived Usefulness, Attitude, and Intentions
H_{2c}	Result Demonstrability and Perceived Usefulness
H_{2d}	Output Quality and Perceived Usefulness
H_{2i}	Subjective Norm, Image, Job Relevance, Output Quality, Result Demonstrability, Perceived Ease of Use, and Perceived Usefulness

Three new hypotheses were developed to reflect changes in the model that occurred after removing the Attitude, Output Quality, and Result Demonstrability constructs. These hypotheses are listed below and are depicted in Figure 12.

Research Question One

H_0^{1h} – No relationship will exist between perceived ease of use and intentions.

H_{1h} – A relationship will exist between perceived ease of use and intentions.

Independent Variable: Perceived ease of use

Dependent Variable: Intentions

H_0^{1i} – Together, perceived usefulness, subjective norm, and perceived ease of use will account for <40% of the variance in intentions.

H_{1i} – Together, perceived usefulness, subjective norm, and perceived ease of use will account for $\geq$40% of the variance in intentions.

Independent Variables: Perceived usefulness, subjective norm, perceived ease of use

Dependent Variable: Coefficient of Determination for intentions

Research Question Two

H_0^{2j} – Together, subjective norm, image, job relevance, and perceived ease of use will account for <50% of the variance in perceived usefulness.

H_{2j} – Together, subjective norm, image, job relevance, and perceived ease of use will account for $\geq$50% of the variance in perceived usefulness.

Independent Variables: subjective norm, image, job relevance, perceived ease of use

Dependent Variable: Coefficient of Determination for perceived usefulness

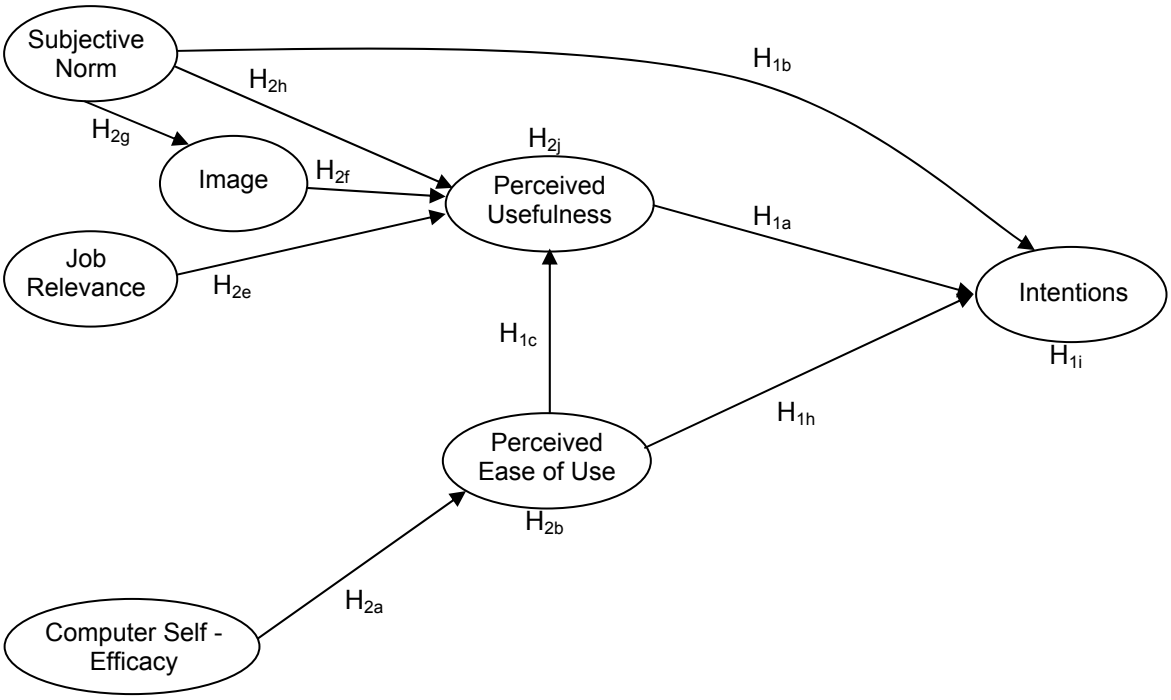


Figure 12. The final model tested along with the remaining hypotheses

Research Questions One and Two

In this study, hypothesis testing for research questions one and two was conducted within the context of a structural equation model (Figure 12). The first step in evaluating the results of a using a structural equation model analysis is to obtain model fit statistics. These statistics provide an indication of how well the model fits (or describes) the sample data. In the present study, model fit statistics provide an indication of how well the proposed model in Figure 12 describes the data gathered from the attendees in New Orleans. Adequate model fit is a prerequisite to drawing practical and/or theoretical conclusions from the data, including the hypotheses to be tested (Byrne, 2001; Gefen et al., 2000; Hair et al., 1998; Kline, 1998).

Four model fit statistics (discussed in the Methods section) were used in evaluating the model. They are presented in Table 19. All fit indices indicate that the

model did not fit, or describe the sample data. Therefore, hypotheses for research questions one and two were not tested because the lack of adequate model fit prevents drawing any substantive conclusions from the hypotheses.

Table 19. Model fit indices for the proposed model

	x^2 statistic	**GFI**	**CFI**	**RMSEA**
Desired Value	Nonsignificant	> .9	> .95	< .1 (< .08)
Obtained Value	638.246, $p < .001$	.632	.8	.119

Research Question Three

Research question three was also based on the results of the structural equation model. This question was intended to determine if there was a difference in the model's ability to explain pharmacists' intentions to use PDAs to document interventions if given before and after a 3-hour training session on PDA use. The hypothesis associated with this research question was also unable to be tested because adequate model fit is a prerequisite for conducting the statistical analysis.

Research Question Four

Research question four was intended to determine if there was a difference in the attendees' intentions to use PDAs to document interventions before and after the 3-hour training session. A paired t-test was used to compare the attendees' summed intention scores before and after the presentation.

The pre-presentation mean was at the high end of the range, with 14 being the highest possible score. The results indicate that the attendees' average intention scores did increase after the training session, but the increase was not significant. The null hypothesis for research question four was accepted. The mean pre-presentation intention score was 12 and the mean post-presentation score was 12.46 (*p-value* = .097). The presence of high scores indicates the possibility of a restriction of range for the intention scores.

Research Question Five

Research question five was intended to identify possible relationships between five demographic characteristics of the attendees and their intentions. The demographic characteristics were position (H_{5a}), pharmacy department size (H_{5b}), gender (H_{5c}), age (H_{5d}), and experience (H_{5e}). A correlational analysis was used to assess the hypothesized relationships. The results are presented in Table 20.

All correlations except for Pharmacy Department Size were non-significant. Null hypotheses 5a, 5c, 5d, and 5e were accepted. The results of this study do indicate a significant correlation between the attendees' intentions to document interventions and the size of the pharmacy department in which they worked. For data analysis purposes, the attendees' responses to this item were coded such that a smaller number indicated a smaller department size. Accordingly, the negative correlation indicates that intentions increased as the size of the pharmacy department decreased. The results of this study support rejecting the null hypothesis (H_0^{5b}) of no relationship between pharmacy department size and intentions.

Table 20. Results of demographic correlations with intentions

	Position	**Pharmacy Department Size**	**Gender**	**Age**	**Experience**
r	.1	-.245	-.095	-.155	-.192
p-value	.396	.036	.422	.187	.102

Modifications to Planned Data Analysis

Reliability Calculations

As described in the Methods section, an ipsatization procedure was performed on all constructs, pre and post, to explore the impact of an apparent ceiling effect in the Intention construct on item reliability. Reliabilities are presented in Table 21 with ipsatized values in parentheses.

Table 21. Reliabilities and ipsatized values for each construct on both questionnaires

	Cronbach's Alpha	
Construct	Pre-presentation (Ipsatized)	Post-presentation (Ipsatized)
Subjective Norm	.77 (.77)	.8 (.79)
Job Relevance	.8 (.92)	.78 (.92)
Output Quality	.56 (.6)	.29 (.8)
Result Demonstrability	.02 (.24)	-.14 (.1)
Computer Self-Efficacy	.93 (.94)	.93 (.96)
Image	.88 (.88)	.91 (.9)
Perceived Usefulness	.89 (.94)	.81 (.96)
Perceived Ease of Use	.76 (.89)	.89 (.97)
Intentions	.94 (.98)	.85 (.97)

Generally, the ipsatized reliabilities across all constructs indicate small changes from the non-ipsatized values. The pre-presentation ipsatized reliability for Output Quality (.6) remained below acceptable levels for reliability. However, the post-presentation ipsatized reliability for Output Quality (.8) did increase to acceptable levels. The pre-presentation and post-presentation ipsatized reliabilities for Result Demonstrability remained below the acceptable level for reliability, .24 and .1, respectively.

Despite the improvement in the post-presentation reliability, the ipsatization procedure did not support retaining Output Quality in the model because the pre-

presentation reliability remained below the acceptable level. The ipsatization procedure also did not support retaining Result Demonstrability in the model because all reliabilities remained below the acceptable level for reliability. These results indicate that a restriction of range did not lead to poor reliabilities for these two constructs.

Research Questions One, Two, and Three

As described in the Methods section, a bootstrap procedure was performed because the sample of 74 attendees was smaller than the desired sample size of 150. Specifically, 300 subsamples were created from the sample data provided by the 74 attendees who were included in the original data analysis. Attitude, Output Quality, and Result Demonstrability, again, were not retained in the model for data analysis purposes.

A structural equation modeling analysis was then performed on the bootstrapped data. All fit indices indicated that the model did not fit the bootstrapped data. The specific values for each fit index were identical to the values obtained on the original sample of 74 attendees. Therefore, bootstrapping, which increased the sample size to 300, did not improve the model's fit to the data. Again, the hypotheses for research questions one, two, and three were not tested because the lack of adequate model fit prevents drawing any substantive conclusions from the hypotheses.

VI. DISCUSSION

The purpose of this investigation was to apply a modified Technology Acceptance Model 2 (TAM2) to pharmacists' intentions to use personal digital assistants (PDAs) to document interventions in acute care and ambulatory care settings. The modified TAM2's ability to explain pharmacists' intentions to use PDAs to document interventions was the focus of this research. This chapter begins with a discussion of hypotheses and their implications. Following this discussion, the overall implications of this study are presented. This chapter concludes with a discussion of the limitations of this investigation and suggestions for future research.

Hypothesis Testing and Implications

Research Question One

Research question one had five associated null hypotheses. These hypotheses are presented below. None of these hypotheses were able to be tested due to poor model fit to the sample data.

H_0^{1a} – No relationship will exist between perceived usefulness and intentions.

H_0^{1b} – No relationship will exist between subjective norm and intentions.

H_0^{1c} – No relationship will exist between perceived ease of use and perceived usefulness.

H_{1h} – No relationship will exist between perceived ease of use and intentions.

H_0^{1i} – Together, perceived usefulness, subjective norm, and perceived ease of use will account for <40% of the variance in intentions.

Research Question Two

Research question two had seven associated null hypotheses. These hypotheses are presented below. None of these hypotheses were able to be tested due to poor model fit to the sample data.

H_0^{2a} – No relationship will exist between computer self-efficacy and perceived ease of use.

H_0^{2b} – Computer self-efficacy will account for <30% of the variance in perceived ease of use.

H_0^{2e} – No relationship will exist between job relevance and perceived usefulness.

H_0^{2f} – No relationship will exist between image and perceived usefulness.

H_0^{2g} – No relationship will exist between subjective norm and image.

H_0^{2h} – No relationship will exist between subjective norm and perceived usefulness.

H_0^{2j} – Together, subjective norm, image, job relevance, and perceived ease of use will account for <50% of the variance in perceived usefulness.

Research Question Three

One null hypothesis was associated with research question three. This hypothesis was not able to be tested due to inadequate model fit to the sample data. The hypothesis is presented below.

H_0^3 – There will not be a difference in the explained variance in pharmacists' intentions to use PDAs before and after a 3-hour training session on PDA use.

Research Questions One, Two, and Three

Poor model fit to the collected data precluded the testing of any hypotheses associated with these research questions. More importantly, the model fit indices obtained indicate that the modified TAM2 did not describe the sample data. This suggests that, in this sample, the model under study does not provide sufficient explanatory insight into the factors influencing pharmacists' intentions to use PDAs to document interventions. Several potential reasons for poor model fit are presented.

Time Element. The time element of the behavior (PDA usage) was not included in the questionnaire statements. The time element is one of the four elements of the behavior in question that must be defined to allow optimal prediction of the behavior from intentions. The other three elements of behavior are action, target, and context. The time element was not specifically included in the questionnaires because the attendees were expected to be a broad group of pharmacists who were anticipated to have

varying goals, obstacles, and time frames for implementing a new PDA-based documentation system.

The principal investigator's goal was to determine general intentions without respect to the time period. Despite this goal, the absence of a time element does potentially introduce a level of ambiguity about the activity. This uncertainty could have decreased the attendees' ability to form intentions about the behavior due to the lack of specificity for the behavior. In summary, the absence of the time element could have potentially impacted model fit by introducing uncertainty regarding PDA usage intentions.

Intention Target. The overwhelming majority of published TAM and TAM2 literature has focused on software as the target technology. In these studies, the models have consistently explained approximately 40% of users' intentions to use the target software. The focus of this study, PDA-based intervention documentation, is actually two technologies: PDA hardware and documentation software. This difference in target technology could have potentially led to inadequate model fit due to the complexity of intention formation when the target technology is actually two separate technologies. According to this rationale, it is possible that the model may be more applicable to evaluate intentions toward separate PDA-based documentation applications than PDA-based documentation itself.

Business versus Healthcare Professionals. The overwhelming majority of published TAM and TAM2 literature has focused on business students and business

professionals as the study group. In these studies, the models have consistently explained approximately 40% of business users' intentions. It is possible that there are intrinsic differences between the pharmacists in this study and the business subjects usually found in TAM(2) research. Pharmacy students often begin specialized curricula in their 1st or 2nd years of college. It is plausible that something in their background, educational processes, or environmental factors cause pharmacists to have different sources of motivation than the customary TAM subjects. These potential differences may account for the model's inadequate fit to the sample data.

Outcome Orientation. Examination of the statements in the TAM literature reveals that the statements primarily focus on evaluating the target technology from a process point of view. The general nature of the statements (that was originally intended to allow the model to be used for a variety of settings) centers on the target technology from a functional point of view. Conversely, pharmacy has adopted pharmaceutical care as its philosophy of practice. This philosophy of practice centers on outcomes as the ultimate goal of pharmacists' activities. The TAM(2) statements do not focus on the target technology's ability to achieve outcomes specific to the potential user. This lack of matching between pharmacists' focus on outcomes and the instrument's focus on process is a potential explanation for the absence of adequate model fit in this study.

Research Question Four

One null hypothesis was associated with research question four. This hypothesis is presented below. It states that pharmacists' intentions to use PDAs to document

interventions will not change from before to after a training session on PDA use. The null hypothesis for research question four was accepted. The mean pre-presentation intention score was 12 and the mean post-presentation score was 12.46 (*p-value* = .097).

H_0^4 – There will not be a difference in pharmacists' intentions to use PDAs to document interventions after a 3-hour training session on PDA use.

Intention scores were arrived at by summing two intention items on both versions of the presentation questionnaire. The highest possible summed score on each version was 14; the lowest was two. The mean pre-presentation score of 12.00 across all subjects indicates that this sample had strong, positive intentions toward the use of PDAs to document intentions prior to the presentation.

ASHP Advantage publicized the presentation through several methods. A registration web site was developed and hosted several months prior to the actual day of the presentation. All registered meeting attendees who stayed in any official meeting hotel received an informational card placed in a plastic bag that was hung on their hotel room door. The presentation was also listed in the electronic, PDA-based meeting guide that was made freely available to all meeting registrants. Also, the official, paper-based meeting guide contained an announcement of the program. This guide was made available to all registered meeting attendees. These promotional materials contained all, or a variation of the information presented in Appendix K, depending on their location of publication.

These marketing efforts were undertaken to use as many channels as possible to inform the meeting attendees about the presentation. Despite these efforts, one can not

definitively say that every person attending the meeting actually read some type of promotional information about the session. However, one can say with a high degree of certainty that those who did attend the presentation had strong, positive intentions toward the use of PDAs to document intentions. This is evident in the pre-presentation intention scores, which indicate that the presentation attendees had strong, positive intentions toward the use of PDAs to document intentions prior to the presentation.

These intentions did not significantly change after the presentation. The mean, post-presentation intention score of 12.46 was not statistically different than the pre-presentation score of 12.00 (*p-value* = .097). The highest possible mean intention score on both questionnaires was 14. Several potential explanations exist for the observed non-significant change in intention scores. These explanations follow.

The first two explanations for the non-significant change in intention scores suggest that a restriction of range may be present in the study. A restriction of range, or ceiling effect, occurs when a characteristic of the sample or measurement instrument limits the upper range of possible scores. An ipsatization procedure was performed on the data because of poor reliability for two constructs. This poor reliability was thought to possibly be due to a restriction of range in the intention construct. Results from the ipsatization procedure suggest that a restriction of range was not present. However, a restriction of range can not be ruled out. Therefore, two potential explanations for a restriction of range are presented.

In the present study, the measurement instrument itself could be designed in such a way to introduce a range restriction. While this is an acknowledged possibility, the likelihood of this causing the restriction of range is viewed as negligible. The specific

items used on the questionnaires to elicit the attendees' intentions were taken directly from published studies; the only difference in the items being the target action of using PDAs to document interventions. No previously published studies identified restriction of range problems with these items.

The second source of the potential restriction of range is the attendees' apparent pre-existing intentions about using PDAs to document interventions. As discussed above, circumstances surrounding the presentation and the pre-presentation intention scores suggest that this sample of pharmacists had an existing strong, positive attitude toward using PDAs to document interventions. This characteristic of the group could have made it more difficult to observe changes within the group because the majority of the attendees appear to have been gathered on the end of the spectrum corresponding to strong intentions to adopt PDAs.

The third potential explanation for the observed, non-significant increase in intentions relates to the content of the presentation. It is possible that the increase in intentions was not significant because the content of the presentation did not significantly impact the attendees' intentions in a positive manner toward PDA use. The sample's average pre-presentation intention score of 12 indicates that the group had an existing strong, positive attitude toward using PDAs to document interventions. The presentation was designed to equip the attendees to be able to:

- Outline a sequence for the adoption of PDA technology into the workflow and workload of a pharmacist.

- List and discuss commercially available PDA-based intervention documentation and database development software that are appropriate for a health system's pharmacy practice.
- Compare and contrast at least two PDA-based intervention documentation strategies in terms of usefulness, ease of use, scalability, and other logistical considerations.
- List the critical clinical fields that should be available in both proprietary PDA-based intervention documentation applications and self-developed database software used to document interventions.
- Develop a spreadsheet evaluation matrix that includes clinical, financial, and selection considerations for the implementation of a PDA-based intervention documentation initiative.
- Describe a likely scenario for the future development and integration of intervention documentation software into a clinical suite of other PDA-based software.

While the principal investigator and Bill G. Felkey generally believe that PDA-based documentation is a better method than existing approaches to intervention documentation, their presentation was designed to provide the attendees with objective information about using PDAs to document interventions. Accordingly, it is reasonable to expect that this information could have caused some attendees to weaken, or at least not strengthen their intentions to implement PDA-based documentation. Therefore, hypothesis H_0^4 was not rejected.

Research Question Five

Research question five asked if there were any differences in pharmacists' intentions to use PDAs to document interventions based on demographic variables. There were five null hypotheses associated with this research question. These hypotheses are presented below. These hypotheses tested the relationships between five demographic variables and intentions to use PDAs to document interventions. The five demographic variables are: professional position, pharmacy department size, gender, age, and experience.

H_0^{5a} – No relationship will exist between position and intentions.

H_0^{5b} – No relationship will exist between pharmacy department size and intentions.

H_0^{5c} – No relationship will exist between gender and intentions.

H_0^{5d} – No relationship will exist between age and intentions.

H_0^{5e} – No relationship will exist between experience and intentions.

Correlational analysis indicated that a statistically significant relationship existed between pharmacy department size and intentions. This was an inverse relationship; as the size of the pharmacy department decreased, intentions to use PDAs to document interventions increased (r = -.245, *p-value* = .036). Table 20 presents the Pearson Produce Moment correlation for each independent variable and the dependent variable. None of the other demographic variables exhibited a significant relationship with intentions. While correlational relationships do not indicate the presence of a cause and

effect relationship, two possible explanations for the association between pharmacy department size and intentions are presented.

Regardless of the pharmacy department size, a primary impetus for documenting interventions is to demonstrate and record the pharmaceutical care activities that pharmacists perform (Brown, 1991; Hatoum, Hutchinson, Elliott et al., 1988). The emphasis placed on intervention documentation in the literature (Brown, 1991; Gibson et al., 1982; Hatoum et al., 1986; Johnson et al., 2002; Klinger, 1990) supports the importance of this activity. Additional literature suggests interest among practitioners for more efficient documentation methods (Bluml & Enlow, 1993; Clark & Klauck, 2003; Reilly et al., 2001). Indeed, several information technology companies (HealthProLink, www.healthprolink.com; MedKeeper, www.medkeeper.com; and PIDS, www.pidsware.com) market electronic, PDA-based tools designed solely for documenting pharmacists' interventions.

It is also possible that unmeasured characteristics of smaller pharmacy departments could account for the observed relationship between intentions and department size. Pharmacy department size can serve as a surrogate marker of overall institution size because a primary function of institutional pharmacies is to support clinical staff by managing medications used in the treatment of the institution's patients. While regional factors such as individual prescribing patterns, institutional formularies, and most commonly treated conditions can impact an institution's medication usage, smaller institutions (measured by the number of patient beds) generally have correspondingly smaller pharmacy departments (measured by the number of FTEs) than larger institutions.

Institutional Culture

Is there a characteristic of smaller institutions that can account for the relationship observed between intentions and pharmacy department size? One possible institutional characteristic that may impact pharmacists' intentions is the institution's culture. From his professional experiences, the principal investigator has observed that small pharmacy departments have fewer pharmacists to perform a set of tasks similar to those found in larger institutional pharmacies. While the investigator has observed that the volume of activities performed is generally lower in smaller pharmacy departments, the set of tasks that these pharmacists performed has been relatively consistent with those of pharmacists in larger institutions.

Consequently, pharmacists in small pharmacy departments often perform a broad set of tasks that would normally be shared among multiple pharmacists in larger pharmacy departments. These tasks can include serving on institutional committees, responding to requests from other clinicians, and documenting interventions. By performing this broad task set, pharmacists in smaller hospitals have frequent opportunities to interact with other clinicians.

Furthermore, just as fewer numbers of pharmacists are found in smaller institutions, it is often the case that smaller institutions have fewer clinicians from other disciplines. The principal investigator has observed that smaller health care institutions are often located in small communities. Generally, small communities have less demand for health care providers than large communities, simply due to fewer individuals needing care. As a result, pharmacists in smaller institutions often interact with the same clinicians routinely. Therefore, pharmacists in smaller institutions often have more

opportunities to interact with a small group of clinicians, giving them opportunities to build relationships with these clinicians.

These relationships are a characteristic of small pharmacy departments that can possibly explain the relationship observed between department size and intentions. The nature of intervention documentation can sometimes dictate that pharmacists question the actions or judgment of other clinicians. Presumably, the presence of collegial relationships between pharmacists and other clinicians can decrease the pharmacists' expectation of resistance to their interventions. Subsequently, pharmacists will feel more comfortable performing interventions. Also, it is reasonable to expect that collegial relationships will create a feeling among other clinicians that pharmacists are an approachable, valuable resource that can provide meaningful input into patient care. Other clinicians will then solicit pharmacists' input, providing opportunities for interventions.

This line of reasoning provides one plausible explanation for why pharmacists might feel more inclined to document interventions in smaller institutions, but it does not explain why they might intend to use PDAs to perform this task. According to recommendations by Ajzen and Fishbein (1980), the intention statements used in the questionnaires specifically identified PDAs as the target technology for the pharmacists' intentions. As discussed above, this group of pharmacists had strong, positive feelings about using PDAs before the presentation began. Also, 65% of the group had previous experience with paper-based documentation methods. Published literature suggests interest among practitioners to find more efficient intervention documentation methods (Fraser, 1994; Johnson et al., 2002; Mason et al., 1994; Zimmerman et al., 1995). It is

possible that the observed intentions are actually reflecting the attendees' desire to use any documentation method that is potentially better than their current method. In the case of this research, the alternative method is PDAs.

In summary, the culture in smaller health care institutions gives pharmacists opportunities to interact with other clinicians, leading to the development of collegial relationships. In turn, pharmacists are more likely to perform interventions. Due to this cultural difference, this group of pharmacists may have had intervention documentation experiences beyond that customarily seen in larger institutions. Because of a desire to improve documentation (which was not measured in this study), this group may have viewed PDAs as a promising alternative. If this proposed explanation is accurate, it would suggest that the attendees' responses were actually a measure of their intentions to find an alternative documentation method.

Measurement Artifact

A second possible explanation for the observed relationship between pharmacy department size and intentions is that the relationship is an artifact of the study. Data from item 48 indicate that the number of FTEs at the attendees' pharmacy departments ranged from one to 60. The mean was 19.6 FTEs, and the standard deviation was 15.4 FTEs, indicating substantial variability in the range of FTEs reported by the attendees. Forty-one attendees were distributed below the mean, and 32 were above the mean.

If the data are examined in terms of the standard deviation, 82% of the FTEs reported below the mean fall within one standard deviation of the mean, with a second standard deviation capturing all FTEs reported below the mean. One standard deviation

above the mean captures 59% of the FTEs reported above the mean. Two standard deviations above the mean captures an additional 28% of the FTEs reported, leaving 13% of the FTEs reported above the mean falling between two and three standard deviations.

Several conclusions can be drawn from these facts. First, the majority of attendees (56%) practice pharmacy in departments with FTE totals below the mean. Furthermore, pharmacy departments with smaller numbers of FTEs are more representative of the sample as a whole because these departments fall primarily within one standard deviation of the mean. Conversely, pharmacy departments with larger numbers of FTEs are less representative of the sample as a whole because 41% of these departments fall within two and three standard deviations of the mean. In summary, the sample contained a larger number of pharmacists from smaller pharmacy departments than larger pharmacy departments, based on the number of full-time equivalent (FTE) pharmacist positions within the pharmacy.

As a whole, the sample had strong, preexisting intentions to use PDAs to document interventions, as indicated by the mean pre-presentation intention score. The observed, inverse relationship between FTEs and intentions to use PDAs could be due to chance because intentions were high in this sample, and this sample contained a larger number of attendees from smaller pharmacy departments.

Summary and Overall Conclusions

The purpose of this investigation was to apply a modified Technology Acceptance Model 2 (TAM2) to pharmacists' intentions to use personal digital assistants (PDAs) to document interventions in acute care and ambulatory care settings. The modified

TAM2's ability to explain pharmacists' intentions to use PDAs to document interventions was the focus of this research. Results from this study indicate that the model tested did not accurately describe the sample of 74 pharmacists. This suggests that the modified TAM2 is not a useful model to explain this group of pharmacists' intentions to use PDAs to document interventions.

A bootstrap procedure was performed on the data due to the low rate of usable responses (n = 74). Bootstrapping has been identified as a way to perform a structural equation modeling analysis in situations of moderately small sample sizes (Byrne, 2001). The usable response rate in this study is approximately half the recommended sample size for a structural equation modeling analysis (Hair et al., 1998; Thompson, 2002). Model fit indices obtained after performing the bootstrap procedure indicated that the modified TAM2 did not accurately describe the bootstrapped data. This supports the results obtained on the sample data, and further suggests that the modified TAM2 is not a useful model to explain the PDA usage intentions of pharmacists similar to those in the sample.

Data analysis also indicated unreliable measurement of two constructs, Output Quality and Result Demonstrability. The measurement items for these constructs in this study were no different than other published uses, other than modifications to fit the use of PDAs to document interventions. Previously published research has shown acceptable reliability for these constructs (Chismar & Wiley-Patton, 2002; Venkatesh & Davis, 2000). However, Venkatesh and Davis (2000) found an interaction relationship between these constructs. Chismar and Wiley-Patton (2002) did not find this relationship. The present research did not test for an interaction because the results of Chismar and Wiley-

Patton's (2002) study did not find an interaction and because structural equation modeling does not test for interaction relationships. These two constructs were not included in data analysis.

The dependent variable in this study was pharmacists' intentions to use PDAs to document interventions. Results indicate that the attendees had strong, positive intentions before the presentation began. Intention scores increased after the training session, but this change was not significant. Several potential explanations were presented. Two explanations suggested that a ceiling effect was present due to instrument design or the sample's general, strong positive pre-existing intentions to use PDAs to document interventions. An ipsatization procedure that was performed on the data due to poor reliability for two constructs suggests that a restriction of range was not present in the intention construct. The third explanation offered for the non-significant increase in intentions was that the nature and content of the presentation did not impact the attendees in a manner to increase their PDA usage intentions.

Five demographic variables were tested for relationships with intentions: professional position, pharmacy department size, gender, age, and experience. Correlational analyses indicated that pharmacy department size was the only demographic variable to exhibit a significant relationship with intentions. The relationship was inverse; intentions to use PDAs to document interventions increased as the size of the pharmacy department decreased. One can only speculate as to what factor(s) account for this association. Two possible explanations were presented.

First, the culture of smaller health care institutions (where small pharmacy departments are generally located) could create an environment that is more conducive to

intervention documentation. This environment is believed to be due to the presence of more opportunities for pharmacists to interact with other clinicians. Through these interactions, pharmacists are able to establish relationships that remove barriers and open doors to intervention documentation. It is possible that the measurement of pharmacists' intentions to use PDAs are actually indicators of their desire to use any documentation method that appears to offer advantages over their current methods. Recent publications offer support of the supposition that better documentation methods are desired (Fraser, 1994; Johnson et al., 2002; Mason et al., 1994; Zimmerman et al., 1995). It is possible that

Secondly, the observed relationship between intentions and department size may simply be an artifact of the study. The majority of attendees in the presentation were from smaller pharmacy departments. The average pre-presentation intention score indicated strong, positive intentions toward the use of PDAs to document interventions. It is possible that pharmacists from smaller departments appeared to have higher intentions because they outnumbered the pharmacists from larger institutions in a group who, as a whole, had strong, positive intentions.

Limitations

This research is subject to several limitations. First, the time element of the behavior (PDA usage) was not included in the questionnaires. The time element is one of the four elements of the behavior in question that must be defined to allow optimal prediction of the behavior from intentions. The other three elements of behavior are action, target, and context. The time element was not specifically included in the

questionnaires because the attendees were expected to be a broad group of pharmacists who were anticipated to have varying goals, obstacles, and time frames for implementing a new PDA-based documentation system. These differences could cause someone who was truly planning on implementing PDA-based documentation to indicate that they did not intend to use PDAs because the specified time frame did not fit their situation. The principal investigator's goal was to determine general intentions without respect to the time period. Despite this goal, the absence of a time element does potentially introduce a level of ambiguity about the activity. This uncertainty is a limitation because it can influence the attendees' ability to form intentions about the behavior due to the lack of specificity for the behavior.

Second, the study sample was composed of individuals who may not represent the population of acute care and ambulatory care pharmacists practicing in the United States. Presumably, this convenience sample chose to attend the presentation based on promotional materials they read describing the presentation. Thousands of other pharmacists received these materials and did not attend the presentation. Furthermore, the attendees demonstrated a strong interest in the topic by choosing to attend the presentation instead of enjoying the tourism activities and numerous other concurrent sessions available to them. This indicates that the attendees may not represent the pharmacists to whom the results would logically be generalized.

A third limitation is also related to the sample. Specifically, adequate sample size was not achieved. The sample size of 74 is approximately half of the size recommended in the literature (Hair et al., 1998; Thompson, 2002). A bootstrap procedure was performed to potentially overcome this limitation. Recommendations in the literature call

for the use of bootstrapping when sample sizes are moderately small without quantifying what constitutes moderately small (Byrne, 2001). It is possible, then, that the poor model fit was a result of the inadequate sample size.

A fourth limitation is related to the Attitude item. Sixteen of the 74 attendees did not completely answer this item. This represented 21.6% of the final sample, and the item was subsequently dropped to prevent further reductions of the sample size. The high percentage of partial answers to this item indicates that the instructions were inadequate, confusing, or misleading. It is possible that better designed instructions could have prevented removal of this item from the study.

A fifth limitation of this study is the potential for nonresponse bias to influence the results. No measures were taken to account for nonresponse bias. The pre-presentation questionnaire was 50 items long. The principal investigator and Bill G. Felkey were concerned that the addition of another set of items would potentially decrease response rates. Therefore, the possibility exists that the participating attendees were different than those who were present for the presentation but did not complete their questionnaires.

A sixth limitation of the study is the potential for social desirability to influence the attendees' responses to the questionnaires. Through their scholarly efforts, the principal investigator and Bill G. Felkey have a high level of visibility within the pharmacy profession. Furthermore, this presentation was the fourth one given in four consecutive years at the ASHP Midyear Clinical Meeting focusing on the use of portable technology. Generally, these presentations have described how pharmacists can use portable technology to improve their efficiency and effectiveness. Because the focus of

these scholarly efforts is the implementation of information technology in pharmacy, it is reasonable to believe that the attendees could have felt that the principal investigator and/or Bill G. Felkey wanted the attendees to indicate positive feelings towards PDAs. This could potentially cause the attendees to answer the questionnaires in a manner that was not an accurate depiction of their feelings. No measure was taken to assess the potential existence of this limitation.

Future Research

Several opportunities for future investigation can be drawn from this research. First, replication of the study should be performed prior to concluding that the modified TAM2 is an inadequate model for explaining pharmacists' intentions to use PDAs. The small sample size and the use of a convenience sample in this study suggest the need for replication in larger, more diverse samples using different empirical approaches, such as real-time online questionnaires.

Second, the TAM and TAM2 were initially developed for use in the information systems field to explain intentions and usage of information technology in volitional situations. Little published research has applied these models to health care professionals (Liang, Xue, & Byrd, 2003; Patrick Y. K. Chau & Hu, 2002). It is possible that there are intrinsic differences between pharmacists and the subjects usually found in TAM research, college level business students and business professionals. Pharmacy students often begin specialized curricula in their 1st or 2nd years of college. It is plausible that something in their background, educational processes, or environmental factors cause pharmacists to have different sources of motivation than the customary TAM subjects.

These sources of motivation may not be reflected in the original TAM, TAM2, or the modified TAM2 here. Future research should search for factors that may be unique to health care professionals in influencing their intentions to use information technology. Additionally, this research should not be limited to the use of PDAs to document interventions. Electronic health records and computerized prescriber order entry are two important information technology topics in health care today. These technologies represent potential target technologies.

Third, TAM is but one of many proposed methods of explaining an individual's usage of information technology. Other methods of explaining behavior include the Model of PC Utilization, the Innovation Diffusion Theory, and the Motivational Model. Research published after the initiation of this study found that a model combining eight other models (including TAM) was able to explain information technology usage intentions better than any of the eight models (Venkatesh, Morris, Davis, & Davis, 2003). Although not explicitly designed for use in health care, this model's ability to explain 69% of the variance in intentions warrants future study.

Finally, early TAM research, and the majority of subsequent TAM research has consistently measured intentions instead of actual usage of the target technology. It is often the case that intentions are measured due to convenience. Intentions are also measured to identify potential problems that may occur in order to develop methods to overcome these problems during implementation. Because of the time and expense often expended in adopting new information technology, future research should further explore the relationship between intentions and actual technology usage.

BIBLIOGRAPHY

Adams, D. A., & Nelson, R. R. (1992). Perceived usefulness, ease of use, and usage of information technology: A replication. *MIS Quarterly, 16*(2), 227-247.

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

Ajzen, I. (2002). *Theory of planned behavior (TpB)*. Retrieved November 28, 2003, from http://www-unix.oit.umass.edu/~aizen/tpb.html.

Ajzen, I., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Ary, D., Jacobs, L. C., & Razavieh, A. (2002). *Introduction to Research in Education* (6th ed.). Belmont, CA: Wadsworth Group.

ASHP. (2003). *38th ASHP Midyear Clinical Meeting and Exhibits: Educational Information*. Retrieved November 10, 2003, from http://www.ashp.com/meetings/midyear/program/educ-info.cfm.

Barker, K. (1967). The future role of the hospital pharmacist in drug distribution systems. *American Journal of Hospital Pharmacy, 24*, 220-227.

Barker, K. (1969). The effects of an experimental medication system on medication errors and cost, Part One: Introduction and errors study. *American Journal of Hospital Pharmacy, 26*(June), 324-333.

Barker, K., Heller, W., Brennan, J., & Sheldon, E. (1964a). The development of a centralized unit dose dispensing system, Part Six: The pilot study - medication errors and drug losses. *American Journal of Hospital Pharmacy, 21*, 609-624.

Barker, K., Heller, W., Brennan, J., & Sheldon, E. (1964b). The development of a centralized unit dose dispensing system, Part Three: An editing center for physicians' medication orders. *American Journal of Hospital Pharmacy, 21*, 66-77.

Bethune, J.-A., Zellmer, W., & Sage-Gagne, W. (2002). *The early years of ASHP: A history*. Retrieved April 5, 2004, from http://www.ashp.org/aboutashp/ashpearlyyears.pdf.

Bluml, B. M., & Enlow, M. (1993). Use of hand-held computers to record and analyze intervention data. *Topics in Hospital Pharmacy Management, 13*(2), 25-31.

Brody, J. A., Camamo, J. M., & Maloney, M. E. (2001). Implementing a personal digital assistant to document clinical interventions by pharmacy residents. *American Journal of Health-System Pharmacy, 58*, 1520-1522.

Brown, G. (1991). Assessing the clinical impact of pharmacists' interventions. *American Journal of Hospital Pharmacy, 48*, 2644-2647.

Bryant, F. B. (2002). Assessing the validity of measurement. In P. R. Yarnold (Ed.), *Reading and understanding more multivariate statistics* (pp. 99-146). Washington, DC: American Psychological Association.

Byrne, B. M. (2001). *Structural equation modeling with AMOS: Basic concepts, applications, and programming*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Center, C. P. R. (2002). *Detailed overview of the Transtheoretical Model*. Retrieved June 2, 2004, from http://www.uri.edu/research/cprc/TTM/detailedoverview.htm.

Chau, P. Y. K. (2001). Influence of computer attitude and self-efficacy on IT usage behavior. *Journal of End User Computing, 13*(1), 26-33.

Chau, P. Y. K., & Hu, P. J.-H. (2002). Investigating healthcare professionals' decisions to accept telemedicine technology: An empirical test of competing theories. *Information & Management, 39*(4), 297-311.

Chismar, W. G., & Wiley-Patton, S. (2002). Test of the Technology Acceptance Model for the Internet in Pediatrics. *Proceedings of the AMIA 2002 Annual Symposium*, 155-159.

Cipolle, R. J., Strand, L. M., & Morley, P. C. (1998). *Pharmaceutical Care Practice*. New York: McGraw-Hill.

Clark, J. S., & Klauck, J. A. (2003). Recording pharmacists' interventions with a personal digital assistant. *American Journal of Health-System Pharmacy, 60*, 1772-1774.

CNN. (1996, April 4). *Electronic organizer links to your computer*. Retrieved November 27, 2003, from http://www.cnn.com/TECH/9604/04/pocket_computer/.

Compeau, D. R., & Higgins, C. A. (1995). Computer self efficacy: Development of a measure and initial test. *MIS Quarterly, 19*(2), 189-211.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319-340.

Davis, F. D. (1993). User acceptance of information technology: System characteristics, user perceptions and behavioral impacts. *International Journal of Man-Machine Studies, 38*, 475-487.

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*, 19-45.

Doll, W. J., Hendrickson, A., & Deng, X. (1998). Using Davis's perceived usefulness and ease-of-use instruments for decision making: A confirmatory and multigroup invariance analysis. *Decision Sciences, 29*(4), 839-869.

Felkey, B. G., & Fox, B. I. (2003). Informatics: The Integration of Technology into Pharamceutical Care. In R. P. Penna (Ed.), *Pharmaceutical Care* (2nd ed.). Bethesda, MD: American Society of Health-System Pharmacists.

Folli, H. L. P., Robert L. Benitz, William E. Russo, Janita C. (1987). Medication error prevented by clinical pharmacists in two children's hospitals., *Pediatrics DE - MEDICATION errors CLINICAL pharmacology PHARMACISTS PEDIATRICS -- Study & teaching (Continuing education) PG - 5p*.

Francke, G. N. (1969). Evolvement of clinical pharmacy. *Drug Intelligence and Clinical Pharmacy, 3*, 348-354.

Fraser, J. (1994). Standardize intervention recording. *Hospital Pharmacy Practice, 4*(October), 373-374,376-377.

Gefen, D., Straub, D. W., & Boudreau, M.-C. (2000). *Structural equation modeling and regression: Guidelines for research practice*. Retrieved November 14, 2003, from http://cais.isworld.org/articles/4-7/default.asp?View=pdf&x=29&y=16.

Gibson, F. M., Hyneck, M. L., & Scherrer, J. J. (1982). Documented effectiveness of clinical pharmacy services. *American Journal of Hospital Pharmacy, 39*, 1902-1903.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate Data Analysis* (5th ed.). Upper Saddle River, NJ: Prentice Hall.

Hatoum, H. T., Catizone, C., Hutchinson, R. A., & Purohit, A. (1986). An eleven-year review of the pharmacy literature: Documentation of the value and acceptance of clinical pharmacy. *Drug Intelligence and Clinical Pharmacy, 20*, 33-48.

Hatoum, H. T., Hutchinson, R. A., Elliott, L. R., & Kendzierski, D. L. (1988). Physicians' review of significant interventions by clinical pharmacists in inpatient care. *Drug Intelligence and Clinical Pharmacy, 22*, 980-982.

Hatoum, H. T., Hutchinson, R. A., Witte, K. W., & Newby, G. P. (1988). Evaluation of the contribution of clinical pharmacists: Inpatient care and cost reduction. *Drug Intelligence and Clinical Pharmacy, 22*, 252-259.

Healthy PalmPilot. (2003, September 18,2003). Retrieved November 1, 2003, from http://www.healthypalmpilot.com/.

Hendrickson, A. R., Massey, P. D., & Cronan, T. P. (1993). On the test-retest reliability of perceived usefulness and perceived ease of use scales. *MIS Quarterly, 17*(2), 227.

Hepler, C. D., & Strand, L. M. (1990). Opportunities and responsibilities in pharmaceutical care. *American Journal of Hospital Pharmacy, 47*(3), 533-543.

Higby, G. J. (2003). From Compounding to Caring: An Abridged History of American Pharmacy. In R. P. Penna (Ed.), *Pharmaceutical Care* (2nd ed.). Bethesda, MD: American Society of Health-System Pharmacists.

Hudmon, K., & Berger, B. (1995). Pharmacy applications of the transtheoretical model in smoking cessation. *American Journal of Health-System Pharmacy, 52*, 282-287.

Igbaria, M., Guimaraes, T., & Davis, G. B. (1995). Testing the determinants of microcomputer usage via a structural equation model. *Journal of Management Information Systems, 11*(4), 87.

Igbaria, M., Zinatelli, N., Cragg, P., & Cavaye, A. L. M. (1997). Personal computing acceptance factors: A structural equation model. *MIS Quarterly, 21*(3), 279-302.

Isetts, B. J., Brown, L. M., Schondelmeyer, S. W., & Lenarz, L. A. (2003). Quality assessment of a collaborative approach for decreasing drug-related morbidity and achieving therapeutic goals. *Archives of Internal Medicine, 163*, 1813-1820.

Johnson, S. T., Brown, G. C., & Shea, K. M. (2002). Reengineering a pharmacist intervention program. *American Journal of Health-System Pharmacy., 59*(10), 916-917.

Kerlinger, F. N., & Lee, H. B. (2000). *Foundations of Behavioral Research* (4th ed.). Orlando, FL: Harcourt, Inc.

Klem, L. (2002). Structural equation modeling. In P. R. Yarnold (Ed.), *Reading and understanding more multivariate statistics* (pp. 227-260). Washington, DC: American Psychological Association.

Kline, R. B. (1998). *Principles and Practice of Structural Equation Modeling*. New York: The Guilford Press.

Klinger, P. (1990). Protocols for pharmacists' intervention in a 160 bed hospital. *Hospital Pharmacy., 25*(10), 917-921.

Lau, A., Balen, R. M., Lam, R., & Malyuk, D. L. (2001). Using a personal digital assistant to document clinical pharmacy services in an intensive care unit. *American Journal of Health-System Pharmacy, 58*, 1229-1232.

Lee, A. J., Boro, M. S., Knapp, K. K., Meier, J. L., & Korman, N. E. (2002). Clinical and economic outcomes of pharmacist recommendations in a Veterans Affairs medical center. *American Journal of Health-System Pharmacy, 59*(21), 2070-2077.

Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & Management, 40*(3), 191-204.

Liang, H., Xue, Y., & Byrd, T. A. (2003). PDA usage in healthcare professionals: testing an extended technology acceptance model. *International Journal of Mobile Communications, 1*(4), 372-389.

Lynx, D. H., Brockmiller, H. R., Connelly, R. T., & Crawford, S. Y. (2003). Use of a PDA-based pharmacist intervention system. *American Journal of Health-System Pharmacy, 60*, 2341-2344.

Mason, R. N., Pugh, C. B., Boyer, S. B., & Steining, K. K. (1994). Computerized documentation of pharmacists' interventions. *American Journal of Hospital Pharmacy, 51*, 2131-2138.

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

McConnell, W., Barker, K., & Garrity, L. (1961). Centralized unit-dose dispensing: Report of a study. *American Journal of Hospital Pharmacy, 18*, 530-541.

McGhan, W. F., Rowland, C. R., & Bootman, J. L. (1978). Cost-benefit and cost-effectiveness: Methodologies for evaluating innovative pharmacy services. *American Journal of Hospital Pharmacy, 35*, 133-140.

McLeod, D. C. (1976). Clinical pharmacy: The past, present and future. *American Journal of Hospital Pharmacy, 33*, 29-38.

Mooney, C. Z., & Duval, R. D. (1993). Bootstrapping: A nonparametric approach to statistical inference. In M. Lewis-Beck (Ed.), *Quantitative Applications in the Social Sciences*. Newbury Park, CA: Sage Publications, Inc.

Mutnick, A. H., Sterba, K. J., Peroutka, J. A., Sloan, N. E., Beltz, E. A., & Sorenson, M. K. (1997). Cost savings and avoidance from clinical interventions. *American Journal of Health-System Pharmacy., 54*(4), 392-396.

Nunnally, J. C. (1978). *Psychometric Theory* (2nd ed.). New York: McGraw-Hill.

Overhage, J. M., & Lukes, A. (1999). Practical, reliable, comprehensive method for characterizing pharmacists' clinical activities. *American Journal of Health-System Pharmacy, 56*(23), 2444-2450.

PalmSource. (2003). *Why develop for Palm OS?* Retrieved September 20, 2003, from http://www.palmsource.com/developers/why_develop.html

Penna, R. P. (1990). Pharmaceutical care: pharmacy's mission for the 1990s. *American Journal of Hospital Pharmacy., 47*(3), 543-549.

Pettey, C. (2003). *Gartner says Palm OS licensees accounted for 51 percent of PDA shipments and 41 percent of worldwide revenue in second quarter of 2003*. Retrieved September 20, 2003, from http://www3.gartner.com/5_about/press_releases/pr15aug2003b.jsp

Prochaska, J. O. (1979). *Systems of Psychotherapy: A Transtheoretical Analysis*. Homewood, Illinois: The Dorsey Press.

Prochaska, J. O. (1984). *Systems of Psychotherapy: A Transtheoretical Analysis* (2 ed.). Homewood, Illinois: The Dorsey Press.

Prochaska, J. O., & DiClemente, C. C. (1984). *The Transtheoretical Approach: Crossing Traditional Boundaries of Therapy*. Homewood, Illinois: Dow Jones-Irwin.

Reilly, J. C., Wallace, M., & Campbell, M. M. (2001). Tracking pharmacist interventions with a hand-held computer. *American Journal of Health-System Pharmacy, 58*, 158-161.

Schumock, G. T., Guenette, A. J., Clark, T., & McBride, J. M. (1993). Hospital mainframe computer documentation of pharmacist interventions. *Topics in Hospital Pharmacy Management., 13*(2), 16-24.

Simonian, A. I. (2003). Documenting pharmacist interventions on an intranet. *American Journal of Health-System Pharmacy, 60*, 151-155.

Slaughter, R. L., Erickson, S. R., & Thomson, P. A. (1994). Clinical interventions provided by Doctor of Pharmacy students. *Annals of Pharmacotherapy, 28*(5), 665-670.

Strong, D. K., & Tsang, G. W. Y. (1993). Focus and impact of pharmacists' interventions. *The Canadian Journal of Hospital Pharmacy, 46*(3), 101-108.

Subramanian, G. (1994). A replication of perceived usefulness and perceived ease of use measurement. *Decision Sciences, 5-6*, 863-873.

Szajna, B. (1996). Empirical evaluation of the revised technology acceptance model. *Management Science, 42*(1), 85.

Taylor, C. T., Church, C. O., & Byrd, D. C. (2000). Documentation of clinical interventions by pharmacy faculty, residents, and students. *The Annals of Pharmacotherapy, 34*, 843-847.

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

Taylor, S., & Todd, P. A. (2001). Understanding information technology usage: A test of competing models. *Information Systems Research, 6*(2), 144-176.

Thompson, B. (2002). Ten commandments of structural equation modeling. In P. R. Yarnold (Ed.), *Reading and understanding more multivariate statistics* (pp. 261-283). Washington, DC: American Psychological Association.

Vecchione, A. (1997). New data-collection tool speeds up reporting process. *Hospital Pharmacist Report, 11*, 64.

Venkatesh, V. (2000). Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model., *Information Systems Research* (Vol. 11, pp. 342): INFORMS: Institute for Operations Research.

Venkatesh, V., & Davis, F. D. (1996). A model of the antecedents of perceived ease of use: Development and test. *Decision Sciences, 27*(3), 451.

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. (2000). Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior. *MIS Quarterly, 24*(1), 115-139.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly, 27*(3), 425-478.

Villaume, W. A., & Weaver, J. B. (1996). A factorial approach to establishing reliable listening measures from the WBLT and the KCLT: Full information factor analysis of dichotomous data. *International Journal of Listening, 10*, 1-20.

Zimmerman, C. R., Smolarek, R. T., & Stevenson, J. G. (1995). A computerized system to improve documentation and reporting of pharmacists' clinical interventions, cost savings, and workload activities. *Pharmacotherapy, 15*(2), 220-227.

Zimmerman, C. R., Smolarek, R. T., & Stevenson, J. G. (1997). Peer review and continuous quality improvement of pharmacists' clinical interventions. *American Journal of Health-System Pharmacy, 54*, 1722-1727.

APPENDIX A

PRE-PRESENTATION QUESTIONNAIRE

Pre-Presentation Questionnaire

Consider the following definitions when providing answers to the statements below:

- **Personal Digital Assistant (PDA)** – a handheld, pen-based computing device with information storage/retrieval capabilities, including the ability to access clinical information and document clinical activities such as interventions

- **Intervention** - any solicited or unsolicited information provided by a pharmacist to another healthcare professional or to a patient in regard to the optimal use of medications for patient care

Your responses to these questions are completely anonymous.

Please use the scale below to indicate your level of agreement with statements 1 – 26.

1 Strongly Disagree	2 Moderately Disagree	3 Somewhat Disagree	4 Neutral	5 Somewhat Agree	6 Moderately Agree	7 Strongly Agree

1.	Assuming that I have access to a PDA intervention documentation tool, I intend to use it.....	1	2	3	4	5	6	7
2.	Given that I have access to a PDA intervention documentation tool, I predict that I would use it.....	1	2	3	4	5	6	7
3.	I believe I could communicate to others the consequences of using a PDA intervention documentation tool.....	1	2	3	4	5	6	7
4.	I would not find it easy to get a PDA to do what I want it to do as an intervention documentation tool.....	1	2	3	4	5	6	7
5.	My use of a PDA intervention documentation tool would be voluntary.....	1	2	3	4	5	6	7
6.	I would have no problem with the quality of a PDA intervention documentation tool's output.....	1	2	3	4	5	6	7
7.	It would not be easy for me to become skillful at using a PDA as an intervention documentation tool.....	1	2	3	4	5	6	7
8.	People in my organization who use a PDA intervention documentation tool would have more prestige than those who do not.....	1	2	3	4	5	6	7
9.	In my job, usage of a PDA intervention documentation tool would be relevant.	1	2	3	4	5	6	7
10.	I would find a PDA intervention documentation tool easy to use.....	1	2	3	4	5	6	7
11.	I would have difficulty explaining why using a PDA intervention documentation tool may or may not be beneficial.....	1	2	3	4	5	6	7
12.	In my job, usage of a PDA intervention documentation tool would not be important.....	1	2	3	4	5	6	7

		SD			N			SA
13.	People in my organization who use a PDA intervention documentation tool would have a high profile.....	1	2	3	4	5	6	7
14.	Using a PDA would improve my performance in documenting patient interventions.....	1	2	3	4	5	6	7
15.	The quality of the output I would get from a PDA intervention documentation tool is high.....	1	2	3	4	5	6	7
16.	My superior would not require me to use a PDA intervention documentation tool.....	1	2	3	4	5	6	7
17.	Using a PDA during patient interventions would not increase my productivity.	1	2	3	4	5	6	7
18.	I would have no difficulty telling others about the results of using a PDA intervention documentation tool.....	1	2	3	4	5	6	7
19.	People who are important to me think that I should use a PDA intervention documentation tool.....	1	2	3	4	5	6	7
20.	Using a PDA would enhance my effectiveness in documenting patient interventions.....	1	2	3	4	5	6	7
21.	Although it might be helpful, using a PDA intervention documentation tool would certainly not be compulsory in my job.....	1	2	3	4	5	6	7
22.	I would find a PDA useful in documenting patient interventions.....	1	2	3	4	5	6	7
23.	Having a PDA intervention documentation tool would be a status symbol in my organization.....	1	2	3	4	5	6	7
24.	The results of using a PDA intervention documentation tool would not be apparent to me.....	1	2	3	4	5	6	7
25.	Learning to operate a PDA as an intervention documentation tool would be easy for me.....	1	2	3	4	5	6	7
26.	People who influence my behavior think that I should use a PDA intervention documentation tool.....	1	2	3	4	5	6	7

For item 27, rate the four adjective pairs (left to right) according to how you feel about the use of a PDA intervention documentation tool. After reading the sentence, place a check mark in the location that best matches your opinion for each adjective pair.

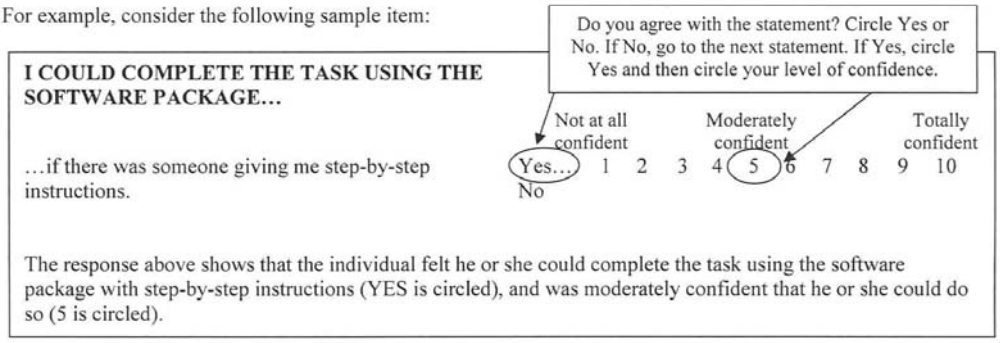
27. All things considered, my using a PDA intervention documentation tool in my job would be:

	very	moderately	somewhat	neutral	somewhat	moderately	very	
Good	_____	_____	_____	_____	_____	_____	_____	Bad
Unfavorable	_____	_____	_____	_____	_____	_____	_____	Favorable
Harmful	_____	_____	_____	_____	_____	_____	_____	Beneficial
Negative	_____	_____	_____	_____	_____	_____	_____	Positive

Often in our jobs we are told about software packages that are available to make work easier. For the following questions, imagine that you are given a new software package for some aspect of your work. It does not matter specifically what this software packages does, only that it is intended to make your job easier and that you have never used it before.

The following questions ask you to indicate whether you could use this unfamiliar software package under a variety of conditions. For each of the conditions, please indicate whether you think you would be able to complete the task using the software package. Then, for each condition that you answer "Yes," please rate your confidence about your first judgment, by circling a number from 1 to 10, where 1 indicates "Not at all confident," 5 indicates "Moderately confident," and 10 indicates "Totally confident."

For example, consider the following sample item:



Please respond to statements 28 – 37 in the manner demonstrated in the sample item above.

I COULD COMPLETE THE TASK USING THE SOFTWARE PACKAGE…	Not at all confident				Moderately confident					Totally confident
28. …if there was no one to tell me what to do as I go.	Yes…. 1	2	3	4	5	6	7	8	9	10
	No									
29. …if I had never used a tool like it before.	Yes…. 1	2	3	4	5	6	7	8	9	10
	No									
30. …if I had only the manuals for reference.	Yes…. 1	2	3	4	5	6	7	8	9	10
	No									
31. …if I had seen someone else using it before trying it myself.	Yes…. 1	2	3	4	5	6	7	8	9	10
	No									
32. …if I could call someone for help if I got stuck.	Yes…. 1	2	3	4	5	6	7	8	9	10
	No									
33. …if someone else had helped me get started.	Yes…. 1	2	3	4	5	6	7	8	9	10
	No									
34. …if I had a lot of time to complete the job for which the tool was provided.	Yes…. 1	2	3	4	5	6	7	8	9	10
	No									

35.	...if I had just the built-in help feature for assistance.	Yes.... No	1	2	3	4	5	6	7	8	9	10
36.	...if someone showed me how to do it first.	Yes.... No	1	2	3	4	5	6	7	8	9	10
37.	...if I had used similar tools before this one to do the same task.	Yes.... No	1	2	3	4	5	6	7	8	9	10

General Personal Digital Assistant Questions

Please answer questions 38 – 43 by circling the appropriate response or by providing the information requested. Use N/A to indicate Not Applicable.

38. Do you currently use a personal digital assistant for work-related activities? 38. Yes No

39. For both current and past PDA users, how long (in months) have you personally used a PDA for work-related activities? Write N/A if you have never used a PDA for work-related activities. 39. _____

40. Does your institution require PDA use to document interventions? 40. Yes No N/A

41. For each item in the following bulleted list, please indicate your current average **DAILY** frequency of PDA use by circling the appropriate range in the column to the right:

	PDA Uses/Day			
• Personal information management (address book, etc.)	0	1-2	3-4	≥5
• Drug information (electronic reference resource)	0	1-2	3-4	≥5
• Patient tracking (electronic patient database)	0	1-2	3-4	≥5
• Formulary information (national and/or institution specific)	0	1-2	3-4	≥5
• Documenting interventions (ADRs, medication errors, etc.)	0	1-2	3-4	≥5
• Calculators/conversions (kinetics, CrCl, BMI, drip rates, etc.)	0	1-2	3-4	≥5
• Wireless communication (infrared, WiFi, Bluetooth, cellular phone)	0	1-2	3-4	≥5
• Other:_____	0	1-2	3-4	≥5

Intervention Questions

42. Is your pharmacy department currently documenting interventions? 42. Yes No N/A

43. Please indicate all methods you have personally used or are personally using to document interventions. **CIRCLE ALL THAT APPLY** in the list to the right.

43.
a. Direct chart notation
b. Paper-based documentation
c. Mainframe computer
d. Desktop computer
e. Notebook computer
f. Subnotebook computer
g. Tablet PC
h. Personal Digital Assistant
i. None
j. Other: _____

General Demographic Questions

Please answer questions 44 – 50 by circling the appropriate response or by providing the information requested.

44. Are you currently practicing pharmacy in the U.S.?
    - If No, skip to question 46.

    44. Yes No

45. How many years have you practiced pharmacy in the U.S.? 45. _____

46. What is your primary work setting (i.e., acute care, long term care, hospice, ambulatory clinic, industry, academia, community, etc.)? Indicate your answer in the space to the right. 46. _____

47. If you practice in an institutional setting, what is your position? Circle the response that most closely matches your position.
    a. Pharmacy director
    b. Supervisor
    c. Staff pharmacist
    d. Other _____

48. If you practice in an institutional setting, how many pharmacists does your institution employ (in Full Time Equivalents)? If you are unsure of the exact number, please provide your best estimate. 48. _____

49. Please indicate your gender. 49. Female Male

50. Please circle the range in which your age falls.

    < 39 40 – 54 > 55

Thank you for your time!

APPENDIX B

POST-PRESENTATION QUESTIONNAIRE

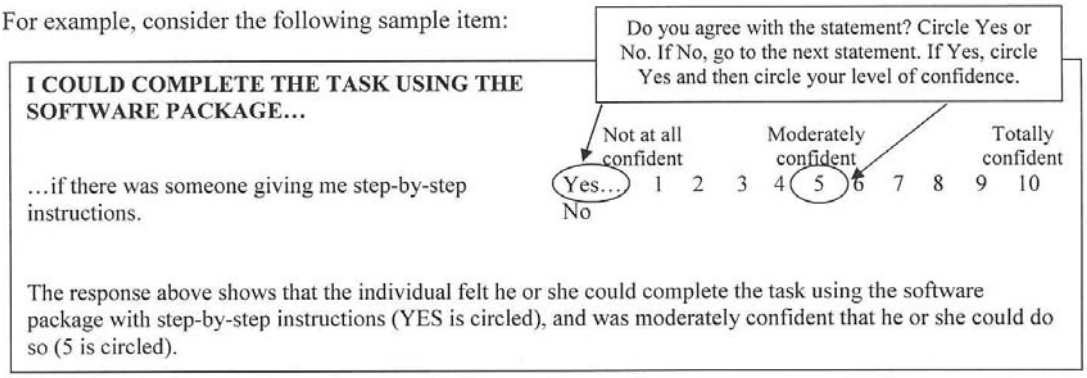
Post-Presentation Questionnaire

Your responses to these questions are completely anonymous.

Often in our jobs we are told about software packages that are available to make work easier. For the following questions, imagine that you are given a new software package for some aspect of your work. It does not matter specifically what this software packages does, only that it is intended to make your job easier and that you have never used it before.

The following questions ask you to indicate whether you could use this unfamiliar software package under a variety of conditions. For each of the conditions, please indicate whether you think you would be able to complete the task using the software package. Then, for each condition that you answer "Yes," please rate your confidence about your first judgment, by circling a number from 1 to 10, where 1 indicates "Not at all confident," 5 indicates "Moderately confident," and 10 indicates "Totally confident."

For example, consider the following sample item:



Please respond to statements 1 – 10 in the manner demonstrated in the sample item above.

	I COULD COMPLETE THE TASK USING THE SOFTWARE PACKAGE…	Not at all confident				Moderately confident					Totally confident
1.	…if someone else had helped me get started.	Yes…. 1	2	3	4	5	6	7	8	9	10
		No									
2.	…if I had used similar tools before this one to do the same task.	Yes…. 1	2	3	4	5	6	7	8	9	10
		No									
3.	…if I had just the built-in help feature for assistance.	Yes…. 1	2	3	4	5	6	7	8	9	10
		No									
4.	…if I had a lot of time to complete the job for which the tool was provided.	Yes…. 1	2	3	4	5	6	7	8	9	10
		No									

5.	...if I had seen someone else using it before trying it myself.	Yes.... No	1	2	3	4	5	6	7	8	9	10
6.	...if I had never used a tool like it before.	Yes.... No	1	2	3	4	5	6	7	8	9	10
7.	...if there was no one to tell me what to do as I go.	Yes.... No	1	2	3	4	5	6	7	8	9	10
8.	...if someone showed me how to do it first.	Yes.... No	1	2	3	4	5	6	7	8	9	10
9.	...if I could call someone for help if I got stuck.	Yes.... No	1	2	3	4	5	6	7	8	9	10
10.	...if I had only the manuals for reference.	Yes.... No	1	2	3	4	5	6	7	8	9	10

Consider the following definitions when providing answers to the statements below:

- **Personal Digital Assistant (PDA)** – a handheld, pen-based computing device with information storage/retrieval capabilities, including the ability to access clinical information and document clinical activities such as interventions
- **Intervention** - any solicited or unsolicited information provided by a pharmacist to another healthcare professional or to a patient in regard to the optimal use of medications for patient care

Please use the scale below to indicate your level of agreement with statements 11 – 36.

1 Strongly Disagree	2 Moderately Disagree	3 Somewhat Disagree	4 Neutral	5 Somewhat Agree	6 Moderately Agree	7 Strongly Agree

11.	Given that I have access to a PDA intervention documentation tool, I predict that I would use it.....	1	2	3	4	5	6	7
12.	Assuming that I have access to a PDA intervention documentation tool, I intend to use it.....	1	2	3	4	5	6	7
13.	The quality of the output I would get from a PDA intervention documentation tool is high.....	1	2	3	4	5	6	7
14.	Although it might be helpful, using a PDA intervention documentation tool would certainly not be compulsory in my job.....	1	2	3	4	5	6	7

		SD			N			SA
15.	Learning to operate a PDA as an intervention documentation tool would be easy for me.....	1	2	3	4	5	6	7
16.	The results of using a PDA intervention documentation tool would not be apparent to me.....	1	2	3	4	5	6	7
17.	In my job, usage of a PDA intervention documentation tool would be relevant.	1	2	3	4	5	6	7
18.	I believe I could communicate to others the consequences of using a PDA intervention documentation tool.....	1	2	3	4	5	6	7
19.	People in my organization who use a PDA intervention documentation tool would have a high profile.....	1	2	3	4	5	6	7
20.	People who are important to me think that I should use a PDA intervention documentation tool.....	1	2	3	4	5	6	7
21.	I would have no problem with the quality of a PDA intervention documentation tool's output.....	1	2	3	4	5	6	7
22.	I would not find it easy to get a PDA to do what I want it to do as an intervention documentation tool.....	1	2	3	4	5	6	7
23.	I would find a PDA useful in documenting patient interventions.....	1	2	3	4	5	6	7
24.	My use of a PDA intervention documentation tool would be voluntary.....	1	2	3	4	5	6	7
25.	I would find a PDA intervention documentation tool easy to use.....	1	2	3	4	5	6	7
26.	Using a PDA during patient interventions would not increase my productivity.	1	2	3	4	5	6	7
27.	People who influence my behavior think that I should use a PDA intervention documentation tool.....	1	2	3	4	5	6	7
28.	People in my organization who use a PDA intervention documentation tool would have more prestige than those who do not.....	1	2	3	4	5	6	7
29.	Using a PDA would improve my performance in documenting patient interventions.....	1	2	3	4	5	6	7
30.	It would not be easy for me to become skillful at using a PDA as an intervention documentation tool.....	1	2	3	4	5	6	7
31.	In my job, usage of a PDA intervention documentation tool would not be important.....	1	2	3	4	5	6	7
32.	I would have no difficulty telling others about the results of using a PDA intervention documentation tool.....	1	2	3	4	5	6	7

		SD			N			SA
33.	Having a PDA intervention documentation tool would be a status symbol in my organization.....	1	2	3	4	5	6	7
34.	My superior would not require me to use a PDA intervention documentation tool.....	1	2	3	4	5	6	7
35.	I would have difficulty explaining why using a PDA intervention documentation tool may or may not be beneficial.....	1	2	3	4	5	6	7
36.	Using a PDA would enhance my effectiveness in documenting patient interventions.....	1	2	3	4	5	6	7

For item 37, rate the four adjective pairs (left to right) according to how you feel about the use of a PDA intervention documentation tool. After reading the sentence, place a check mark in the location that best matches your opinion for each adjective pair.

37. All things considered, my using a PDA intervention documentation tool in my job would be:

	very	moderately	somewhat	neutral	somewhat	moderately	very	
Bad	_____	_____	_____	_____	_____	_____	_____	Good
Unfavorable	_____	_____	_____	_____	_____	_____	_____	Favorable
Beneficial	_____	_____	_____	_____	_____	_____	_____	Harmful
Positive	_____	_____	_____	_____	_____	_____	_____	Negative

Thank you for your time!

APPENDIX C

AUBURN UNIVERSITY IRB PROTOCOL APPROVAL LETTER

Auburn University

Auburn University, Alabama 36849

Office of Human Subjects Research
307 Samford Hall

Telephone: 334-844-5966
Fax: 334-844-4391
hsubjec@auburn.edu

November 17, 2003

MEMORANDUM TO: Brent Fox
Pharmacy Care Systems

PROTOCOL TITLE: "Explaining Pharmacists' Intentions to Use Personal Digital Assistants (PDAs) as Clinical Resources During Patient Care Interventions"

IRB FILE: 03-188 EX 0311
APPROVAL DATE: November 12, 2003
EXPIRATION DATE: November 11, 2004

The referenced protocol was approved "Exempt" from further review under 45 CFR 46.101 (b)(2) by IRB procedure on November 12, 2003. You should retain this letter in your files, along with a copy of the revised protocol and other pertinent information concerning your study. If you should anticipate a change in any of the procedures authorized in protocol # 03-188 EX 0311, you must request and receive IRB approval prior to implementation of any revision. Please reference the above IRB File in any correspondence regarding this project.

If you will be unable to file a Final Report on your project before November 11, 2004, you must submit a request for an extension of approval to the IRB no later than October 31, 2004. If your IRB authorization expires and/or you have not received written notice that a request for an extension has been approved prior to November 11, 2004 , you must suspend the project immediately and contact the Office of Human Subjects Research for assistance.

A Final Report will be required to close your IRB project file.

If you have any questions concerning this Board action, please contact the Office of Human Subjects Research at 844-5966.

Sincerely,

E. N. (Chip) Burson, Executive Director
Office of Human Subjects Research

cc: Dr. Bruce Berger

APPENDIX D

INFORMATION LETTER

Auburn University

HARRISON SCHOOL OF PHARMACY

Department of Pharmacy Care Systems
128 Miller Hall
Auburn University, Alabama 36849-5506

Telephone: (334) 844-5152
Fax: (334) 844-8307
E-Mail: aupypcs@auburn.edu

INFORMATION LETTER FOR
EXPLAINING PHARMACISTS' INTENTIONS TO USE PERSONAL DIGITAL ASSISTANTS (PDAs) AS CLINICAL RESOURCES DURING PATIENT CARE INTERVENTIONS

You are invited to participate in a research study to identify the determinants of pharmacists' intentions to use personal digital assistants (PDAs) as resources during patient care interventions. This study is being conducted by Brent I. Fox, Pharm.D., under the supervision of Bill G. Felkey, M.S., Associate Professor at Auburn University's Harrison School of Pharmacy. We hope to learn 1) the major determinants of pharmacists' intentions to use PDAs to document patient care interventions, 2) if any determinant is responsible for explaining more of pharmacists' intentions to use PDAs to document patient care interventions, and 3) how pharmacists' characteristics affect their intentions to use PDAs to document patient care interventions. You were selected as a possible participant because of your interest in the presentation titled, "*Turning the Corner: PDA-based Clinical Documentation*".

If you decide to participate, we will ask you to fill out a questionnaire before the presentation begins. The presentation will take approximately 3 hours. After viewing the presentation, we will ask you to fill out a second questionnaire regarding the content presented in the presentation. The first questionnaire will take approximately 10 minutes to complete. The second questionnaire will take approximately 7 minutes to complete.

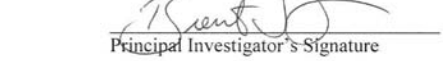
There should be no risks to you for participating in the study. All data will be gathered anonymously and will be reported in aggregate. Information collected through your participation may be used to fulfill the principal investigator's dissertation requirements, published in professional journals, and/or presented at professional meetings. You will receive ACPE-approved continuing education credit for attending the presentation. This will be awarded independently of your decision to participate in the study.

Your decision whether or not to participate will not jeopardize your future relations with Auburn University, the Department of Pharmacy Care Systems, or the sponsors of the study: the American Foundation for Pharmaceutical Education and Roche Laboratories.

If you have any questions or comments, we invite you to ask them now. If you have questions later, Dr. Brent I. Fox, the principal investigator, will be happy to answer them. His phone number is (334)-844-5153, his email address is foxbren@auburn.edu, and his mailing address is: 128 Miller Hall; Auburn University, AL 36849.

For more information regarding your rights as a research participant you may contact the Office of Human Subjects Research by phone or e-mail. The people to contact there are Executive Director E.N. "Chip" Burson (334) 844-5966 (bursoen@auburn.edu) or IRB Chair Dr. Peter Grandjean at (334) 844-1462 (grandpw@auburn.edu) .

YOUR SUBMISSION OF THE QUESTIONNAIRES INDICATES YOUR WILLINGNESS TO PARTICIPATE IN THE RESEARCH STUDY.



Principal Investigator's Signature

APPENDIX E

NOTE REMINDING PARTICIPANTS TO RETURN TO THE PRESENTATION AFTER THE PLANNED BREAK FOR THE AWARDING OF DOOR PRIZES

Door prizes will be awarded after the break!

APPENDIX F

ALL RESPONSES TO PRE-PRESENTATION QUESTION 39

Number of Months	Frequency of Responses	Cumulative Percent
0 (N/A)	13	17.6
1	1	1.36
2	3	4.1
3	2	2.7
6	5	6.8
7 & 9	1 each	2.7
11	2	2.7
12	6	8.1
13, 14, 18, & 22	1 each	5.4
24	14	18.9
25, 26, 29, & 30	1 each	5.4
36	11	14.9
42	1	1.36
48	4	5.4
60	1	1.36
***Total**	**73**	**98.6**

*Does not include the attendee who wrote “yes” in the blank

APPENDIX G

ALL RESPONSES TO PRE-PRESENTATION QUESTION 45

Number of Months	Frequency of Responses	Cumulative Percent
12	2	2.7
20	1	1.36
24	2	2.7
30, 36, 60, 72, 84, 90	1 each	8.1
96	4	5.4
108, 120	3 each	8.1
132, 144, 156, 168	2 each	10.8
180, 192, 204, 210	1 each	5.4
216	2	2.7
228	4	5.4
240	3	4.1
244, 252	1 each	2.7
264, 276, 288, 300	3 each	16.3
312, 324	1 each	2.7
336, 348	3 each	8.1
360, 372	1 each	2.7
384	3	4.1
408, 444, 456, 480, 504	1 each	6.8
Total	74	100

APPENDIX H

ALL RESPONSES TO PRE-PRESENTATION QUESTION 48

Number of FTEs	Frequency of Responses	Cumulative Percent
1, 1.5, 2, 2.4	1 each	5.4
2.5	2	2.7
3, 3.5	1 each	2.7
4	2	2.7
4.75, 5, 6	1 each	4.1
7	4	5.4
7.5	2	2.7
8, 9	1 each	2.7
10	5	6.8
11, 12	1 each	2.7
14	6	8.1
15	5	6.8
16	4	5.4
20	8	10.8
21, 23	1 each	2.7
25, 30	3 each	8.2
35	2	2.7
40	5	6.8
42, 44	2 each	5.4
60	4	5.4
Total	74	100

APPENDIX I

FACTOR LOADINGS FOR EACH PRE-PRESENTATION QUESTIONNAIRE ITEM ON ITS RESPECTIVE CONSTRUCT

Item Number	Construct	Factor Loading	Item Number	Construct	Factor Loading
1	Intentions	.97	28	Computer Self Efficacy	.75
2	Intentions	.88	29	Computer Self Efficacy	.77
4	Perceived Ease of Use	.38	30	Computer Self Efficacy	.74
7	Perceived Ease of Use	.68	31	Computer Self Efficacy	.93
10	Perceived Ease of Use	.91	32	Computer Self Efficacy	.90
25	Perceived Ease of Use	.78	33	Computer Self Efficacy	.83
19	Subjective Norm	.80	34	Computer Self Efficacy	.77
26	Subjective Norm	.80	35	Computer Self Efficacy	.70
9	Job Relevance	.91	36	Computer Self Efficacy	.68
12	Job Relevance	.73	37	Computer Self Efficacy	.70
14	Perceived Usefulness	.79	8	Image	.87
17	Perceived Usefulness	.60	13	Image	.89
20	Perceived Usefulness	.94	23	Image	.79
22	Perceived Usefulness	.89	-	-	-

APPENDIX J

INTERCONSTRUCT CORRELATIONS

Constructs	Correlation (*r*)
Intentions – Subjective Norm	.34
Intentions – Image	-.002
Intentions – Perceived Usefulness	.76
Intentions – Job Relevance	.91
Intentions – Perceived Ease of Use	.64
Intentions – Computer Self Efficacy	.34
Subjective Norm – Image	.53
Subjective Norm – Perceived Usefulness	.21
Subjective Norm – Job Relevance	.48
Subjective Norm – Perceived Ease of Use	.03
Subjective Norm – Computer Self Efficacy	.12
Image – Perceived Usefulness	.06
Image – Job Relevance	-.04
Image – Perceived Ease of Use	-.03
Image – Computer Self Efficacy	-.15
Perceived Usefulness – Job Relevance	.79
Perceived Usefulness – Computer Self Efficacy	.30
Perceived Ease of Use – Perceived Usefulness	.79
Perceived Ease of Use – Job Relevance	.64
Perceived Ease of Use – Computer Self Efficacy	.41
Job Relevance – Computer Self Efficacy	.26

APPENDIX K

INFORMATION PUBLISHED IN PROMOTIONAL MATERIALS ABOUT THE PRESENTATION

Turning the Corner: PDA-based Clinical Documentation
Sunday, December 7
1:00 p.m. – 4:00 p.m.
New Orleans Hilton Riverside

Pharmacists are among the early adopters of PDA technology. Many health-system pharmacy departments have integrated PDA technology into their workflow. The broad availability of useful and affordable clinical software applications has facilitated this integration. For pharmacy departments, the PDA can be a powerful tool for documenting and tracking the impact of clinical interventions. This interactive and lively program will explore and provide insight into the advanced use of PDA technology in the pharmacy department including the use of these devices for clinical intervention documentation. New applications for PDA use will be demonstrated during the session.

Program Faculty

Bill Felkey, MS, Associate Professor
Auburn University School of Pharmacy
Auburn University, Alabama

Brent I. Fox, Pharm.D., Informatics Research Associate
Auburn University School of Pharmacy
Auburn University, Alabama

Program Objectives

Following the seminar, the participant should be able to:

- Outline a sequence for the adoption of PDA technology into the workflow and workload of a pharmacist.

- List and discuss commercially available PDA-based intervention documentation and database development software that are appropriate for a health system's pharmacy practice.

- Compare and contrast at least two PDA-based intervention documentation strategies in terms of usefulness, ease of use, scalability, and other logistical considerations.

- List the critical clinical fields that should be available in both proprietary PDA-based intervention documentation applications and self-developed database software used to document interventions.

- Develop a spreadsheet evaluation matrix that includes clinical, financial, and selection considerations for the implementation of a PDA-based intervention documentation initiative.

- Describe a likely scenario for the future development and integration of intervention documentation software into a clinical suite of other PDA-based software.

Target Audience
This symposium is intended for pharmacists who are involved in health-system practice and are interested in using PDA devices in their practice.

3.0 hours (0.3 CEUs) of continuing pharmaceutical education credit. Universal program number 204-000-03-433-L04.

For complete program and continuing education information and online registration, visit the program Web site at www.ashpadvantage.com/outstanding or call (301) 657-3000, ext. 1840.

This program is planned and conducted by ASHP Advantage and supported by an educational grant from Roche Laboratories.

(both logos)

Continuing Education Accreditation

The American Society of Health-System Pharmacists is approved by the American Council on Pharmaceutical Education as a provider of continuing pharmaceutical education. Official continuing education statements will be provided to attendees within six weeks after the program.