2005-01-13

Understanding Process Improvement: Social Psychological Factors Affecting the Use of Project Management Practices

Russell K. Thornley
Brigham Young University - Provo

UNDERSTANDING PROCESS IMPROVEMENT: SOCIAL PSYCHOLOGICAL FACTORS AFFECTING THE USE OF PROJECT MANAGEMENT PRACTICES

by

Russell K. Thornley

A dissertation submitted to the faculty of

Brigham Young University

in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

Department of Psychology

BRIGHAM YOUNG UNIVERSITY

December 2004

BRIGHAM YOUNG UNIVERSITY

GRADUATE COMMITTEE APPROVAL

of a dissertation submitted by

Russell K. Thornley

This dissertation has been read by each of the following members of the graduate committee and by a majority vote has been found to be satisfactory.

Date	Robert D. Ridge, Chair
Date	Bruce R. Brown
Date	Darhl M. Pedersen
Date	Matthew Spackman
Date	Joseph A. Olsen

BRIGHAM YOUNG UNIVERSITY

As chair of the candidate's graduate committee, I have read this dissertation by Russell K. Thornley in its final form and have found that (1) its format, citations, and bibliographical style are consistent and acceptable and fulfill university and department style requirements; (2) its illustrative materials including figures, tables, and charts are in place; and (3) the final manuscript is satisfactory to the graduate committee and is ready for submission to the Psychology Department graduate secretary.

Date

Robert D. Ridge
Chair, Graduate Committee

Accepted for the Department

Harold L. Miller, Jr.
Graduate Coordinator

Accepted for the College

Renata Forste
Associate Dean,
College of Family, Home & Social Science

ABSTRACT

UNDERSTANDING PROCESS IMPROVEMENT: SOCIAL PSYCHOLOGICAL FACTORS AFFECTING THE USE OF PROJECT MANAGEMENT PRACTICES

Russell K. Thornley

Department of Psychology

Doctor of Philosophy

To facilitate a better understanding of the social psychological factors that influence adoption of project management practices, this study draws upon the theory of reasoned action (TRA) and the theory of planned behavior (TPB) from social psychology, and the technology acceptance model (TAM) from information systems research. These models define and relate a number of belief constructs that predict the acceptance of technologies in a variety of settings. In general, the three models each have relatively consistent empirical support, with comparison studies showing mixed support for each of the models being the moderately "better" model. In the current study, the three models are thoroughly integrated using a latent constructs approach and structural equation modeling (SEM) techniques. Overall, constructs from TRA and TAM, but not TPB, predict the use of specific project estimating, plan development, and plan commitment practices defined in the Capability Maturity Models (CMM/I).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Running Head: Understanding Process Improvement

Chapter 1

INTRODUCTION

The most widely used collection of proven software and systems engineering best practices in the industry are described in a group of “capability maturity models” developed over the past two decades by the Software Engineering Institute (SEI) at Carnegie-Mellon University. According to these models, project management practices constitute the most basic discipline for process improvement, and institutionalizing project management practices is considered a key to successful process improvement initiatives (e.g., Standish Group, 1995; Sommerville, 1995; Humphrey, 1989; 1995). Successfully institutionalizing project management practices, however, requires managers and consultants to have a theoretically sound understanding of the social-psychological factors that influence project managers to adopt them. As such, the purpose of this research is to facilitate a better understanding of the social-psychological factors underlying the use of project management best practices. I facilitate this understanding by discussing and integrating the explanatory constructs from three popular theories used in social psychology and information systems research to explain behavior and technology usage.

Understanding Process Improvement: Overview

Since 1987, when the SEI first published the Capability Maturity Model for Software (SW-CMM), well over 5,000 organizations worldwide have engaged in process improvement initiatives to implement the best practices defined there. In doing so, these organizations have achieved overall median annual productivity improvements of 35%, time-to-market reductions of 19% per year, and post-release defect reductions of 39% (Software Engineering Institute, 2001). The overall savings accruing to these organizations have been about 5 times the amount spent on the improvement initiatives themselves (e.g., Herbsleb, Carleton, Rozum, Siegel, & Zubrow, 1994). These impressive results have prompted some industry experts to warn that organizations that fail to adopt the best practices and principles of these maturity models will "forcibly lose at least 50 percent of their core functions to more capable external service providers" (Hotle, 1998, p. 5).

Not all CMM-based process improvement initiatives, however, are as successful as these numbers suggest. For instance, Goldenson & Herbsleb (1995) surveyed software practitioners in 56 software organizations that have conducted CMM-based process improvement initiatives and found that 26% of respondents report that "nothing much has changed" since the CMM appraisal; 49% report "disillusionment over the lack of improvement;" and 67% of respondents state that they need more guidance about how to implement successful process improvement initiatives. Echoing similar sentiments, following a review of experience reports and case studies from 31 software organizations that had conducted CMM-based improvement efforts, Stelzer and Mellis (1999) concluded, “practitioners that wish to implement process improvement initiatives need a thorough understanding of the factors that affect success and failure of improvement activities. Despite the growing interest in the improvement of software development, however, a profound knowledge of the enablers and inhibitors of software process improvement is still lacking” (p. 4).

What factors contribute to the adoption of software and systems engineering best practices in general, and project management practices in particular? The purpose of the current study is to provide an answer to this question. I begin with the assumption that the benefits of these improvement efforts cannot be realized unless practitioners actually engage in the best practice behaviors described in the industry standards. As such, the ultimate aim of the current study is to facilitate a theoretically-sound and empirically-based understanding of the social psychological factors that influence the sustained adoption of best practices. Such an understanding would enable information systems managers, practitioners and consultants to better identify and manage risks on improvement initiatives, base their interventions on sound theory and empirically-based research, increase the degree to which the outcomes of improvement efforts can be predicted, and reduce the costs of improvement efforts by increasing the degree to which practitioners actually engage in best practice behaviors.

As a theoretical framework for the current study, I draw upon the Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975) and the Theory of Planned Behavior (TPB; Ajzen, 1991), from social psychology, and the Technology Acceptance Model (TAM; Davis, 1986; Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Davis, 1993) from information systems research. The TRA and TPB have shown remarkable heuristic value in predicting and explaining a broad range of behaviors. As such, they are highly relevant to understanding the use of project management practices. Similarly, the TAM has been used to explain and predict the use of a wide variety of traditional information technology applications. By "traditional" technology, we typically refer to computer hardware, system software, telecommunications components, as well as information systems and products such as database applications (e.g., Fowler, 1994). For this study, I consider technology in its broadest sense, as "tools that enable us to transform parts of our environment and extend our human capabilities" (see Tornatzky, 1990). In this regard, the TAM is also highly relevant to our understanding of the use of project management best practices.

Overall, the research shows that both TAM and TPB tend to predict and explain traditional technology usage about equally well, with each theory having its strengths and weaknesses (e.g., Agarwal & Prasad, 1999; Karahanna & Straub, 1999; Venkatesh & Davis, 2000; Mathieson, 1991; Taylor & Todd, 1995a, 1995b, 1995c). As such, a practical problem arises for managers, consultants, and practitioners desiring to apply one of these models: Which one should be used? The answer to this question I offer in this research is that *both* theories should be used. That is, given their common conceptual ancestry – the Theory of Reasoned Action (Fishbein & Ajzen, 1975) – it makes practical and theoretical sense to integrate the theories, leveraging the strengths of each. The approach to integration I take in this study is to propose a "latent variable" model that integrates the components of TAM and TPB into a theoretically sound framework for explaining the use of project management best practices.

In the following chapters, I first provide an overview of the CMM standards that supply the theoretical framework for “best practices” in project management and systems engineering. In Chapters 3 and 4, I review the published literature on the three theories from social psychology and information systems research, starting with the TRA and TPB, and followed by TAM. Chapter 5 summarizes the published research that has attempted various comparisons and integrations of the three theories, and concludes with a description of the latent variable model I propose for this study. In Chapter 6 I describe the research methodology and analytic strategy for developing the measurement and structural aspects of the latent variable model. In this section, I also describe the participants, instrument construction, and procedures, and in the analytic strategy section, I discuss the approach to comparing the models. Finally, I conclude with a discussion of the contributions this study makes to the improvement of project management practice in the industry.

Chapter 2

CAPABILITY MATURITY IN SOFTWARE AND SYSTEMS ENGINEERING

The Capability Maturity Model (CMM) and its related derivatives provide detailed descriptions of industry best practices for planning, engineering, and managing software-intensive systems development. Generally, the CMM models refer to best practices as “key practices” (or “specific practices”) that are organized into five “maturity levels” (explained below). The practices are considered “key” because they have been found to be “the essential elements of an effective software process” (Paulk, Weber, Garcia, Chrissis, & Bush, 1993b, p. O-35). The practices are considered “best” because they represent those software and systems engineering behaviors of industry, government, and academic practitioners that have been proven to result in the delivery of cost-effective, timely, high-quality software solutions (e.g., Goldenson & Herbsleb, 1997; Herbsleb, Carleton, Rozum, Siegel, & Zubrow, 1994).

Five Maturity Levels and Their Key Process Areas

The CMM models operationally define the key practices in great detail, and organize them into an evolutionary series of five “maturity levels.” Maturity Level 1 is the Initial level, describing the typical organization that has ad hoc and chaotic approaches to software-intensive systems development and acquisition. As such, no key practices are defined for Level 1. It is described as “initial” because this state of practice, or *lack of* good practice discipline, is typically the “starting point” for most organizations that undertake an improvement effort. Level 2 is the Repeatable level, describing characteristic behaviors of practitioners in organizations that have in place sufficient, basic project management processes and discipline to be able to repeat earlier successes. Level 3 is the Defined level. Organizations at this level of maturity have formalized and integrated both project management and engineering activities into a standard process for the organization. Level 4 is the Managed level, describing behaviors of practitioners in organizations that quantitatively understand and control their process and product quality. Finally, Level 5 is the Optimizing level of maturity. Organizations at this level are characterized by a culture of continuous process improvement, enabled by practices that provide quantitative feedback for systematically optimizing their engineering processes and pursuing innovative ideas and technologies (Paulk et al., 1993a).

As shown in Table1 (adapted from Paulk et al., 1993b, p. O-19), the five maturity levels of the CMM models are each comprised of up to seven "key process areas." These key process areas constitute clusters of related key practices. In the model, the purpose, scope, boundaries, and intent of each key process area are described in detail. For example, one of six key process areas for Level 2 is Project Planning. The model explains that "The purpose of Project Planning is to establish reasonable plans for performing the software engineering and for managing the project" (Paulk, Weber, Garcia, Chrissis, & Bush, 1993b, p. L2-11). Following this statement of purpose is elaboration of the scope, boundaries, and intent of project planning, as well as the key practices for the project planning process area. The collective performance of these key practices achieves important quality goals that provide the foundation for progression to the next level of maturity.

Table 1. CMM Maturity Levels and Key Process Areas

Level	Key Process Areas
Level 1: Initial - The software process is characterized as ad hoc, and occasionally even chaotic. Few processes are defined, and success depends on individual effort.	None.
Level 2: Repeatable - Basic project management processes are established to track cost, schedule, and functionality. The necessary process discipline is in place to repeat earlier successes on projects with similar applications.	Requirements Management *Project Planning* Project Tracking & Oversight Subcontract Management Quality Assurance Configuration Management
Level 3: Defined - The software process for both management and engineering activities is documented, standardized, and integrated into a standard software process for the organization. All projects use an approved, tailored version of the organization's standard software process for developing and maintaining software.	Organization Process Focus Organization Process Definition Training Program Integrated Product Management Product Engineering Intergroup Coordination Peer Reviews
Level 4. Managed - Detailed measures of the software process and product quality are collected. Both the software process and products are quantitatively understood and controlled.	Quantitative Process Management Quality Management
Level 5: Optimizing - Continuous process improvement is enabled by quantitative feedback from the process and from piloting innovative ideas and technologies.	Defect Prevention Technology Change Management Process Change Management

Moreover, each key process area contains one or more clearly defined "quality goals" that are stated in the affirmative, present tense. These goals are essentially the quality "outcomes" that are to be realized by carrying out the key practice behaviors. These goals are used to determine whether or not an organization or project has effectively implemented the key practices that fully satisfy the intent and requirements of the key process area. For example, one of the three quality goals for the Project Planning key process area is "Goal 1: Software estimates are documented for use in planning and tracking the software project" (Paulk et al., 1993b, p. L2-12).

The model next defines the key practices that bring about the fulfillment of the quality goals. The key practices are further elaborated by descriptions of sub-practices, examples, illustrations, and elaborations. For example, to achieve the project planning goal just mentioned, 25 key practices are specified, including such activities as "Activity 9: Estimates for the size of the software work products (or changes to the size of software work products) are derived according to a documented procedure" (Paulk et al., 1993b, p. L2-21).

To determine the Maturity Level of an organization, one of several assessment methods is followed (e.g., Dunaway & Masters, 1996). The initial instrument typically used in all of these methods is the Maturity Questionnaire (Zubrow, Hayes, Siegel, & Goldenson, 1994). The Maturity Questionnaire contains from 7 to 9 items for each key process area. These items assess the degree to which members of the organization engage in the key practice behaviors. For example, items used to assess project planning practices include "Are estimates (e.g., size, cost, and schedule) documented for use in planning and tracking the software project?" and "Does the project manager review the activities for planning the software project on both a periodic and event-driven basis?"

Respondents are instructed to answer the questions, based on their individual knowledge and experience in their "current project," by answering "Yes," "No," "Does Not Apply," or "Don't Know" to each question. Participants are instructed to check "Yes" when "The practice is well established and consistently performed," meaning the practice is performed "nearly always" and "as a standard operating procedure." Participants are instructed to check "No" when "The practice is not well established or is inconsistently performed," meaning that the practice may be performed "sometimes, or even frequently, but it is omitted under difficult circumstances" (Zubrow, et al., 1994, p. 4). Finally, participants are instructed to check Does Not Apply or Don't Know as appropriate, and are provided with a place to make comments.

Progress in process improvement efforts is typically measured by creating a profile of the organization's practices in each process area. This profile identifies the percentage of applicable key practices that are satisfied. When all of the applicable key practices of a process area are satisfied, the organization is considered to have achieved a capability in that process area. For instance, an organization is considered to have achieved a project planning capability when all of the project planning key practices have either been satisfied or do not apply. When an organization has established a capability in all of the process areas of a given maturity level, they have established a foundation of good practice that enables them to move to the next maturity level in the model.

Validity of and Empirical Support for the Capability Maturity Models

Although validity and reliability studies have been conducted on the assessment methods overall (e.g., Dunaway & Baker, 2001), very few studies following the original instrument development study have examined the reliability and validity of the questionnaire itself. The original reliability study for the Maturity Questionnaire reported an alpha coefficient of .90. For economic and other reasons, however, subsequent analyses of the data collected and reported to the SEI on assessments and profiles that have used the Maturity Questionnaire have not examined the questionnaire's reliability (R. Whitney, Software Engineering Institute, personal communication, August 27, 2002; cf. Humphrey, 1986; CMU/SEI-87-TR-23).

The validity of the CMM models derives in part from an applied context for their development and in part from their origins in the quality tradition of Shewart, Deming, Crosby, Juran, and others (e.g., Humphrey, 1987; 1989). As computer technologies continued to become increasingly critical to military and defense operations during the late seventies and early eighties, the U.S. government became increasingly reliant on software development contractors. Over the years, some contractors were able to repeatedly deliver on their contractual promises, whereas other organizations lacked sufficient capability to meet contract requirements. Therefore, the government set out to find a way for the Department of Defense to distinguish reliable from unreliable software contractors prior to making contractual commitments. They turned to the Software Engineering Institute (SEI), a research and development center sponsored by the U.S.

Department of Defense and operated by Carnegie Mellon University (Paulk, Curtis, Chrissis, & Weber, 1993a).

Meanwhile, under the direction of Watts Humphrey, Ron Radice and his colleagues at IBM were working to identify and integrate specific software development best practices into an initial maturity framework (Radice, 1985). This framework was explicitly based on classic quality principles in general (e.g., Deming, 1986; Juran, 1988), and Philip Crosby's five-stage Quality Management Maturity Grid in particular (Crosby, 1979). Watts Humphrey later joined the SEI and directed a number of studies of organizations developing software development for the U.S. Department of Defense in the early eighties. Through these studies Humphrey and colleagues identified the specific software management and engineering "key practices" that were included in the CMM.

Based on this work, the SEI developed an initial version of a maturity model and maturity questionnaire. The objective was to provide an effective model that captured "best practices" actually used in industry, along with a corresponding instrument that could be used to efficiently evaluate and compare the software engineering capability of contractors bidding for work with the U.S. Department of Defense (Humphrey, 1989). Early versions of Humphrey's maturity framework and questionnaire are described more fully in SEI technical reports, papers, and in his book, "Managing the Software Process" (Humphrey, 1987; 1988; 1989).

The work of Humphrey, Radice, and many others, combined with the quality tradition upon which the CMM models are based, has provided consultants, experts, and researchers ample confidence that the CMM models do, indeed, define software and systems engineering practices that are "best practices." Best practices should be those software development behaviors that, if put into practice, result in high-quality software (having few defects), with the needed set of functionality, delivered on schedule, and for the price (budget) agreed. I have illustrated this conceptual relationship in Figure 1, showing how best practices, as defined and measured by the CMM maturity levels, are related to software development success, as measured by outcomes such as software quality, timeliness of delivery, budget, functionality, and customer satisfaction.

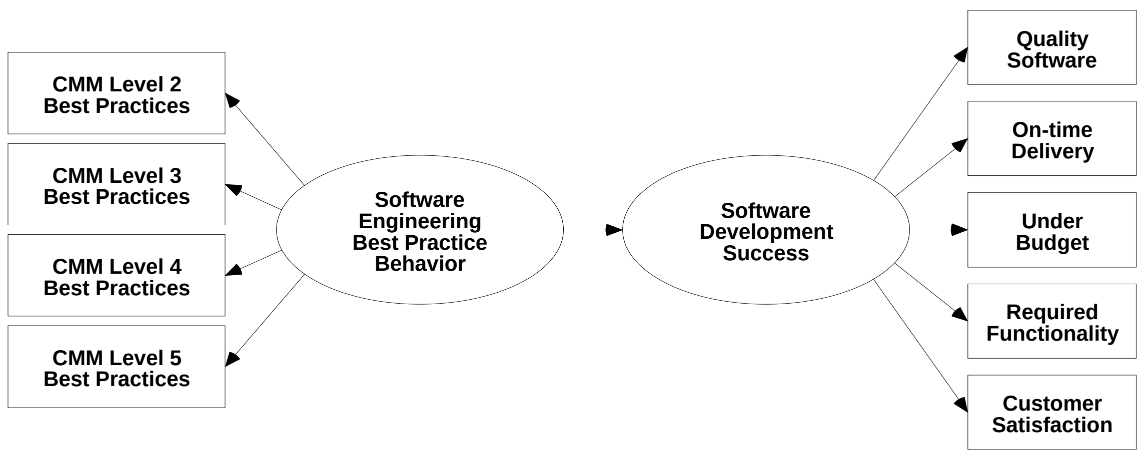

Figure 1. Conceptual Relationship Between CMM Practices & Development Outcomes

In the face of market pressures, however, some pundits have criticized the CMM for being too "heavy" and bureaucratic, and have questioned whether or not the CMM key practices are, indeed, "best practices" (e.g., Cockburn, 2001; Bach, 1994). Therefore, a few researchers have sought more empirical evidence. A number of resulting case studies have shown that CMM-based process improvement has measurably improved the ability of a number of organizations to meet cost, quality, and schedule goals (Radice, Harding, Munnis, & Phillips, 1985; Humphrey, Snyder, & Willis, 1991; Lipke & Butler, 1992; Dion, 1993; Wohlwend & Rosenbaum, 1993; Billings, Clifton, Kolkhorst, Lee, & Wingert, 1994; Herbsleb et al., 1994; Johnson, J., 1994).

For instance, Herbsleb et al., (1994) documented process improvement efforts in 13 organizations by showing improvements in cycle time, defect density, and productivity. Specifically, the organizations included in the study achieved 37% average gain per year in productivity; 18% increase per year in the proportion of defects detected and corrected in pre-test activities; 19% reduction in time to market; and 45% reduction in field error reports per year. Moreover, assuming that the benefits of engaging in "best practices" will outweigh the costs, benefit-to-cost ratios have been used as another indicator that the CMM models define best practices. In this regard, Herbsleb et al. (1994) found benefit-to-cost ratios to range from 4-to-1 up to almost 9-to-1. Taken together, these case studies present credible evidence that the CMM models are models of industry "best practices," the implementation and institutionalization of which can result in bottom-line benefits to software organizations.

Although CMM-based improvement efforts have been shown to provide a number of quality and productivity benefits, they are not without challenges, especially for lower-level organizations. Data reported to the SEI shows that the journey from Level 1 to Level 2 can take several years, and moving between the other levels usually takes around two years. Specifically, the median time for organizational improvement from Level 1 to Level 2 is 27 months. From there, moving to Level 3 is likely to take another two years. In other words, the typical organization beginning its CMM-based initiatives today requires more than three and one-half years to reach a level of process capability that would enable it to consistently deliver software-intensive solutions on time and within budget.

With this in mind, critics point out that by the time some organizations actually institutionalize the key practice behaviors to a level that allows them to be competitive (typically Level 3), a number of changes are likely to have occurred. Senior management may have changed, the market may have changed, and/or the technology used by the organization may have become obsolete, rendering the process improvement initiative a waste of time and money. In this regard, experts critical of CMM-based approaches predict that organizations pursuing a traditional, incremental improvement process have less than a 50 percent chance of recognizing any benefits at all, and that more than half of organizations employing these traditional methods will fail to realize any benefits from these efforts (Hotle, 1998). By implication, then, more effective and efficient approaches to process improvement must be found.

To summarize, the CMM models operationally define the specific behaviors in which software development practitioners must engage to increase the probability of their producing high-quality software solutions. In principle, using these definitions, the degree to which practitioners in a given organization actually engage in these best practices can be measured in such a way as to facilitate systematic improvement in the direction of clearly defined and measurable capability goals. As practitioners actually engage in these behaviors, the entire organization develops an engineering culture that becomes increasingly capable of producing high quality software-intensive systems on-time, within budget, and with the required functionality.

Unfortunately, due to a lack of sound theory and research, the degree to which the CMM best practice behaviors will actually be adopted in any given organization cannot be reliably predicted. As such, CMM-based improvement initiatives may take longer and be fraught with greater risk than are justified by the promised benefits. Moreover, the social psychological factors influencing the actual use of these best practices are not well understood. It is for the purpose of addressing this deficiency that I now turn to the theories from social psychology and information systems research.

Theoretical Foundations for Understanding Process Improvement

Since the early 1980s, information systems researchers have looked to a group of "intention models" from social psychology as a theoretical foundation for understanding and conducting research on the behavior of IS users (e.g., Swanson, 1982; Christie, 1981). Fishbein and Ajzen's (1975) theory of reasoned action (TRA), and Ajzen's (1991) theory of planned behavior (TPB) are well-researched intention models that have been successfully used in predicting behavior in a wide variety of domains. In addition, the technology acceptance model (TAM) is an adaptation of TRA that was specifically designed to explain and predict computer usage behavior (Davis, 1989; 1993; Davis, Bagozzi, & Warshaw, 1989), and has been widely used by information systems researchers.

When it comes to the practical application of these theories, however, managers, consultants, and practitioners have a dilemma. To justify their use of any particular model, they must be able to answer an important question: Which of these three models better predicts the actual usage of information systems? The purpose of this review is to provide an answer to this question while improving our understanding of the factors that predict technology acceptance. Toward this end, I examine the research published on these three models as they have been used to predict technology acceptance.

I located articles for this review through computerized searches of social science and information systems databases (e.g., PsycINFO 1967—2003) using combinations of the following key words and phrases: "technology acceptance model," "TAM," "theory of reasoned action," "TRA," "theory of planned behavior," "TPB." References were also located through cross-referencing among relevant articles. In this manner, a number of studies were identified that modeled the key factors in the three theories and their influence on various aspects of information systems acceptance.

I divided the studies into two categories: model-generating studies and model comparison studies. In the second section of this review, I examine the model-generating studies by reviewing the models individually, discussing the components and relationships of each one. In the subsequent section, I compare and contrast the models, and review the empirical support for and comparisons of the models. I then discuss differences and similarities in the operational definitions of belief constructs to argue for the integration of the models. I next discuss some empirical support for integrated models, and propose a particular integrated model that is more parsimonious. Such an integrated model would enhance our understanding of the beliefs and processes involved in the acceptance of technology and provide a sound basis for the application of this understanding to real-world situations. Finally, I present the methods and results of an empirical survey of practicing project managers – their attitudes, beliefs, perceptions of social influences, and perceptions of behavioral control over three different kinds of project planning practices. I conclude with a discussion of the practical implications of the survey results, as well as the limitations of the research, along with recommendations for future research.

Chapter 3

THE THEORY OF REASONED ACTION

AND THE THEORY OF PLANNED BEHAVIOR

As the name of the theory implies, Fishbein and Ajzen's (1975) approach centers on the notion of "reasoned action," by which they mean that people are essentially rational, making "systematic use of information available to them," and are not "controlled by unconscious motives or overpowering desires," neither is their behavior "capricious or thoughtless" (Ajzen & Fishbein, 1980, introduction). Moreover, "the ultimate determinants of any behavior are the behavioral beliefs concerning its consequences and normative beliefs concerning the prescriptions of others" (Ajzen & Fishbein, 1980, p. 239).

Thus, according to the theory of reasoned action (TRA; Ajzen & Fishbein, 1980), behavior (B) follows from an intention to behave (I_B), and behavioral intention is formed based on a person's attitude toward the behavior (A_B) as well as their subjective norm regarding the behavior (SN_B), as shown in Figure 2. The model was "designed to explain virtually any human behavior" (Ajzen & Fishbein, 1980, p. 4). Thus, for example, a person's actual use of a software application is thought to be the result of their *intention* to use the application. This intention is influenced, in turn, by their *attitude toward using* the application, as well as their perception that important others expect them to use the application (*subjective norm*). Finally, there is an additional relationship posited between attitude and subjective norm: a covariance, indicated by the curved, double-headed arrow in Figure 2. This covariance is not typically considered a key aspect of the theory, and is discussed later.

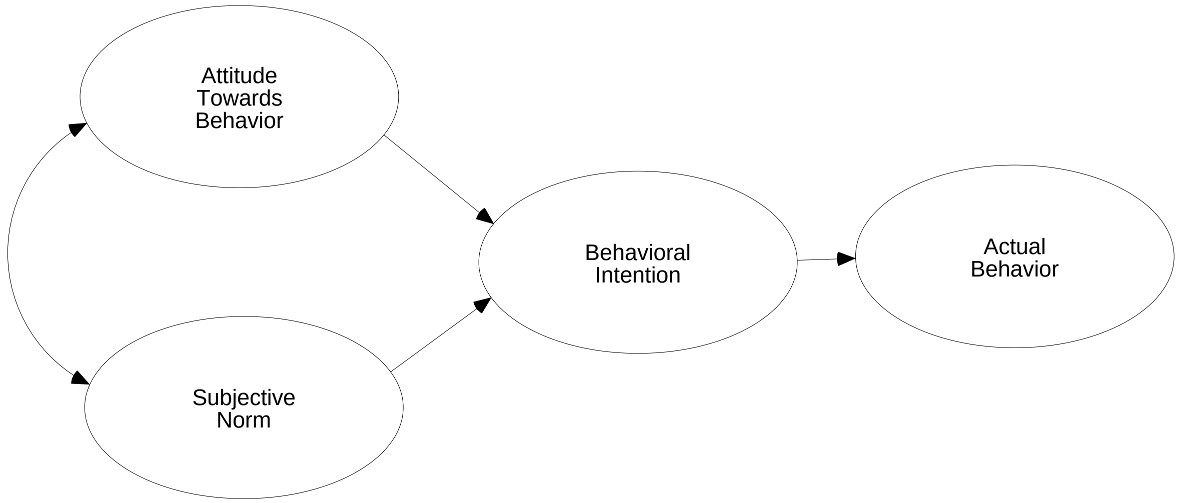

Figure 2. The Theory of Reasoned Action (Fishbein & Ajzen, 1975)

In more formal terms, TRA can be defined using three linear equations:

$\mathbf{B} = \mathbf{I_B} = w_1(\mathbf{A_B}) + w_2(\mathbf{SN_B})$ *(Equation 1)*

$\mathbf{A_B} = \sum_{i=1,n}(\mathbf{bb_i})(\mathbf{ev_i})$ *(Equation 2)*

$\mathbf{SN_B} = \sum_{i=1,n}(\mathbf{nb_i})(\mathbf{mc_i})$ *(Equation 3)*

where B is the behavior (i.e., behavioral criterion); I_B is defined as "an individual's subjective probability that they will perform a specified behavior" (cf. Fishbein & Ajzen, 1975, p. 288); A_B refers to "an individual's degree of evaluative affect toward a target behavior" (cf. Fishbein & Ajzen, 1975, p. 216); and SN_B refers to "the person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein & Ajzen, 1975, p. 302). These are the four key components of the model. In addition, w_1, w_2 are the importance weights, and are estimated using multiple regression to reflect the relative influence of the attitudinal and normative components in a given situation; bb_i refers to behavioral beliefs; ev_i is the subject's evaluation of consequences, or "belief strength;" nb_i refers to normative beliefs; and mc_i is the motivation to comply with important others. In order to apply TRA, several important issues with regard to each of these elements must be considered.

The Behavioral Criterion

Ajzen and Fishbein (1980) maintain that, in defining an adequate behavioral criterion, it is important to decide whether the behavior in question is a specific act or an outcome. For example, "passing a test" is not a measure of behavior that could be considered a specific act; rather, it is an "outcome" of specific acts like reading books, attending lectures, and taking notes. Similarly, in CMM terms, "establishing a plan for managing a project" is an outcome of specific acts like "identifying work products," "estimating work product size," and "documenting size estimates." Many different behavioral acts can potentially lead to the same outcome.

Because the study of outcomes is also part of social science, Fishbein and Ajzen (1974, 1975; Ajzen & Fishbein, 1980) distinguish single, specific acts from outcomes or "behavioral categories." A specific behavior is simply a single act performed by an individual. The measurement of a single act requires that it be defined clearly so as to determine whether or not the individual has actually performed it. This determination must be evident to all observers. As such, the judgment of single acts must have high inter-judge reliability to qualify as an adequate behavioral criterion.

Behavioral categories, on the other hand, involve multiple actions rather than a single, specific behavior. For this reason they are also called "multiple-act criteria" (see Fishbein & Ajzen, 1974). The behavioral categories themselves are "latent" constructs – they cannot be directly observed, but must be inferred from single acts that can be observed. To construct a general behavioral criterion, therefore, the researcher must carefully select a set of at least ten or more related, single actions, all of which must meet the same standards of high inter-judge reliability (Fishbein, 1980).

An important part of TRA is the notion that the psychological variables of the model should be defined and measured at a level of specificity that corresponds to the level of specificity at which the behavioral criterion is measured. Put more simply, the model variables should be worded in a way that is comparable to the wording of the target behavior. Failure to ensure this correspondence may diminish prediction. More specifically, the wording should be comparable in terms of target, action, context, and time period elements (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980). Ajzen and Fishbein explain:

> "Imagine that we want to predict… whether [a respondent] will buy a color television set. Further, suppose we decided to wait a year before measuring whether the behavior has occurred. It can be seen that this criterion specifies an action (buying), a target class (color television sets), and a time period (the year in

> question), but it leaves the contextual element unspecified. The only measure of intention that corresponds exactly to this behavioral criterion is a measure of the person's intention to 'buy a color television set within a year.' (Ajzen & Fishbein, 1980, p. 43).

Moreover, measurement of an individual's behavior over time can be accomplished using either absolute frequency or relative frequency measurements. Absolute frequency involves simply tallying the number of times the behavioral criterion was performed; relative frequency involves tallying the proportion of times the behavioral criterion was performed relative to the total number of opportunities the subject had to engage in the behavior. Additionally, many behaviors are not directly accessible to an observer. In these cases, Ajzen & Fishbein (1980) maintain it is appropriate and acceptable to rely on the actor's self-report.

Behavioral Intention

According to Ajzen and Fishbein (1980), all human behavior is a matter of choice because all voluntary human action entails, at a minimum, a choice between performing and not performing the behavior in question. As such, obtaining a measure of behavioral intention is straightforward: simply present the subject with the available behavioral alternatives and ask them which alternative they intend to perform. Operationally, this intention is often considered to be a "decision," and is the best predictor of actual behavior.

Although a number of factors can influence the relationship between behavioral intention and behavior, Ajzen and Fishbein (1980) specifically point out two: the degree of correspondence between the measure of intention and behavior, and the stability of the intention over time. The degree of correspondence between intention and behavior refers to the level of specificity mentioned earlier. The stability of the intention over time is an issue because, to put it simply, intentions change over time. Generally, Ajzen and Fishbein (1980) state the inverse relationship between prediction and time thus: as the length of time between the measure of intention and behavior increases, the expected relationship between them will decrease. For this reason they maintain it is desirable to "measure the intention as close as possible to the behavioral observation in order to obtain an accurate prediction" (1980, p. 47).

Finally, there are times when the research interest is in long-range prediction, for instance, the forecasting of general behavioral trends in large segments of a population. In such situations, Ajzen and Fishbein (1980) contend that prediction at the aggregate level is likely to balance out the idiosyncratic events that may otherwise confound and compromise the relationship between intention and behavior. As such, they contend, aggregate measures of intention will be much more stable over time and will, therefore, provide better prediction. Ajzen and Fishbein (1980) affirm that "there is considerable evidence that even when individual prediction is relatively poor, prediction of behavior from intention at the aggregate level is often remarkably accurate" (p. 48).

Attitude, Behavioral Beliefs (Belief Strength) and Outcome Evaluations

According to TRA, the most salient determinant of behavioral intention is an individual's attitude. Typically, attitude measures have assessed beliefs and evaluative affect toward some object, such as a car or other product. Because researchers typically seek to predict and understand behavior, however, Fishbein and Ajzen (1975) suggest that a more direct measure of attitude toward behavior should be more predictive than a less direct measure of attitude toward an object. As such, in TRA they make an important distinction between an attitude toward a *behavior* (A_B) and an attitude toward an *object* (A_O).

Moreover, Fishbein and Ajzen (1975) argue for an "informational basis for the formation of attitudes" (p. 222), which they operationalize in a unique way. The constructs in TRA were based in part on "the age-old trilogy of affect, cognition, and conation," (Ajzen & Fishbein, 1980, p. 11-12). As such, behavioral intention serves as the conative component, and their unique operationalization of attitude represents the cognitive and affective components in a way that is identical, in principle, to expectancy-value models of attitude (e.g., Fishbein, 1963).

More specifically, individuals have an expectancy about what consequences may follow from a given behavior. These expectancies are also known as "behavioral beliefs," and are defined as the person's estimate of the likelihood that performing a behavior will result in a salient outcome (i in Equation 2). Fishbein and Ajzen (1975) refer to this "subjective probability" as the individual's "belief strength." The subject's belief strength is typically measured by Likert-type scales that assess the individual's expectancy that performing the behavior will lead to the stated outcome (e.g., likely - unlikely). Furthermore, individuals differ in their "valuation" (i.e., evaluation) of these expected outcomes, by which they refer to "an individual's degree of evaluative affect toward a target behavior" (Fishbein & Ajzen, 1975, p. 216). This is the "value" component of the "expectancy-value" model. The researcher typically employs semantic-differential scales that locate the individual on a bipolar evaluative dimension (e.g., good - bad).

Within the expectancy-value conception of attitude, the hyphen between the two words is highly significant. According to Fishbein (1975), attitudes are the sum of *evaluated salient beliefs* where a specific belief "links an object (action) with an attribute (outcome)" (p.12). As such, both the expectancy as well as the evaluation are associated with the entire conceptual constellation – the behavior, the link, and the expected outcome. For this reason, the behavioral beliefs (cognitive component) and the evaluations (the affective component) are combined multiplicatively, and were not meant to be treated separately. Attitude, then, is simply the sum total of the outcome evaluations of the salient beliefs multiplied by the belief strength estimates, as shown in Equation 2.

$$\mathbf{A_B} = \sum_{i = 1, n} (\mathbf{bb_i})(\mathbf{ev_i}) \quad \textit{(Equation 2)}$$

Fishbein and Ajzen (1975) point out that "Although a person may hold a relatively large number of beliefs about a given object, it appears that only a relatively small number of beliefs serve as determinants of his attitude at any given moment" (p. 218). Those beliefs that exert influence on one's attitude are referred to as "salient beliefs" (also "accessible beliefs;" see Ajzen, 1991). Fishbein and Ajzen (1975) contend that not all beliefs are salient for all contexts. As such, researchers using the model must first identify the beliefs that are salient for subjects regarding the behavior under investigation. To elicit situation-specific beliefs, Fishbein and Ajzen (1975, p. 218) and Ajzen and Fishbein (1980, p. 68) propose that researchers employ a free response format whereby representative subjects are directly asked to list the consequences of performing the target behavior that come to mind. From these responses, researchers should identify the "modal" salient beliefs by taking the five to nine most frequently occurring beliefs from the representative sample.

Although this approach increases the likelihood that the behavioral beliefs used in assessing attitude are salient for the individual, it does not guarantee that the first beliefs emitted are the person's salient beliefs with regard to that behavior, nor that all beliefs elicited are important. Fishbein and Ajzen (1975) concede "It is possible, however, that only the first two or three beliefs are salient for a given individual and that individual beliefs elicited beyond this point are not primary determinants of his attitude" (p. 218).

The foregoing procedures can be easily tailored to assess beliefs and attitudes that are salient to a group. To do so, salient beliefs are elicited from a representative sample of the targeted population. Their responses are categorized according to dimensions of similarity, and a tally made of how frequently they occurred. The final abridged set is known as the "modal salient beliefs" for the population. After ascertaining the modal beliefs, determining the group attitude follows the techniques described above for assessing individual attitudes.

Subjective Norm, Normative Beliefs, and Motivation to Comply

Like the attitude construct, the subjective norm construct in TRA is also based on an expectancy-value model. The third equation specifies that the individual's subjective norm is a function of "the perceived expectation of specific referent individuals or groups, and by the person's motivation to comply with those expectations" (Fishbein & Ajzen, 1975, p. 302). Stated more formally, TRA posits that an individual's subjective norm (SN_B) is a multiplicative function of their normative beliefs (nb_i), defined as perceived expectations of specific referent individuals or groups, and their motivation to comply (mc_i) with those expectations. That is, subjective norm is the summed total of the products of the individual's normative beliefs (beliefs regarding the expectations of significant others) and motivation to comply with these important referents, as shown in Equation 3:

$$\mathbf{SN_B} = \sum_{i = 1, n} (\mathbf{nb_i})(\mathbf{mc_i}) \quad \textit{(Equation 3)}$$

This component of the model comprises Fishbein and Ajzen's (1975) account of social influence on intentions and behavior. It refers to the person's perception that most people who are important to him or her, think he or she should or should not perform the behavior in question. The more the person perceives that important others think he or she should perform the behavior, the more he or she will intend to do so. The normative component is measured in the same way that attitude is measured. Instead of eliciting behavioral beliefs, however, the individual's "normative beliefs" are obtained using a free response format. Belief strength, which in this case is the individual's motivation to comply with the salient referents, is also measured by employing a Likert-type scale. The subjective norm is then determined by summing the products of these two measures, normative beliefs and motivation to comply. As with all other components in the model, a close correspondence between the subjective norm and the behavioral criterion is essential, and the procedures are readily adapted to modal normative beliefs for groups.

Fishbein and Ajzen (1975) acknowledge that subjective norm is the most obscure part of the model since "Very little research... has dealt with the formation of normative beliefs" (p. 304). On the expectancy-value conception of attitudes, subjects may have an expectancy about *social* outcomes of a given behavior. That is, subjects may consider complying with important referents as a salient consequence of behavior. As such, Fishbein and Ajzen (1975) acknowledge that normative beliefs may be conceptually related to the attitude component rather than as a separate component of the model. Nevertheless, Fishbein and Ajzen (1975) claim "it is useful to maintain the distinction between beliefs about the consequences of performing a behavior and beliefs about expectations of relevant referents" (p. 304). Because of the close conceptual relationship between normative beliefs and attitude, therefore, a positive covariance is typically posited between these two constructs, as shown by the curved arrow in Figure 2. This covariance, however, is not typically considered a primary conceptual feature of the model.

External Variables

Finally, Fishbein and Ajzen (1975) contend that any other factors that influence behavior do so only indirectly by influencing the attitude and subjective norm components of the model. More specifically, all "external variables" have their influence on intentions and, ultimately behavior, by influencing the relative weights of the belief elements in the model. Examples of external variables in the context of information systems research include such factors as system design characteristics, user characteristics (including cognitive styles and other personality variables), task characteristics, gender, and so forth.

Overall, TRA has been empirically well supported as a model for predicting a wide range of behaviors in a number of settings. As a model for predicting technology-related behaviors, however, the support is somewhat lacking and mixed. Moreover, TRA has been criticized on theoretical grounds for two basic reasons that are significant for the current study. First, TRA has been criticized for its failure to account for the frequent situation where human action is not entirely under the actor's volitional control (see Ajzen, 1985). Theory and research carried out to address this omission resulted in the theory of planned behavior (TPB). Second, for the purposes of applying TRA to a specific domain of interest, Davis (1986) took exception with how Fishbein and Ajzen (1975) conceptualized and modeled belief constructs. Theory and research carried out to address this concern resulted in the technology acceptance model (TAM), which I discuss following the discussion of TPB.

The Theory of Planned Behavior

An important assumption of TRA is that “most actions of social relevance are under volitional control” (Fishbein & Ajzen, 1980, p. 5). Complete control in real life situations, however, is rare. For instance, among the behaviors considered by Fishbein and Ajzen (1980) to be beyond the scope of the model are, “emotional outbursts and performance of well-learned skills, such as turning the pages of a book or driving a car” (p. 245). In a similar but different sense, in the context of efforts to adopt information technologies, managers often mandate the use of certain standardized information systems, rendering system usage no longer completely under volitional (or “voluntary”) control. The ability of the theory of reasoned action to predict usage behavior in such a case may be diminished. The theory of planned behavior (TPB), therefore, was introduced by Ajzen (1985) as a model specifically tailored to address the problem of voluntariness in behavior.

TPB posits that two key determinants of behavioral intention are attitudes toward the behavior and subjective norms. In addition, TPB posits perceived behavioral control (PBC) as a determinant of behavioral intention and behavior itself. Thus, TPB asserts that behavior (B) is a direct function of behavioral intention (BI) and perceived behavioral control (PBC). Behavioral intention is formed by one’s attitude (A), which reflects feelings of favorableness or unfavorableness towards performing a behavior; subjective norm (SN), which reflects perceptions that significant referents desire the individual to perform or not perform a behavior; and perceived behavioral control (PBC), which reflects perceptions of internal and external constraints on behavior (Ajzen 1991), as shown in Figure 3.

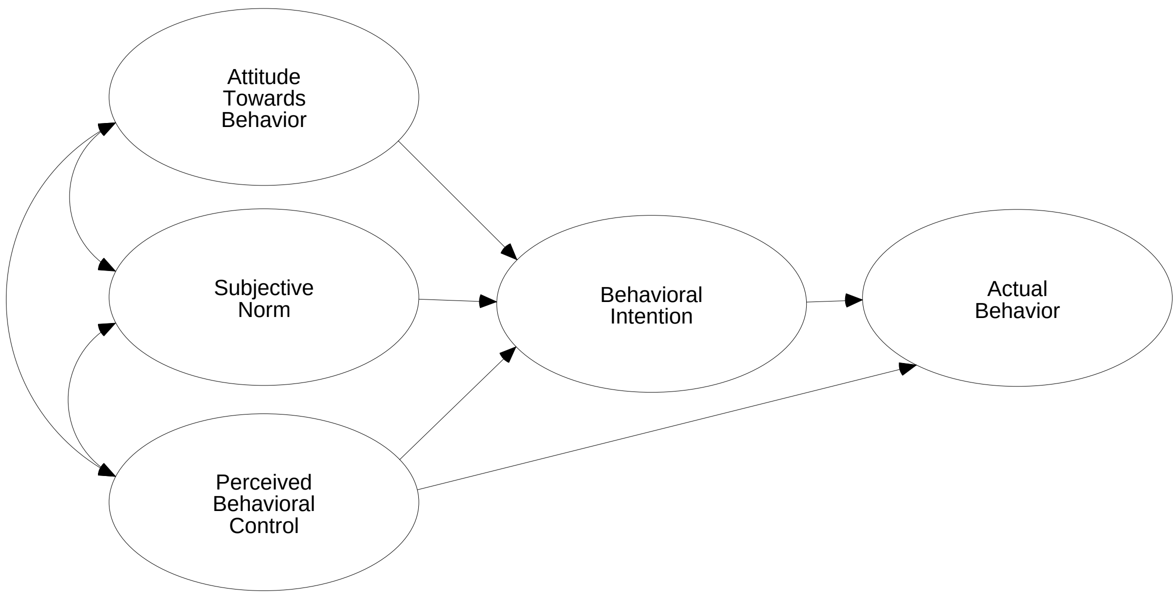

Figure 3. The Theory of Planned Behavior

More formally, behavior is a weighted function of behavioral intention and perceived behavioral control, and behavioral intention is the weighted sum of attitude, subjective norm and perceived behavioral control components, as in the following formulas:

$\mathbf{B} = w_1\mathbf{BI} + w_2\mathbf{PBC}$ *(Equation 4)*

$\mathbf{BI} = w_3\mathbf{A} + w_4\mathbf{SN} + w_5\mathbf{PBC}$ *(Equation 5)*

As with TRA, each of the determinants of intention (i.e. attitude, subjective norm, and perceived behavioral control) is, in turn, a function of underlying belief structures. These belief structures are referred to as behavioral (or, sometimes “attitudinal”) beliefs (bb_i), normative beliefs (nb_i), and control beliefs (cb_i), which are related to attitude, subjective norm and perceived behavioral control, respectively. Each of the belief structures for attitude and subjective norm are functions of the cross products of these beliefs and outcome evaluations (ev_i) and motivation to comply (mc_i), respectively, just as in TRA. The perceived behavioral control construct, like the other two, is also an expectancy-value conception. It reflects expectancy beliefs regarding likely access to resources, skills and opportunities needed to perform a behavior, and “valuations” of the importance of those resources, skills and opportunities (Ajzen 1991). As such, perceived behavioral control (PBC) is formed as the sum of the control beliefs (cb_i) weighted by the perceived facilitation (pf_i) of each control belief in either inhibiting or facilitating the behavior, as shown in Equation 5.

$$\mathbf{PBC} = \sum_{i = 1, n} (\mathbf{cb_i})(\mathbf{pf_i}) \quad \textit{(Equation 5)}$$

It is important to distinguish PBC from *actual control*. Actual control refers to the amount of requisite opportunities and resources (e.g., time, money, skills, cooperation of others) an actor possesses to be able to reach a goal. Intention and actual control jointly determine whether or not the behavior is performed. Because actual control has been very difficult to operationalize, however, it has rarely been examined in tests of TPB

(Ajzen & Madden, 1986). Moreover, as with TRA, normative beliefs and perceived behavioral control may be conceptually related to the expectancy-value attitude component. Because of these relationships between normative beliefs, behavioral control beliefs, and attitude, therefore, covariances are typically posited among these constructs, as shown by the curved arrows in Figure 3.

There has been a great deal of empirical evidence to support the effectiveness of TPB in predicting a range of behaviors. For instance, Schifter and Ajzen (1985) successfully applied TPB to the prediction of weight loss behavior, and Ajzen and Madden (1986) used TPB to predict students' decisions about attending class and earning a good grade. Relatively few empirical studies, however, have directly employed TPB to predict technology-related intentions and behaviors. Of the four studies I located, two are studies that employed TPB separately to predict some technology-related intention or behavior.

Harrison, Mykytyn, and Riemenschneider (1997) used TPB to predict the decisions of small business executives to adopt a competitive information technology as part of their competitive strategy. They identified 162 small businesses that were considering the adoption of some form of information technology. Following the guidelines provided in Ajzen (1991), they developed instruments to measure small business executives' salient behavioral beliefs, control beliefs, and normative beliefs with regards to their unique technology adoption decisions. Their results consistently showed that attitude, perceived behavioral control, and subjective norm were all significant in predicting small business executives' decision to adopt an information system.

Morris and Venkatesh (2000) also applied TPB to investigate age-differences (an external variable) in the usage of new software applications over a five-month period. Using a median split on reported age, they identified older and younger workers in a number of organizations. Using the protocols suggested by Fishbein and Ajzen (1980), they elicited salient beliefs about proposed systems to be implemented in the organizations. Their results showed that younger workers were more influenced by attitude than were older workers, whereas older workers were more influenced by subjective norm and perceived behavioral control than were younger workers. The influence of subjective norm for older workers, however, decreased over time.

To summarize, although there is much evidence supporting the TPB constructs as a general model for predicting a variety of behaviors, very few studies have examined whether or not TPB constructs adequately predict technology usage behaviors in particular. A related question is whether or not the PBC construct adds significant predictive ability beyond that provided by TRA. According to a meta-analysis conducted by Conner and Armitage (1989), the benefits of using TPB over TRA seem to be modest. They found that TPB added only about 4% to 5% to the variance explained in intention and only about 1% to the variance explained in actual behavior above that explained by TRA. None of the studies in this meta-analysis, however, involved the prediction of technology-related behaviors. To find an intention model that directly addresses the prediction of technology-related behaviors, we must turn to the technology acceptance model (TAM), which was also based on TRA.

Chapter 4

THE TECHNOLOGY ACCEPTANCE MODEL

Davis (1986) intended for the technology acceptance model (TAM) to serve as a conceptual framework for tracing the influence of information system design characteristics ("external variables," $X_{1...3}$ in Figure 4) on internal beliefs, attitudes (ATT), and actual system use (USE), as shown in Figure 4. As such, he sought to identify more generalizable belief constructs that could be measured and compared across systems testing contexts. To accomplish this, he had to conceptualize beliefs and attitudes differently than they were in TRA. Based on his review of previous research, Davis posited two specific beliefs - perceived usefulness (USEF) and perceived ease of use (EOU) - as the primary determinants of attitude towards IS usage behaviors.

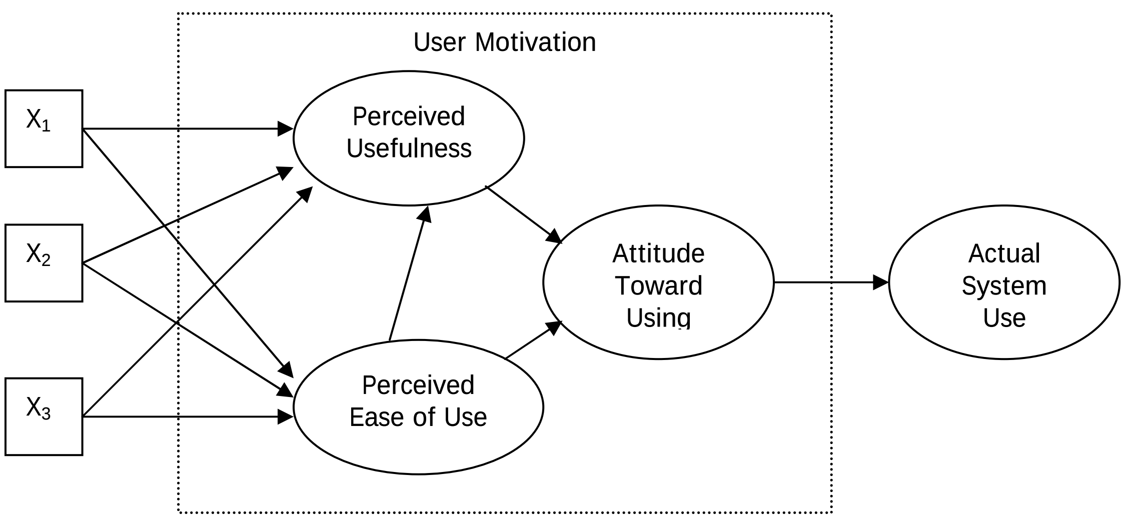

Figure 4. The Technology Acceptance Model (Davis, 1986, p. 24)

TAM can be expressed more formally using the following equations (cf. Davis, 1986, p. 25):

$\mathbf{USE} = [\beta_1\ \mathbf{ATT} + \varepsilon_1] = [\beta_2\ \mathbf{USEF} + \beta_3\ \mathbf{EOU} + \varepsilon_2]$ *(Equation 6)*

$\mathbf{ATT} = \beta_1\ \mathbf{EOU} + \beta_2\ \mathbf{USEF} + \varepsilon_3$ *(Equation 7)*

$\mathbf{USEF} = \sum_{i = 1, n} \beta_i\ \mathbf{X_i} + \beta_n\ \mathbf{EOU} + \varepsilon_4$ *(Equation 8)*

$\mathbf{EOU} = \sum_{i = 1, n} \beta_i\ \mathbf{X_i} + \varepsilon_5$ *(Equation 9)*

where X_i is system design feature i, (for i = 1, n); USE is the actual system usage behavior (i.e., behavioral criterion); ATT refers to "an individual's degree of evaluative affect toward a target behavior" (cf. Fishbein & Ajzen, 1975, p. 216); USEF is perceived usefulness, which refers to "the degree to which a person believes that using a particular system would enhance their job performance" (Davis, 1989, p. 320); and EOU is perceived ease of use, defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). Additionally, $\beta_{1..3}$, β_i, and β_n are standardized partial regression coefficients, and ε is a random error term.

A comparison of the TAM diagram against the TRA model diagram presented earlier reveals that the original TAM was different in at least three important ways. First, TAM did not include a behavioral intention measure. Second, it omitted a social normative influence component. And third, it specified two distinct beliefs as antecedents to attitude. It is to a discussion of these differences that I now turn.

Theoretical Rationale for Davis' (1986) Adaptations of TRA

The first differences to note are that Davis' (1986) TAM did not include a measure of behavioral intention, which is considered to be fundamental to TRA, nor did it include a social normative influence component, as does TRA. Generally speaking, these differences between TAM and TRA are due to the fact that Davis (1986) intended for TAM to be used in an applied setting: to assess information systems usage in the context of a user acceptance testing methodology. Davis reasoned that potential users form "motivational tendencies" toward a new system fairly rapidly. Therefore, potential users could try out new systems in brief testing sessions where they could quickly form judgments and general motivational responses about the features of the information systems under design. Measures of these motivations could then be used to predict actual usage in a "live" setting, and to compare the acceptability of alternative information system designs. With this kind of understanding, system designers could reduce the risk of implementing unsuccessful designs and identify successful design features.

Davis omitted behavioral intention because, in his view, intention reflects a decision, and decisions take time. In the context of user acceptance testing, however, there would not be sufficient time to form an intention prior to measurement. Davis considered attitudes, on the other hand, to be formed rapidly. According to TRA, upon which TAM was based, in the absence of a formed intention, attitude is the direct predictor of behavior in TAM.

Moreover, Davis (1986) raised questions about the presumed independent influence of the attitudinal and normative components on behavioral intention. Specifically, he cited Smetana and Adler (1980) who found that attitude toward the behavior was a function not only of beliefs regarding the consequences of the behavior, but was also influenced by the beliefs concerning the normative expectations of others. Additionally, Davis points out that even Ajzen and Fishbein (1972; 1973) acknowledge, "our present understanding of the determinants of social normative beliefs and motivation to comply is rather limited" (p. 43). Perhaps more importantly, however, Davis omitted the social normative belief construct from TAM because he expected no salient referent information, and no relevant perceived social normative influence, in the context of user acceptance testing.

Within the framework of the expectancy-value model used by Fishbein and Ajzen (1975), to determine the attitude toward the behavior in question the researcher must know how the subject evaluates each of the elicited beliefs, as well as how strongly the subject holds each belief. This is accomplished by employing Likert-type scales that locate the individual on a bipolar evaluative dimension (e.g., good - bad) as well as the individual's expectation (subjective probability) that performing the behavior will lead to the stated outcome (e.g., likely - unlikely). Therefore, attitude is simply the sum total of the outcome evaluations of the salient beliefs *multiplied by* the belief strength, and may be seen as the operational definition of attitude, rather than a specification of an antecedent "belief-evaluation" construct.

Davis (1986) argued that, by modeling belief structures in this aggregated way, TRA does not explicitly allow for the analysis of the relationship between beliefs and evaluations. The justification for positing a multiplicative relationship between beliefs and evaluations is based on the assumption that the size of the multiple correlation between beliefs and attitude does not generally improve when importance weights are included. As such, they "have essentially assumed that the weight is 1.0 and can thus be neglected" (1975, p. 241).

By contrast, Davis (1986) was interested in the *relative* influence of specific beliefs on attitudes toward using an information system. He argued, "Modeling the belief structure in a disaggregated way using multiple regression enables one to compare the relative influence of different beliefs in determining attitude toward using" (p. 27). As such, Davis' reasoning here is not a criticism of Fishbein and Ajzen (1975) on methodological grounds; rather, Davis acknowledges:

> "Although we do not expect the overall proportion of explained variance to significantly surpass that of a unit-weighted model, the estimated regression weights are an important source of diagnostic explanatory information which enables the researcher to gauge the relative influence of perceived usefulness and ease of use in determining attitudes and behavior" (p. 28).

In short, not only does Davis (1986) disaggregate the belief structures from TRA so that he can identify specific beliefs (i.e., usefulness and ease of use), but he uses the belief evaluation term from TRA as a simple *attitude* construct in TAM. In this sense, then, Davis defines attitude in very basic terms – simply as the degree of evaluative affect for or against the behavior (i.e., good – bad). He then estimates the relationship between the belief constructs and the attitude (evaluation) term using multiple regression, rather than combining them multiplicatively as in TRA. He does this for two reasons.

First, Davis argues that there is no evidence that beliefs and evaluations combine multiplicatively. Specifically, multiplying each belief term by its corresponding evaluation term (as in TRA) assumes a ratio level of measurement, which he insists is typically an untenable assumption in TRA research. Second, Davis argues that multiplying each belief term by its corresponding evaluation term (as in TRA) only improves prediction when the belief set contains a mixture of positively and negatively valenced beliefs. Whether or not the belief set contains such a mixture is a function of the data-coding scheme in the first place, and is, therefore, arbitrary.

Moreover, instead of elicited, context-specific "salient beliefs," as used in TRA, beliefs used in TAM are specified a priori, and are based on previously published theoretical and empirical research that spans a wide range of system types and user populations. As such, these beliefs provide confidence that they are salient beliefs across many contexts. Davis argues that this is justified because it is not clear that the qualitative, free-response, belief elicitation procedure recommended by Fishbein and Ajzen (1975) truly identifies the salient beliefs (i.e., those that are influential in attitude formation). For one thing, this procedure assumes that each elicited belief corresponds to a distinct belief construct.

Instead, TAM allows that the conceptual definition of a latent belief construct is inferred from the content of the items loading on the dimension, with the items treated as measures of the dimension. In this regard, then, Davis (1986) acknowledges that perceived usefulness and perceived ease of use might not represent a complete specification of the beliefs that are salient. On practical grounds, however, he contends that if the model with just these two belief constructs "fits well," it is evidence that these belief constructs are an adequate set of salient beliefs (p. 35).

Moreover, following the guidelines of TRA, researchers measure beliefs by directly converting elicited beliefs to belief measures using the recommended standard scale formats (Fishbein & Ajzen, 1980). According to Davis (1986), this protocol creates one-item belief scales, which are typically not reliable or valid. By contrast, Davis created multi-item measurement scales for perceived usefulness and perceived ease of use. First, he based conceptual definitions for the constructs on prior literature, generating an initial pool of measurement items based on these definitions. Then he pre-tested the wording of the items to verify their correspondence with the underlying conceptual variables they are intended to measure. He then operationalized the scale formats in the manner recommended by Fishbein and Ajzen (1980), and then conducted a survey to verify the reliability and validity of the scales. In this way, Davis created scales that were not situation specific but, rather, provided measures of these two key belief constructs that generalized across technologies and populations.

Finally, disaggregating beliefs also allowed Davis to posit a relationship among beliefs in a way that TRA was unable to do. Drawing on Fishbein's and Ajzen's (1975) distinction between *descriptive* beliefs and *inferential* beliefs, Davis argued that perceived ease of use is a descriptive belief that is formed based on directly observable objects or events, such as the subject's direct experience with a target system during a user acceptance test. Such beliefs have an effect on perceived usefulness, which is an inferential belief. It goes beyond directly observable phenomena, such as a test subjects' estimates of the effect the system would have on their job performance. Through this kind of theorizing, and disaggregating the two belief constructs, Davis posits that perceived ease of use will have an effect on perceived usefulness.

Empirical Support for TAM

To establish the validity of the perceived usefulness and ease of use scales, Davis (1989) carried out two studies with a total of 152 users of an e-mail system, a file editor, and two graphics packages. Definitions for the two variables were developed from a number of relevant published studies and used to develop scale items that were pre-tested for content validity, and then tested for reliability and construct validity. In this way, the two belief measures were refined and streamlined, resulting in two six-item scales with reliabilities of .98 for perceived usefulness and .94 for perceived ease of use.

Results showed that, overall, the scales exhibited high convergent, discriminant, and factorial validity. Perceived usefulness was significantly correlated with both self-reported current usage (r = .63, Study 1) and self-predicted future usage (r = .45, Study 2). Perceived ease of use was also significantly correlated with current usage (r = .45, Study 1) and future usage (r = .59, Study 2). In both studies, however, perceived usefulness had a significantly greater correlation with usage behavior than did perceived ease of use. In subsequent regression analyses that examined the combined effects of the two variables on use and on intention to use, perceived ease of use showed mostly insignificant effects, suggesting that perceived ease of use may actually be a causal antecedent to perceived usefulness, as opposed to a parallel, direct determinant of system usage. Based on these results Davis concluded that “ease of use operates through usefulness” (Davis, 1989, p.332), a finding that has been repeated in subsequent research (e.g., Venkatesh & Davis, 1994).

Additionally, TAM, in various forms, has received a great deal of empirical support for predicting the intention to use, as well as the actual use of, a variety of technologies by a range of different user populations. Building on Davis’ work, numerous studies have validated TAM in a variety of field settings and across a broad range of information systems applications, including e-mail and gopher (Venkatesh & Davis, 1994), spreadsheets (Mathieson, 1991; Adams, Nelson, & Todd, 1992), database management systems (DBMS; Szajna, 1994), FAX (Straub, 1994), group support systems (Chin & Gopal, 1995), and expert systems (Keil, Beranek, & Konsynski, 1995).

TAM has also been examined with a variety of user populations, including across cultures (e.g., Straub, 1994; Gefen & Straub, 1997), and on a variety of technologies, including Xedit, Chartmaster, Pendraw, WriteOne, Spreadsheet, Calculator, E-mail, Voicemail, WordPerfect, Lotus 1-2-3, Harvard Graphics, Text Editor, Database Management System (DBMS), Gopher, and a computer resource center. Table 2 summarizes a number of illustrative studies and the coefficient estimates for perceived usefulness (USEF) and perceived ease of use (EOU) in predicting a number of different DVs. Specifically, these studies are variations on the original TAM, with most using USEF and EOU to predict intentions, others to predict attitudes, and others to predict actual behavior. As such, the defining components of TAM are the distinct belief constructs, USEF and EOU (Davis et al., 1989). Overall, these two belief measures have performed relatively consistently as key constructs in determining user attitudes, intentions, and usage behaviors. Unfortunately, because Squared Multiple Correlation (SMC) coefficients and their equivalents are not regularly reported in the literature (see Gefen, Straub, & Boudreau, 2000, for this criticism of the literature), and were not commonly reported across these studies, regression and related coefficients are reported here to show the same statistic across studies.

Table 2. Summary of Illustrative TAM Research Since Davis et al. (1989)

Study	N	Analysis	DV	USEF Coefficients	EOU Coefficients
Davis (1989)	264	Regression	Self-reported Use	.55 to .76	Indirect .25 * to .69
Davis, et al. (1989)	107	Regression	Intention	.62 to .76	.18 to .20
Mathieson (1991)	139	Regression	Intention	.75	.59
Adams, Nelson, & Todd (1992)	300	LISREL	Use	-.03 * to .85	Indirect .68 to .84
Davis, et al. (1992)	240	Regression	Intention & Use	.46 to .79	.18 to .24
Davis (1993)	112	Regression	Attitude & Use	.58 to .65	.54
Szajna (1994)	231	Discriminant Analysis	Choice	60% hit rate	75% hit rate
Venkatesh & Davis (1994)	47	Regression	Intention	.86	.38
Taylor & Todd (1995)	786	Path Analysis	Intention	*	1.69
Davis & Venkatesh (1996)	708	Factor Analysis & Regression	Intention	.53	.36 to .37
Szajna (1996)	61	Regression	Intention	.31 to .72	.09 to .35
Venkatesh & Davis (1996)	108	Regression	Intention	.66 to .89	.36 to .70

* indicates a coefficient that is *not* significant at $p < .05$

Chapter 5

COMPARING AND INTEGRATING TRA, TPB AND TAM

Although TAM was originally designed for use in the context of a user acceptance testing methodology, it did not take long for Davis (1989) and others to realize the more broadly applicable potential of TAM. To make the model more generally applicable, however, the key intention construct from TRA that was omitted in the 1986 version had to be reconsidered. Additionally, Davis, Bagozzi, and Warshaw (1989) were interested in addressing the question of whether or not TAM was an improvement over TRA upon which it was based. To address both of these concerns, Davis et al. (1989) drew upon expectancy theory, self-efficacy theory, cost-benefit research, and “diffusion of innovations” research to theoretically justify the reintroduction of intention into a “revised” version of TAM.

Similar to TRA, in this version of TAM they postulated that IS usage behavior (B) was determined by a behavioral intention (BI) to use a system, which was jointly determined by a person’s attitude (A) towards using the system as well as the system’s perceived usefulness (USEF). Attitude (A) is also jointly determined by the two key belief constructs, perceived usefulness (USEF) and perceived ease of use (EOU). Moreover, they reasoned that increased performance may result from “instrumental” improvements in ease of use. That is, the degree to which increased ease of use leads to improved performance will result in a direct effect of ease of use on perceived usefulness.

Thus, perceived usefulness, in turn, is influenced by perceived ease of use as well as external variables (Davis et al., 1989), as shown in Figure 5.

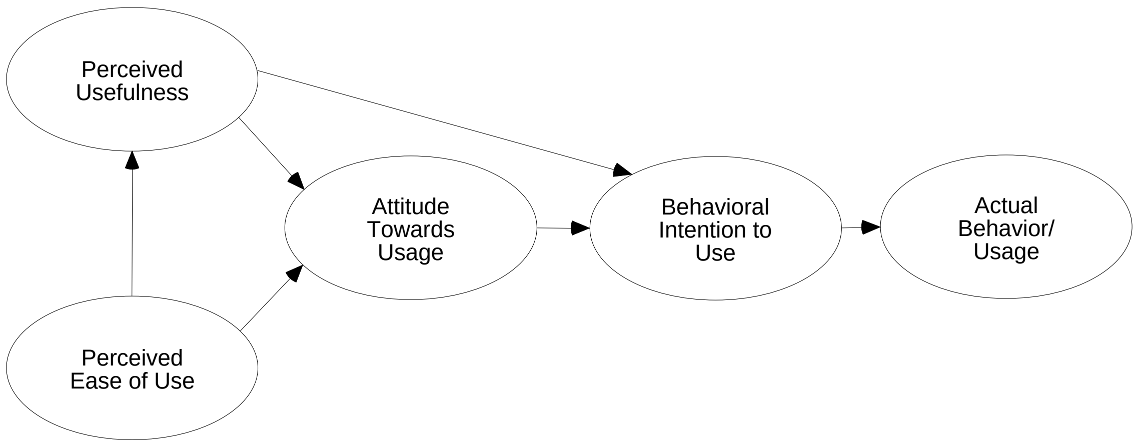

Figure 5. The "Revised" Technology Acceptance Model (Davis, et al., 1989, p. 985)

The more formal equations that depict the key relationships in the 1989 version of TAM are similar to those provided earlier, with one exception. The revised model adds an equation for behavioral intention as shown in Equation 10:

$$\mathbf{USE} = \mathbf{BI} = [\beta_1 \, \mathbf{ATT} + \varepsilon_1] = [\beta_2 \, \mathbf{USEF} + \beta_3 \, \mathbf{EOU} + \varepsilon_2] \quad \textit{(Equation 10)}$$

Once again, subjective norm was not added to TAM in this study because Davis et al. (1989) reiterated that it had an uncertain theoretical and psychometric status. More specifically, they argued that standard measures of subjective norm do not appear to differentiate compliance from internalization and identification processes (Kelman, 1958), and that attitude may covary with subjective norm because of a “false consensus effect” in which people project their own attitudes onto others. Nevertheless, because at least one of the objectives of this study was to compare TAM and TRA, and subjective norm was measured as part of TRA, they tested whether subjective norm explains any variance in behavioral intention beyond that accounted for by attitude and perceived usefulness. Additionally, they compared TAM's predictive ability both with and without the attitude component in order to investigate the ability of the two key belief constructs to predict intention directly.

Was this revised version of TAM an improvement over TRA? To answer this question, Davis et al. (1989) conducted a 14-week longitudinal study. They gathered questionnaire and interview data from 107 fulltime students in the MBA program at a northeastern university. These MBA students had voluntary access to a word processing software program ("Write One") in a student lab setting. Questionnaires and interviews were used to assess beliefs, which were elicited according to the procedures specified by Fishbein and Ajzen (1975), and Ajzen and Fishbein (1980). TAM belief constructs were measured using the validated belief scales (see Davis, 1989). Intentions to use the application, the frequency of use of the application, as well as other information regarding the students' views of the applications, were also measured. Measurements were made at two points in time: after a one-hour introduction to the word-processor (Time 1), and again after 14 weeks (Time 2). Since the data were collected within subjects, the models were directly comparable. Table 3 summarizes the results of this comparison study.

Table 3. Results of Model Comparison by Davis, et al. (1989, p. 992): TRA vs. TAM

	Time 1		Time 2	
	R^2	Beta	R^2	Beta
(1) Explaining Usage at Time 2 From BI measured at Times 1 and 2 (Common to both models)				
USE (Time 2) = BI	0.12***		0.40***	
BI		0.35***		0.63***
(2) TRA				
BI = A + SN	0.32***		0.26***	
A		0.55***		0.48***
SN		0.07		0.10
A = $\sum(bb_i)(ev_i)$	0.07**		0.30***	
$\sum(bb_i)(ev_i)$		0.27**		0.55***
(3) TAM				
BI = A + USEF	0.47***		0.51***	
A		0.27**		0.16
USEF		0.48***		0.61***
A = USEF + EOU	0.37***		0.36***	
USEF		0.61***		0.50***
EOU		0.02		0.24**
USEF = EOU	0.01		0.05*	
EOU		0.10		0.23**

Note: * $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

The results justified the decision to reintroduce behavioral intention back into TAM, making it more consistent – and somewhat of an integration with – the original TRA. Behavioral intention was significantly correlated with usage, and accounted for 40% of the variance in usage at Time 2. Intentions measured right after the introduction were correlated 0.35 with usage frequency 14 weeks later, and intentions and usage measured at the end of the semester were correlated 0.63. Also consistent with both theories, intentions fully mediated the effects of all other variables on usage; hierarchical regression analysis showed that none of the other TRA or TAM variables significantly influenced usage over and above behavioral intentions.

Overall, the constructs from each of the models explained a significant proportion of the variance in behavioral intention. TRA accounted for 32% of the variance in behavioral intention at Time 1 and 26% of the variance at Time 2; whereas TAM explained 47% and 51% of the variance at Times 1 and 2 respectively. Confirming the concern over the status of subjective norm, these results showed that it had no significant influence at either time. It is important to note that this latter result is likely due, at least in part, to the use of a single-item scale for measuring subjective norm (see Davis et al, 1989, p. 998-999). Finally, some unexpected results were noted. Contrary to the predictions based on TAM, attitude correlated with behavioral intentions at Time 1 but not at Time 2 (β = .27 and .16, respectively). And contrary to the predictions based on TRA, hierarchical regression revealed that direct belief-intention relationships were observed. Specifically, the belief summation term, $\sum(bb_i)(ev_i)$, had a direct effect on behavioral intention over and above attitude and subjective norm at Time 2 (β = 0.21) but not at Time 2 (β = 0.11). Hence, Davis et al (1989) concluded "attitude appears to mediate the effects of beliefs on intentions even less than postulated by TRA and TAM" (p. 993).

I located only a couple of additional studies that have compared TAM to one of the other models. Both Mathieson (1991), and Taylor and Todd (1995a; 1995b) utilized TPB in some form to compare and / or combine its constructs with other models to predict intentions and behaviors toward the use of information systems. Briefly, Mathieson (1991) compared TPB and TAM in a study involving 262 university students and their use of a calculator and spreadsheet software (Lotus 1-2-3). Similar to Davis, et al. (1989), Mathieson (1991) elicited beliefs from the target group to test TPB in the context of technology usage. Items used to test TAM were adapted from Davis (1989). Students were asked to complete an assigned task over a two-week period using a calculator or the spreadsheet software, and then responded to a computer-based questionnaire. The comparison of the models was based on a between-subjects comparison of the 149 subjects who responded to the TAM instrument and the 113 subjects who responded to the TPB instrument. The results of this model comparison suggest that TAM performed moderately better than TPB in predicting intentions. Whereas TPB accounted for 60% of the variance in behavioral intentions, TAM accounted for almost 70% (Adjusted R^2 = 0.600 and 0.697, respectively).

To summarize, Davis et al. (1989) reported that the revised TAM predicted software usage intention moderately better than TRA; Mathieson (1991) found that TAM predicted intention only somewhat better than TPB; and in a comparison of TAM against a "pure" (as opposed to "decomposed") TPB, Taylor and Todd (1995) reported that TAM and the "pure" TPB predicted intentions equally well. These latter researchers concluded what is reasonable to conclude from this review of the literature, that all three models are essentially equivalent in predictive ability. Combined with the results of the meta-analysis cited earlier that showed relatively little predictive difference between TRA and TPB (i.e., Conner & Armitage, 1989), the empirical comparisons of these models do not appear to support a clear winner in terms of explanatory power.

Although all three models may be relatively equivalent in their explanatory power, each model also has unique advantages and disadvantages. As Davis et al. (1989) point out, TAM is clearly easier to use and less costly to researchers because no belief elicitation pilot studies are required, as with TPB and TRA. On the other hand, Mathieson (1991) acknowledges that these belief elicitation studies allow researchers to identify obstacles, advantages, disadvantages, and social influences that may increase their context-specific understanding of the factors that influence acceptance of technology. Moreover, TPB provides a model for predicting behavior under conditions when it is not completely under volitional control, which is neglected by the other two models. Particularly in the context of applied research and interventions such as process improvement, context-specific information, as well as project managers' perceptions about whether or not their practices as under their control, may be critical to making informed decisions about a process improvement initiative.

Toward Model Integration

Rather than selecting one model above the others, another option, and the one that forms the premise of the current research, is to integrate the models into one parsimonious framework. Based on their conceptual similarities, it may be possible to integrate the three models in several different ways. The first possible approach leverages the common attitude construct and achieves a *rudimentary* integration. A second possible approach *decomposes* the belief structures in all three models, resulting in a "tighter" integration, but with the added complexity of multiple "cross-over effects." Finally, a third possible approach returns to the original expectancy-value theorizing behind the models, and treats belief measures as manifest indicators of three latent constructs. As such, this possible approach allows both the structural relationships among latent constructs and the measurement relationships among beliefs to be assessed. I now discuss each of these possible approaches in turn.

A rudimentary integration would be based on attitude as a commonality among the three models. As such, it may be possible to integrate the models simply by appending the generalized beliefs from TAM onto the TPB model as determinants of attitude and intention. This approach to integration would be the next logical step following the "Revised" Technology Acceptance Model created by Davis, et al. (1989), and is illustrated in Figure 6 (cf. Taylor & Todd, 1995c).

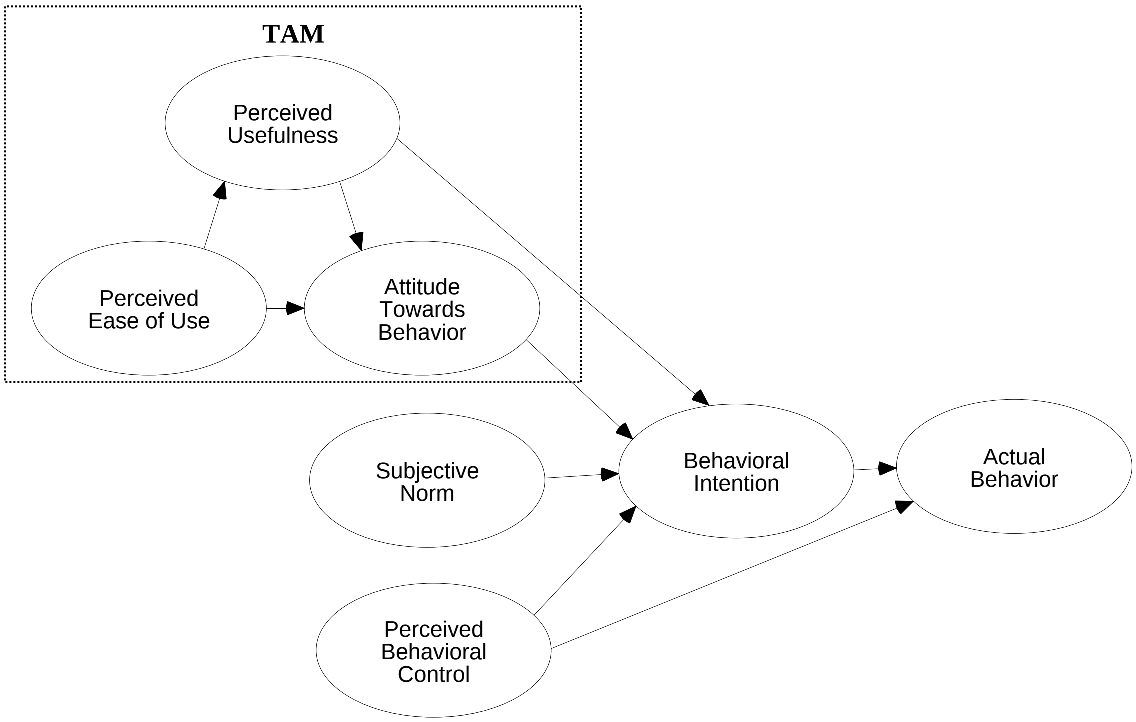

Figure 6. A Simple Integration of TAM and TPB (cf. Taylor & Todd, 1995c)

In their model comparison study, Taylor and Todd (1995c) tested the key relationships suggested by this simple integration in a model they called the "Augmented TAM" (p. 561). As part of a larger study that compared several models to determine whether the determinants of IT usage are the same for experienced and inexperienced users, Taylor and Todd (1995c) surveyed 430 experienced and 356 inexperienced potential student users of a computer resource center (CRC) at a business school. The survey was developed and validated through card-sorting procedures and a pilot test, based on Davis et al. (1989). After the survey, usage measures were collected for a 12-week period. The model was tested separately for experienced and inexperienced users, using LISREL8 with maximum likelihood estimation (Joreskog & Sorbom, 1993).

Although the results showed that the relative influence of some specific determinants depended on experience, the overall model accounted for a reasonable proportion of the variance in intention and behavior for both experienced and inexperienced groups. For experienced users, the fit statistics indicated that the model provided an adequate fit (X_{200}^2 = 1003.66; $p < 0.001$; RNI = 0.86; RMSEA = 0.097), and the model accounted for 21 percent of the variance in behavior and 43 percent of the variance in behavioral intention. The fit statistics from the inexperienced users were comparable (X_{200}^2 = 826.75; $p < 0.001$; RNI = 0.88; RMSEA = 0.094). For this group, the model accounted for 17 percent of the variance in behavior and 60 percent of the variance in intention. Moreover, for both groups, the path coefficients for all direct determinants of intention, with the exception of attitude, were significant. In short, a simple integration of TAM and TPB fit the data better than did either model alone. Taylor and Todd (1995c) concluded, "the augmented version of TAM can be used to predict subsequent usage behavior prior to users having any hands-on experience with a system" (p. 565).

An Integration Based on Belief-Decomposition

The integrated model shown in Figure 6 raises an important conceptual issue about the original rationale for the belief constructs in these models. Recall that, based on the expectancy-value conception in TRA, behavioral beliefs (bb_i) and evaluations (ev_i) were multiplied and summed, as shown in Equation 2.

$$\mathbf{A_B} = \sum_{i = 1, n} (\mathbf{bb_i})(\mathbf{ev_i}) \quad \textit{(Equation 2)}$$

As a derivative of TRA, TAM simply *decomposed* TRA's context-specific behavioral belief component (bb_i), and posited two distinct, generalized belief constructs – perceived usefulness and perceived ease of use – that were highly relevant for user acceptance testing of information technologies (Davis, 1986; 1989). The evaluation term (ev_i) was simply "displaced," with the relative contributions of these new generalized beliefs to be estimated by multiple regression.

Taking a similar approach, in a series of model comparison studies, Taylor and Todd (1995a; 1995b) added another model, the "decomposed theory of planned behavior" (DTPB), by attempting to decompose the belief constructs related to subjective norm and perceived behavioral control. Like the usefulness and ease of use constructs identified by Davis (1986), the objective was to decompose these belief-based constructs and posit specific beliefs that were more generally applicable across a range of contexts. As such, this model looks something like the one shown in Figure 7.

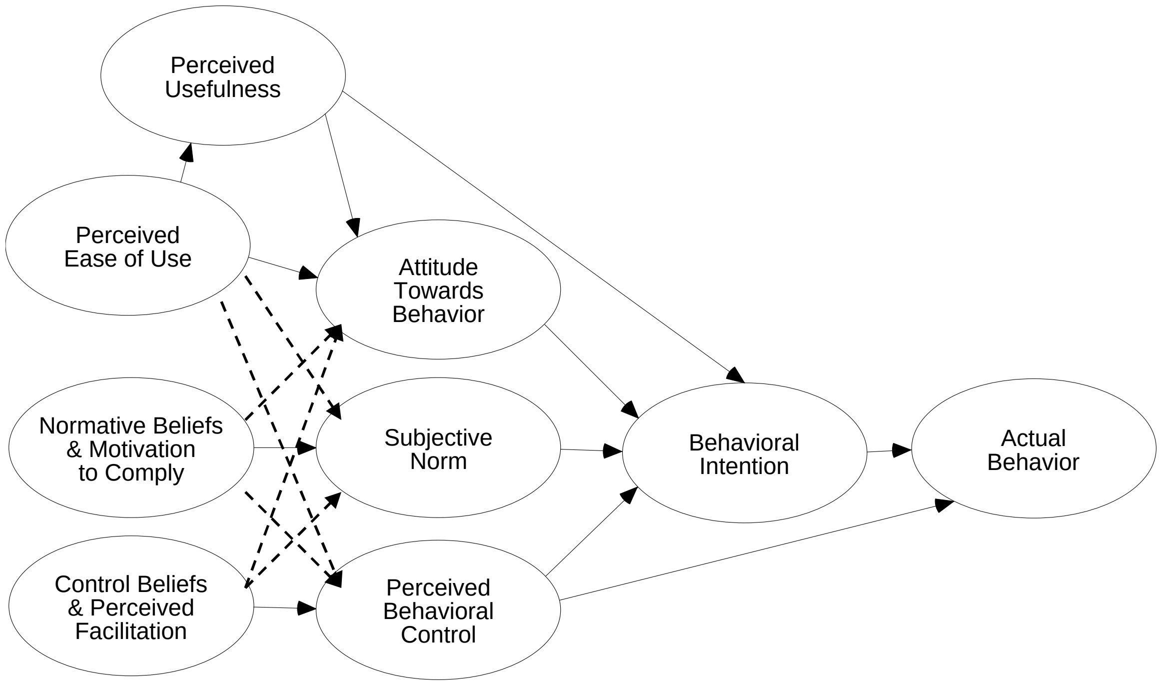

Figure 7. An Integration of a "Decomposed" TPB and TAM (cf. Taylor & Todd, 1995a)

Taylor and Todd (1995a) point out that decomposing these constructs creates the possibility for "cross-over effects." In this context, cross-over effects refer to those influences that these newly decomposed belief constructs may have on the other, related constructs in the model. Thus, for instance, the belief determinants of attitude (e.g., perceived ease of use) may "cross-over" to have an influence on subjective norm and perceived behavioral control, as illustrated by the dashed arrows in Figure 7. The belief constructs derived from subjective norm and perceived behavioral control may also have an influence on one another and on attitude.

They investigated this line of thinking by studying user reactions to and use of a computer resource center. Items measuring TPB constructs were adapted from Ajzen and Fishbein (1980), and Ajzen (1985). Items measuring TAM constructs were adapted from Davis (1989). Additional items used for DTPB were adapted from Moore and Benbasat (1991), and Compeau and Higgins (1991). They recruited 786 students (582 undergraduate and 204 MBA students) to participate in a within-subjects model comparison. Measures of user reactions were made one month into the semester and behavior was monitored and measured over a 12-week period.

The results indicated that the models were fairly comparable, with DTPB explaining intentions better than the other two in terms of proportion of variance accounted for. Whereas TPB and TAM explained 51% and 52% of the variance in intentions, respectively, DTPB explained 60% of the variance in intentions. DTPB also performed slightly better in terms of “Adjusted Goodness-of-Fit Index” (AGFI). The AGFI varies from 0 to 1, with AGFI > 1.0 associated with models with almost perfect fit, and AGFI < 0 associated with models with extremely poor fit, and is typically used in model comparison studies (Byrne, 2001). Whereas TPB and TAM yielded AGFI of .84 and .82, respectively, DTPB yielded an AGFI of .85. It is important to note that, according to Byrne (2001), AGFI should be at least .90. As such, these results suggest that none of the three models fit the data very well.

Moreover, positing a complex set of cross-over effects such as those in Figure 7 raises a couple of important theoretical issues. Recall from the discussion of TRA and TPB that attitude, subjective norm, and perceived behavioral control were conceptually related. That is, Fishbein and Ajzen (1975) acknowledged that subjects might have an expectancy about the social outcomes of a given behavior, and / or their own or personal efficacy (control) in accomplishing the behavior. Specifically, subjects may consider beliefs, such as complying with important social referents or the availability of skills, resources and opportunities, as salient consequences of behavior. As such, these beliefs are conceptually related to the beliefs in the attitude construct. Fishbein and Ajzen (1975) maintained the distinction between these different kinds of beliefs because “it is useful” to do so (p. 304). They accounted for the common variance resulting from this relation by positing and estimating covariances among the three key constructs, as shown earlier by the curved, double-headed arrows in Figures 2 and 3.

The approach illustrated in Figure 7, by contrast, simply decomposes the key TPB elements into their respective belief structures and replaces the covariances with a number of causal relationships, including cross-over effects. As such, this model does not adequately account for the fact that the belief constructs are still conceptually related to one another. To address this problem, the model would have to include covariances among the belief structures themselves. In doing so, however, it is likely that some of these belief structures would co-vary so strongly that it would make more sense to examine the conceptual “overlap” and seek integration at a more fundamental conceptual level.

Intimations of a Latent-Variable Integration

Davis et al. (1989) suspected this very thing after some unanticipated results in their model-comparison study. To further explore their findings, they conducted a post hoc, verimax rotated Principle Components factor analysis of the seven behavioral belief items from TRA along with the four usefulness and four ease of use items from TAM. The results of their exploratory analysis suggested the existence of four dimensions, two of which clearly pertained to "usefulness" and "ease of use" (as in TAM). Specifically, three elicited, context-specific TRA beliefs loaded on a common factor tapping *specific* aspects of "expected performance gains," which at Time 2 converged with TAM's four usefulness items to tap *general* aspects of "expected performance gains" (p. 994).

Using the same data, they re-estimated the path coefficients using a 7-item "usefulness index" comprised of the TAM usefulness items and TRA behavioral belief items and found that it accounted for 57% of the variance in behavioral intentions at Time 2. Moreover, not only did ease of use items load on a different factor than the usefulness and behavioral belief items, but in the re-estimation, ease of use had no significant direct effect on behavioral intentions at either Time 1 or Time 2. Therefore, they concluded, "combining the beliefs of TRA and TAM into a single analysis may yield a better perspective on the determinants of [behavioral intention] than that provided by either model by itself" (p. 994).

Research Framework and Hypothesis

Returning to the practical question with which I began, when it comes to the application of these three theories, how can managers, consultants and practitioners decide between them? The answer to this question that I offer in this research is *all three* theories may be integrated in order to understand the factors that influence the use of project management practices. To summarize the research so far, Davis' (1989) study showed that the original TAM could be "revised" by partly integrating it back with the attitude and intention constructs from TRA, as shown in Figure 5. Similarly, by "decomposing" belief constructs in the same way Davis (1986) did, Taylor and Todd (1995b; 1995c) attempted to integrate the constructs of TRA, TPB and TAM in at least two ways illustrated in Figures 6 and 7. Overall, these attempts at integration have met with mixed success.

Moreover, although the results from Davis' et al. (1989) post hoc exploratory factor analysis should be regarded cautiously, they show that some of the items used to measure the usefulness construct from TAM may be measuring an underlying dimension that may be the same as that being measured by the behavioral belief items from TRA. This should not be surprising. Recall that the original theorizing for TRA and TPB is based on an expectancy-value conception of attitude, subjective norm, and perceived behavioral control. According to this view, the belief terms are the *cognitive* components (i.e., behavioral beliefs, normative beliefs, and control beliefs), and the evaluative terms are the *affective* components (i.e., evaluations, motivation to comply, and perceived facilitation) that are combined multiplicatively as belief-based measures of attitude, subjective norm, and perceived behavioral control, respectively.

For instance, in its original form, the "belief-evaluation term," $\sum(bb_i)(ev_i)$, was part of the operational definition of an expectancy-value conception of *attitude*. Indeed, it had no intuitive interpretation of its own, and was not necessarily meant to stand alone as a distinct construct that is a "determinant" or "causal antecedent" of attitude. The same is true for the other belief-based terms in TRA and TPB – $\sum(nb_i)(mc_i)$ and

$\sum(cb_i)(pf_i)$. They have no independent interpretation, and are meant to be expectancy-value-based measures of subjective norm and perceived behavioral control, respectively. Therefore, not only are the three key constructs measured by *general* items, but each is also measured by a related "*belief-based*" measure. This line of reasoning suggests another possible approach to integrating the three models that returns to the original theorizing upon which they were based. In short, rather than these belief-based measures "causing" the latent constructs (attitude, subjective norm, and perceived behavioral control), as shown in Figure 7, they are "measures of" them as shown in Figure 8.

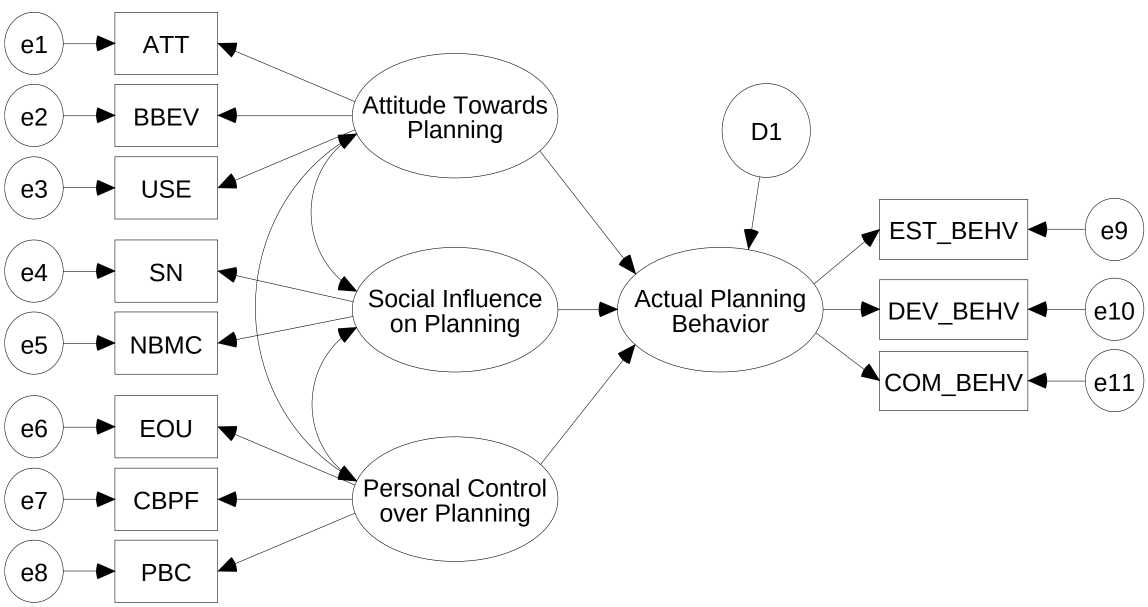

Figure 8. A Hypothesized Latent Variable Integrated Framework

Figure 8 shows an approach to combining the beliefs of TRA, TPB, and TAM into one parsimonious framework by conceiving of attitude, social influence, and control as abstract psychological concepts that are not directly measurable – i.e., latent variables. The global and belief-based measures from TRA and TPB, and the measures of usefulness and ease of use from TAM, on the other hand, are observable, and should serve as the manifest variables that are "indicators" of the latent constructs. As such, the primary objective of the current study is to assess the viability of a latent variable integration of the TRA, TPB and TAM, as shown in Figure 8.

Structural equation modeling is particularly useful for assessing the relationships among latent and manifest variables (Byrne, 2001; Anderson & Gerbing, 1988). Moreover, in structural equation modeling, the relationships among the latent constructs – such as the degree to which attitudes, social influences, and personal control influence project planning behavior – constitute the "structural model." Each latent construct is measured with several observable indicators, such as the responses to specific ease of use and usefulness items from TAM, and global as well as belief-based items from TRA and TPB. The latent constructs are linked to their measures through a factor-analytic "measurement model." That is, each latent construct is modeled as a common factor underlying the associated manifest measures. In short, the structural equation model shown in Figure 8 is comprised of two parts – a *measurement* model and a *structural* model.

The distinction between the measurement model and the structural model is important because, based on the discussion to this point, the latent variable integration of the TRA, TPB and TAM focuses our attention on the *measurement* model. Specifically, the general attitude measures (ATT), the belief-based measure of attitude (behavioral belief-evaluation term; BBEV), and usefulness (USE) are expected to be measuring the underlying construct dealing with attitudes toward planning. Likewise, the general subjective norm measures (SN) and the belief-based measure of subjective norm are tapping a latent construct dealing with social influences on planning. Finally, ease of use (EOU), the belief-based measure of perceived behavioral control (CBPF), and the general measure of perceived behavioral control are loading on an underlying factor dealing with personal control over planning. This set of hypotheses is represented in the confirmatory factor analytic *measurement* model shown in Figure 9.

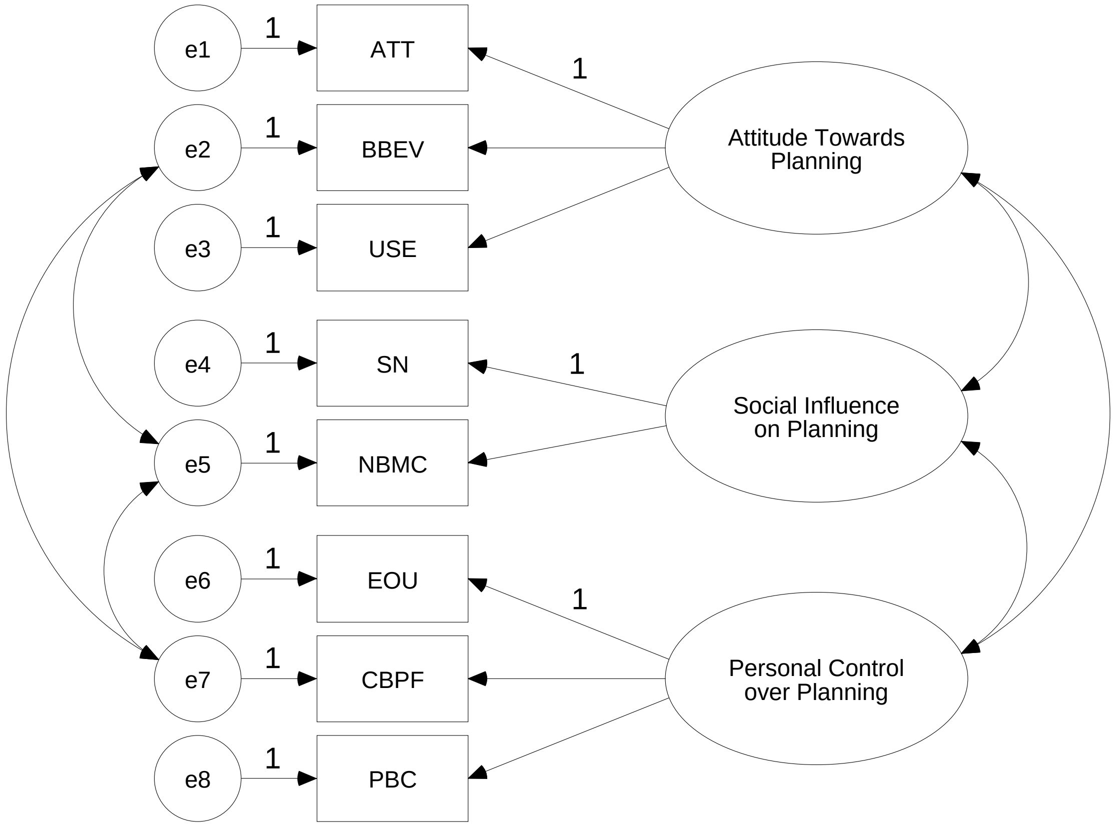

Figure 9. The Hypothesized CFA for a LV Integration of TAM, TRA, and TPB

Associated with each indicator is an error term (e.g., “e1” through “e8” in Figure 9) that represents measurement error – the degree to which observed variables are inadequate measures of the underlying factor. Although some measurement error is random, other measurement error is non-random “error uniqueness,” which is the systematic error variance attributable to a specific indicator variable or set of variables. This is the type of measurement error that might be seen among items that were created using a common method. Such “common method variance” is hypothesized in the current model between the belief-based terms from TRA and TPB. Because all of these terms were created based on the same belief elicitation methods, and all are computed by the multiplicative combination of the belief and the evaluation terms, I expect some amount of common method variance. This hypothesis is shown figuratively in the covariance (double-headed arrow) between the error terms of these three measures (i.e., e2, e5, and e7) in Figure 9.

Finally, Figure 9 also illustrates some other important aspects of structural equation modeling. It also shows the measurement model associated with the measurement of project planning behavior. According to this perspective, project planning behavior is posited as a latent construct measured by three indicators associated with the *estimating* practices, the plan *development* practices, and the plan *commitment* practices that constitute the project planning practices of the CMM/I. These are the behaviors that the attitudinal, social influence, and control constructs are expected to explain. In SEM, the behaviors are known as *endogenous* variables, and the latent constructs with their indicators are known as *exogenous* variables. The relationships between the endogenous and exogenous variables constitute the structural model. In structural equation modeling, the measurement model is typically assessed first to ensure that the measurements are psychometrically sound, followed by an assessment of the structural model as a whole. This two-step methodology (Anderson & Gerbing, 1988) is discussed in the next chapter.

Chapter 6

RESEARCH METHODOLOGY

This investigation of social psychological factors that influence the use of project management best practices employed a survey methodology. This approach involved a number of steps to develop an in-depth, theoretically-grounded questionnaire, and sampling from a nationwide population of project managers. In this section I describe the participants and how they were recruited; the survey instrument and how it was developed, including the elicitation and pilot study; the main procedures by which the participants came to complete the survey; and the measurement model with its related hypotheses. In the next chapter, I report on the data analysis and results.

Participants

The population of interest in the current study is the nationwide population of those who manage projects. The approval to sample from a nationwide population, however, is under review by members of the PMI Research Program Member Advisory Group in the Research Department of the Project Management Institute (PMI). As such, for this phase of this field study, I recruited a convenience sample of project managers from among the members and those affiliated with the Northern Utah Chapter of the PMI. The PMI is the world's leading project management professional association with well over 125,000 members worldwide. The Northern Utah Chapter was chartered by the national organization in 1995 to provide educational, networking, and service opportunities to its professional members.

The Northern Utah Chapter draws its members from 16 U.S. states, including AK, CA, CO, FL, GA, IL, KS, MD, NE, NM, NV, OR, RI, VA, WY, and UT, with about 90% from Utah. Chapter members represent 168 different organizations with offices in Utah, with about 41% coming from Discover Financial Services, Hill Air Force Base, Intermountain Health Care, Ingenix, Iomega, the LDS Church, NuSkin Enterprises, Qwest, and Pacific Corp (PMI NU Chapter 2003-2004 Membership Report).

The membership of the Northern Utah Chapter of the PMI had reached just over 400 members at the time of the survey. Moreover, the Northern Utah Chapter publishes a monthly newsletter to approximately 734 of its members and affiliates via email. With authorization from the Northern Utah Chapter Board of Directors, project manager participants were recruited by ads in the August and September, 2004 newsletters, along with a direct email recruitment message sent in October to the email distribution list. From these recruitment efforts, 186 responses to the final survey were received (response rate of about 24.8%).

Survey Questionnaire Development

The survey instruments for the current study [see Appendix A] were developed according to established guidelines and adapted from several published instruments that have been validated in a number of studies of technology adoption. Specifically, whereas the measures based on the TPB were developed according to the guidelines established by Ajzen (1991; 2002), the measures based on TAM were created by following guidelines set by Davis (1989; see also Taylor & Todd, 1995; and Harrison, Mykytyn et al., 1997). The measures of project planning behavior and intention were developed by following the guidelines in the Software Engineering Institute's "Standard CMMI Appraisal Method for Process Improvement" (SCAMPI^{SM}; see CMU/SEI-2001-TR034).

Measuring TPB Constructs: Elicitation and Pilot Studies

Ajzen's (1991; 2002) guidelines for developing survey instruments based on TPB can be summarized in the following six steps: (1) Define the behavior of interest in terms of action, target, context, and time elements, and create consistent measures of the behavior and behavioral intention; (2) From a representative pilot sample of at least 20 persons, elicit perceived consequences of the behavior, social referents associated with the behavior, and perceived obstacles to the behavior; (3) Select the most often cited (i.e., most salient) consequences, referents, and obstacles from the elicited lists; (4) Create measures of behavioral beliefs and evaluations, normative beliefs and motivations to comply, and control beliefs and perceived facilitation based on the salient beliefs; (5) Create measures of attitude, subjective norm, and perceived behavioral control that are consistent with the behavioral criterion in regard to action, target, context, and time elements; (6) Integrate all measures into a single questionnaire and administer it to a pilot sample.

Accordingly, I sent an email to 25 persons randomly selected from the PMI respondents who agreed to participate. The email asked pilot participants to "take two minutes" to answer a few preliminary, open-ended questions: "Please list the advantages and disadvantages of project planning that come to mind" (salient consequences); "Please list the individuals or groups you know who would approve or disapprove of your engaging in project planning" (salient referents); and "Please list any obstacles that may get in the way of your project planning and/or resources that facilitate your project planning" (salient resources).

I then had two independent raters content-analyze and categorize the responses (23 out of the 25) to these open-ended questions to identify the most frequently occurring (i.e., salient) beliefs. More specifically, recall that Fishbein and Ajzen (1975) advise researchers to use about the first 5 or so beliefs elicited. They also add, "It is possible, however, that only the first two or three beliefs are salient for a given individual and that individual beliefs elicited beyond this point are not primary determinants of his attitude" (p. 218). As such, raters were instructed to identify the top 4 salient beliefs, referents, and obstacles / resources. An initial test showed that raters agreed on about 96% of the ratings. Raters then met to discuss rating differences and reach consensus on the final categories. Table 4 shows the final results of the content-analysis procedures. Numbers in brackets [ ] identify the number of pilot participants expressing each belief.

Table 4. Results of Content Analysis of Open-ended Belief-Elicitation Questions

Consequences (bb & ev)	Referents (nb & mc)	Obstacles/Resources (cb & pf)
Improve communication with customers/clients [10].	My immediate supervisor [9].	Cooperation and approval of resources/technical people [12].
Improve relationships with/satisfaction of customers/clients [6].	Other project managers/peers [9].	Cooperation and approval of management/my supervisor [10].
Allow me to keep pace with the competition/make me more competitive [3].	Upper/top management [8].	Appropriate planning tool knowledge and skill (e.g., MS Project) [5].
Reduce overall costs of projects/doing business [3].	Members of the PMO/Project Management Center of Excellence [4].	Training it would take to get "up to speed" [4].

Using the elicited beliefs, I created belief-based measures of attitude, subjective norm, and perceived behavioral control. Specifically, I developed behavioral belief (bb), evaluation (ev), normative belief (nb), motivation to comply (mc), control belief (cb), and perceived facilitation (pf) items to reflect the specific content of the salient cognitions identified in the elicitation study.

For instance, the normative belief (nb) for "key stakeholders" is measured using a semantic differential scale asking participants to indicate the degree to which they would "approve – disapprove" of "planning your projects over the next six months." Additionally, I used each of the salient referents to create measures of "motivation to comply." Specifically, participants indicate on 7-point scales how "important – unimportant" it is to them to do what each of the salient referents thinks they should do.

Next, I created belief-based measures of perceived behavioral control by using the salient obstacles / resources information to develop control belief and perceived facilitation items. For instance, on these scales participants indicate on 7-point scales their perception about the degree to which (likely – unlikely) having "sufficient time to develop and maintain the project plan" would affect their ability to plan their projects over the next six months. Similarly, participants would indicate on 7-point scales how "important – unimportant" having sufficient time to develop and maintain the project plan is regarding their ability to plan their projects over the next six months. As with all the belief-based and general measures, they are scored on a 1 to 7 scale, with higher numbers indicating more likely or more important, depending on the adjective anchors used.

Applications of the TPB also include *general measures* of attitude, subjective norm, and perceived behavioral control. Therefore, continuing to follow the guidelines provided by Ajzen (1991; 2002), I developed general measures of attitude (ATT), subjective norm (SN), and perceived behavioral control (PBC). Ajzen (1991) reports that correlations between the general and the belief-based measures of these constructs have ranged from 0.41 to 0.72 in a number of different studies. These items are typically created using several bipolar adjectives. For the current study, the wording for the global measures was adapted from Ajzen and Fishbein (1980). For instance, participants indicate on 7-point scales how "harmful – helpful" it would be "for me to plan my projects over the next six months." Similarly, to measure subjective norm, participants indicate on 7-point scales their agreement with such statements as "Overall, people who are important to me would approve of my planning my projects over the next six months." And finally, general measures of perceived behavioral control were created by items asking participants to indicate on 7-point semantic differential scales how "under my control – out of my control" it would be to plan their projects over the next six months.

TAM Measurement Scales

Questions used for measuring the *TAM constructs* – perceived ease of use and perceived usefulness – were based directly on the items developed in previous research (Davis, 1986; 1989; Davis et al., 1989). Although TAM studies have employed items measuring usefulness and ease of use that refer specifically to the use of particular software packages or information systems, the premise behind the original development and validity studies of these more generalizable measures was to enable the assessment of usefulness and ease of use by simply modifying the items to reflect the particular information system of interest. This has been the approach in a number of key studies (e.g., Davis, 1986; 1989; Davis et al., 1989; Mathieson, 1991; Taylor & Todd, 1995), although there is little consensus on which items are the best measures of usefulness and ease of use.

Specifically, Davis (1986) began with 14 items to measure each of the TAM constructs. Through the process of validation studies, the 14 original items were abridged to 6-items for each construct (Davis, 1989), although some additional items were included in this analysis. Subsequently, the scales were refined down to 4 items each (Davis et al., 1989), again, with some changes to the items that make up the usefulness and ease of use scales. Accordingly, creating usefulness and ease of use items for the current study should be straightforward – simply by modifying the items from Davis et al. (1989). Unlike previous research, however, the current study is the first of its kind to assess the usefulness and ease of use of "best practices" – a "technology" in a broader sense of the term than is connoted by studies of particular software and information systems. Merely re-wording the 4 items used in Davis et al. would result in awkwardly-worded items that lacked face validity.

As such, for the current study, I identified those items that were shown to be valid measures of the TAM constructs in at least *two or more* of the previous studies (i.e., Davis (1986; Davis, 1989; and Davis et al., 1989), and eliminated those items that made little sense when applied to project planning behaviors (e.g., "I would find it easy to get [planning my projects] to do what I want it to do;" and items that referred to "user's manuals"), to come up with four items for each construct.

After the items were developed as described, the entire questionnaire was piloted with 7 PMI-affiliated project managers, who identified some typographical errors and suggested several wording changes such as clarifying some questions and eliminating project management technical jargon and acronyms. Appendix B lists the measurement items for the exogenous variable in the current study.

Measuring Behavior and Intention

The endogenous variables in the hypothesized framework are project management-related constructs that have been operationally-defined in the CMM models. Specifically, the "key practices" (i.e., "specific practices" in CMMI) from the Project

Planning key process area were turned into 14 questionnaire items similar to those used in the original Maturity Questionnaire version 1.1 (Zubrow, Hayes, Siegel, & Goldenson, 1994). These 14 items represent three key dimensions of project planning practices that correspond to the three goals of the project planning process area: 4 *estimating* practices, 6 *plan development* practices, and 4 *plan commitment* practices (cf. CMMI-SE/SW/IPPD, v1.1, Continuous Representation, p. 192 – 200). From each of these specific practices I created 4 questionnaire items representing the estimating practices (e.g., "Was a top-level work breakdown structure (WBS) established to estimate the scope of the project?"), 6 items representing the plan development practices (e.g., "Were project risks identified and analyzed?"), and 4 items representing the plan commitment practices (e.g., "Were commitments obtained from relevant stakeholders who were responsible for performing and supporting plan execution?").

As with the original Maturity Questionnaire, preceding each group of questions, participants were provided with a short paragraph describing the key process area, and were instructed to answer the questions based on their individual knowledge and experience on projects in which they had participated within the past 6 months, regardless of whether or not the projects were completed or cancelled, and including their current projects. In this way, project planning behaviors were defined as clearly as possible as regards action, target, context, and time elements.

To the right of each item the survey provided boxes for the four possible responses: "Yes," "No," "Does Not Apply," and "Don't Know." Just as with the Maturity Questionnaire, participants were instructed to check "Yes" when "The practice is well established and consistently performed," meaning the practice should be performed "nearly always" and "as a standard operating procedure." Participants were instructed to check "No" when "The practice is not well established or is inconsistently performed," meaning that the practice may be performed "sometimes, or even frequently, but it is omitted under difficult circumstances" (Zubrow, et al., 1994, p. 4). Finally, participants were instructed to check "Does Not Apply" or "Don't Know" as appropriate. To ensure consistency of action, target, context, and time elements, measures of planning (behavioral) intentions were created in precisely the same way, with the only difference being that participants were instructed to answer the 14 intention questions about their "intentions to do project planning on *future* projects within the *next* 6 months." Appendix A contains the final version of these items.

Consistent with scoring of the Maturity Questionnaire, and based on the guidelines in the Standard CMMI Appraisal Method for Process Improvement (SCAMPI[SM]), the project planning practices were identified and scored as 5 = "best practice;" 4 = "good practice;" 3 = "conventional practice;" 2 = "marginal practice;" and 1 = "no practice/don't know" as shown in Table 5. For each measure (i.e., estimating, development, and commitment), the corresponding items were scored and summed. This use of a questionnaire instrument for appraisal conforms to the guidelines for Class C appraisal methods in the SEI's Appraisal Requirements for CMMI (ARC) version 1.1 (see CMU/SEI-2001-TR034).

Table 5. Project Planning Behavior Categories and Scoring

Measure	Items	Item Description	Score
Plan Estimating	est_b01	Was a top-level work breakdown structure (WBS) established to estimate the scope of the project?	5 BP
	est_b02	Were estimates of the attributes of the work products and tasks established and maintained?	4 GP
	est_b03	Were the project life-cycle phases defined, upon which to scope the planning effort?	3 CP
	est_b04	Were the project effort and cost for the work products and tasks estimated based on estimation rationale?	2 MP
Plan Development	dev_b01	Was the project's budget and schedule established and maintained?	2 MP
	dev_b02	Were project risks identified and analyzed?	3 CP
	dev_b03	Was the management of project data planned?	3 CP
	dev_b04	Were resources to perform the project planned?	4 GP
	dev_b05	Were knowledge/skills for the project planned?	5 BP
	dev_b06	Was the overall project plan established and maintained?	4 GP
Plan Commitment	com_b01	Was the involvement of stakeholders planned?	5 BP
	com_b02	Were all plans that affect the project reviewed to understand project commitments?	3 CP
	com_b03	Was the project plan reconciled to reflect available and estimated resources?	2 MP
	com_b04	Were commitments obtained from relevant stakeholders who were responsible for performing and supporting plan execution?	4 GP

Main Procedures and Survey Administration

The identification and selection of the sample was discussed earlier. Recall that I recruited a sample of project managers from the Northern Utah Chapter of the PMI by ads in the August and September monthly newsletters of the Chapter, followed by a direct email recruitment message sent to approximately 734 Chapter members and affiliates. From these recruitment efforts, 182 responses to the final survey were received, resulting in a response rate of about 24.8%. The cover letter/recruitment message is shown in Appendix A. Most participants were senior professionals, with 64.5% reporting being 35 years or older and 56.5% being over the age of 45, and a majority (61.3%) being currently employed fulltime as a “project leader.” 68.3% of respondents were male. All respondents reported that they reside in Utah.

Participants were sent a recruitment message via email after providing their email addresses in response to newsletter ads in the PMI Northern Utah Chapter monthly newsletters for August and September, 2004. Additionally, as an incentive, following their participation, participants were asked to provide their email address to be entered into a drawing for a chance to win one of a set of recently published books on popular software engineering and project management topics. Participants were also given the opportunity to provide their email addresses if they desired a summary research report on the results of the survey (see Appendix A). To ensure confidentiality, the email addresses were kept separate from the data submitted.

The instrument was posted on an Internet site of a marketing research organization. The final instrument was administered as a Web form that was posted from

September 20th to November 12th, 2004. The web site guided participants through the survey, automatically recording the responses for each participant in a data file on the web server. Following the survey period, a total of 186 respondents completed the survey. No respondents were eliminated due to missing data because respondents were automatically prompted by the Web form to complete omitted items.

A cover letter / recruitment message was presented first in the email message, instructing the participants to click on a link that took them to the online instrument. In the cover letter, participants were assured that their responses would be confidential, and that the survey would not capture any specifically identifiable information from participants. The link took participants to an instructions page explaining how to use the scale instruments in general, and the behavior and intention assessment items in particular (see Appendix A).

Next, participants were presented with the project planning good practice questions and intention items. The items measuring technology acceptance constructs were presented next, with perceived usefulness preceding perceived ease of use. As with previous research comparing the theory of planned behavior with the technology acceptance model (Davis, Bagozzi, & Warshaw, 1989; Taylor & Todd, 1995; Mathieson, 1991), participants next completed the questions related to the theory of planned behavior components, with the global attitude items first, followed by the global perceived behavioral control and subjective norm questions. Following these were the behavioral belief and evaluation items, the control belief and perceived facilitation items, and finally, the normative beliefs and motivation to comply items. The survey concluded with a few brief demographic questions (i.e., gender, age, current position, and state in which they reside), followed by the incentive page whereby participants could enter their email address for the drawing and / or the results. The data files were downloaded from the web server by the system administrator, who provided the separate data files and email lists to me for data analysis.

Chapter 7

DATA ANALYSES AND RESULTS

The ultimate objective for the current study was to test the validity of a hypothesized latent variable integrated model of TRA, TPB, and TAM to facilitate a better understanding of project planning (shown in Figure 8). As discussed in the previous chapters, this integration occurs at the level of the measurement model. Moreover, as with any structural model, it is important to ensure that the measurement of each latent variable is psychometrically sound (Anderson & Gerbing, 1988; Byrne, 2001). Therefore, an important primary objective is to evaluate the measurement model, which is comprised of selected measurement indicators for eight exogenous variables: general and belief-based measures of each of attitude (ATT; BBEV), subjective norm (SN; NBMC), and perceived behavioral control (PBC; CBPF), measures of usefulness (USE) and ease of use (EOU); and three endogenous variables, as shown in Table 6.

Table 6. Summary of Exogenous and Endogenous Measures

Measure	# of Items	Mean	Std. Dev.
Attitude (ATT)	4	6.14	.894
Subjective Norm (SN)	3	6.34	.771
Perceived Behavioral Control (PBC)	3	4.26	1.51
Perceived Usefulness (USE)	4	6.03	.771
Perceived Ease of Use (EOU)	4	5.05	.920

Table 6. Continued: Summary of Exogenous and Endogenous Measures

Measure	# of Items	Mean	Std. Dev.
Belief-based Attitude (BBEV)	4	3.07	.490
Belief-based Subjective Norm (NBMC)	4	5.74	.820
Belief-based Perceived Behavioral Control (CBPF)	4	4.14	.910
Endogenous Variables:			
Plan Estimating Practices (EST_BEHV)	4	10.40	3.14
Plan Development Practices (DEV_BEHV)	6	17.36	3.58
Plan Commitment Practices (COM_BEHV)	4	10.77	3.22

Reliability and Validity of Measures

Adequate internal consistency suggests that the items selected do in fact assess the same underlying construct. Initial estimates of the internal consistency of the TPB measures of ATT, SN, and PBC suggested generally adequate internal consistency, with α = .93, .74, and .80, respectively. Similarly, internal consistency of the TAM measures of USE and EOU were α = .86 and .75, respectively. In general, the distributions of these variables were slightly negatively skewed, although none of the measures of skew exceeded 2.0 (Byrne, 2001).

I also estimated the reliability of the belief-based measures. Ajzen (1991) insists that no assumption need be made that accessible beliefs themselves are internally consistent. According to the expectancy-value model, it is in their *aggregate* that these measures provide the manifest indicators of the latent constructs. When aggregated in the multiplicative manner required by Ajzen (1991), however, potential problems arise. For instance, these measures are assessed on 7-point scales ranging from 1 (extremely unlikely) to 7 (extremely likely). When each behavioral belief, for example, is multiplied by each evaluation term, and then summed in the typical manner, however, the resulting scales can range from 4 to 49, placing them on an underlying metric that differs substantially from the other measures in the model. As such, the measures of BBEV, NBMC, and CBPF were first combined as per Ajzen (1991), and then subjected to a square-root transformation to return them to an underlying metric that is more consistent with the other measures. The resulting measures showed internal consistency of $\alpha = .79$, .83, and .81, respectively. All analyses are carried out using SPSS software, version 9.0 for Windows, or AMOS, version 4.0, developed by Arbuckle (1999).

To assess theory-specific construct validity – that my created measures were adequately assessing the constructs of the different theories – I performed three separate confirmatory factor analyses, first on the global measures of ATT, SN, and PBC (from TPB); then on the multiplicatively-combined belief based measures (from TPB); and finally on the USE and EOU items (from TAM). In their respective models, each of these constructs is considered to have important direct influences on intentions and / or behavior, and each is considered to be conceptually distinct from the other constructs in the theory. Table 7, Table 8, and Table 9 contain the estimated loadings for these measurement items, respectively (factor loadings < .30 are left blank for clearer presentation).

Table 7. Factor Loadings: TPB General Measures of ATT, SN, & PBC

Measure	Item	Brief Description	F1	F2	F3
Attitude	ATT01	good – bad	.942		
	ATT02	harmful – helpful	.911		
	ATT03	positive – negative	.937		
	ATT04	foolish – wise	.665		
Subjective Norm	SN01	overall, people important to me		.800	
	SN02	stakeholders, customers	.473		
	SN03	professional association		.932	
Perceived Behavior Control	PBC01	easy – difficult			.908
	PBC02	under control – out of control			.650
	PBC03	simple – complicated			.857

Table 8. Factor Loadings: Multiplicative Measures of Σ(bbev), Σ(nbmc), & Σ(cbpf)

Measure	Item	Brief Description	F1	F2	F3
Belief-based ATT [Σ(bbev)]	BBEV1	reduce overall costs of doing business.	.873		
	BBEV2	improve relationships with customers.	.720		
	BBEV3	improve communication with customers.	.795		
	BBEV4	keep pace with the competition.	.753		
Belief-based SN [Σ(nbmc)]	NBMC1	Upper/top management		.771	
	NBMC2	Other project managers		.801	
	NBMC3	Other members of the PMO		.787	
	NBMC4	Your immediate supervisor		.878	
Belief-based PBC [Σ(cbpf)]	CBPF1	Training it would take to get up to speed			.770
	CBPF2	Appropriate tool knowledge/skill			.832
	CBPF3	Cooperation of resources/technical people			.841
	CBPF4	Cooperation and approval of management			.879

Table 9. Factor Loadings: TAM Measures of USE & EOU

Measure	Item	Brief Description	F1	F2
Usefulness	USE01	improve my job performance	.833	
	USE02	accomplish tasks more quickly	.799	
	USE03	accomplish more work	.834	
	USE04	enhance my effectiveness	.865	
Ease of Use	EOU01	require mental effort		.591
	EOU02	easy for me to become skillful		.876
	EOU03	easy for me to remember		.825
	EOU04	overall, easy to use		.791

In general, the factor patterns supported the construct validity of the theory-specific measurements. The fact that SN02 did not load on its primary factor, but instead loaded weakly on a couple of other factors suggests that it is not an adequately clear indicator of the meaningful latent construct it was intended to measure. This item measures participants' agreement-disagreement with the statement, "Generally speaking, my stakeholders, customers, and clients would approve of my planning my projects over the next six months." One possible explanation for this is the ambiguity of this item. Participants may have been confused as to whether or not the question was asking about stakeholders, customers, and/or clients, and approval of one may not have been consistent with approval of others. As such, this item was dropped, bringing the internal consistency of the subjective norm indicator to $\alpha = .80$.

Evaluating the Model As a Whole

Next, I examine "goodness of fit" for the model as a whole. Using the sample of 186 participants, I estimated the hypothesized CFA model using AMOS 4.0 to specify and estimate the overall fit and parameters of the model from Figure 9, which is repeated here for convenient reference.

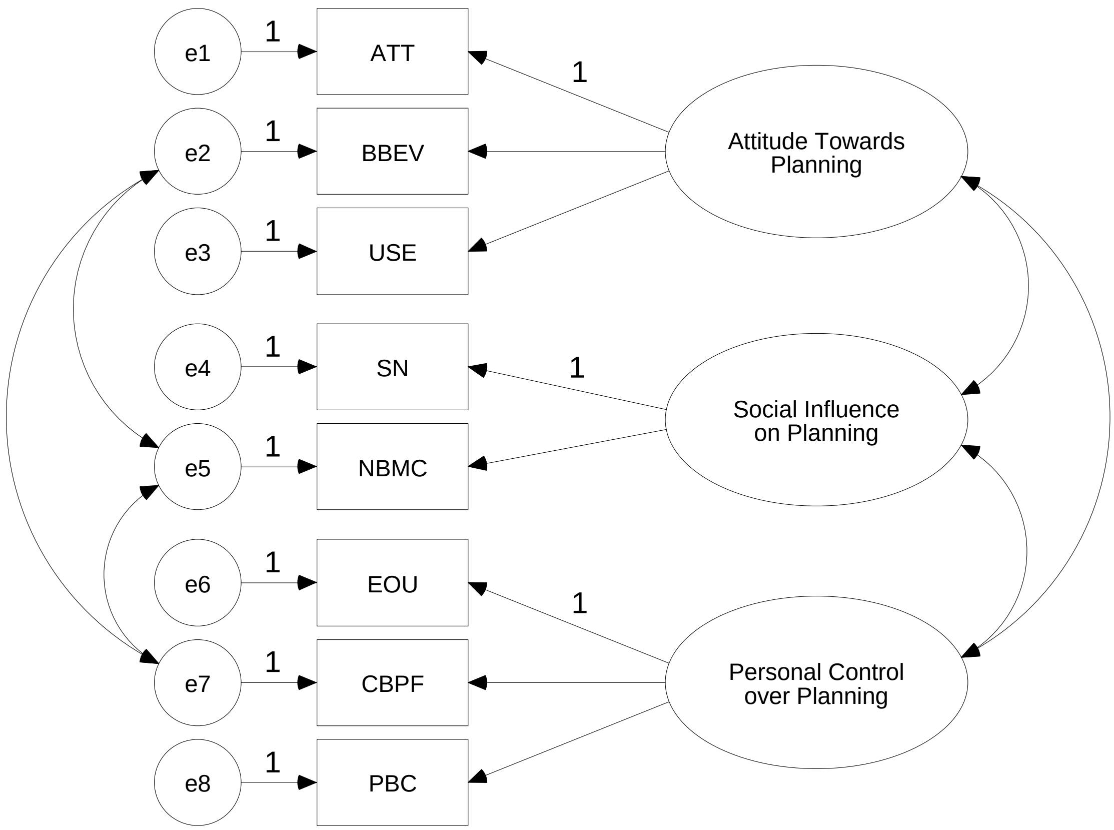

Figure 9. The Hypothesized CFA for a LV Integration of TAM, TRA, and TPB

According to Byrne (2001), the first evidence of poor fit is found when examining the adequacy of parameter estimates – their feasibility, the appropriateness of standard errors, and their statistical significance. In this regard, the hypothesized model evidenced poor fit as manifest by nonsignificant regression weights between the Attitude latent construct and BBEV, as well as the Personal Control latent construct and CBPF and EOU. For the current data, these three are not significant indicators of the expected latent constructs.

There are at least two possible explanations for these results. The first is that, because too few measures were used for each indicator, the ability of these measures to assess the underlying construct may have been attenuated. Given a sufficient variety of measurement items, as used in instrument validation research, rather than a selection of relatively homogenous items, scale reliabilities and factor loadings would likely be stronger. Regarding the nonsignificant contributions of BBEV and EOU, this result may also be consistent with the exploratory analysis of Davis et al. (1989). Recall that their factor analysis suggested two factors pertained to “usefulness” and “ease of use,” with three TRA items and four TAM usefulness items loading on a common factor. Moreover, ease of use had no significant direct effect on behavioral intentions at either Time 1 or Time 2. In this regard, it is also possible that issues of personal control (and ease of use) are not very meaningful factors when it comes to project planning. Recall that TPB was intended to be used in cases when behavior is not entirely under a person’s volitional control. These results suggest that project planning behavior may be perceived as very much under the volitional control of project managers, and perceived behavioral control is not a significant factor in project planning.

Removing the non-significant paths would retain only significant and appropriate parameter estimates, but still also retain key constructs from all three of the theories.

Moreover, it would acknowledge that personal control issues might be only weakly involved in explaining project planning practices. Therefore, for theoretical as well as empirical reasons, these constructs were removed from the hypothesized measurement model, yielding the measurement model shown in Figure 10.

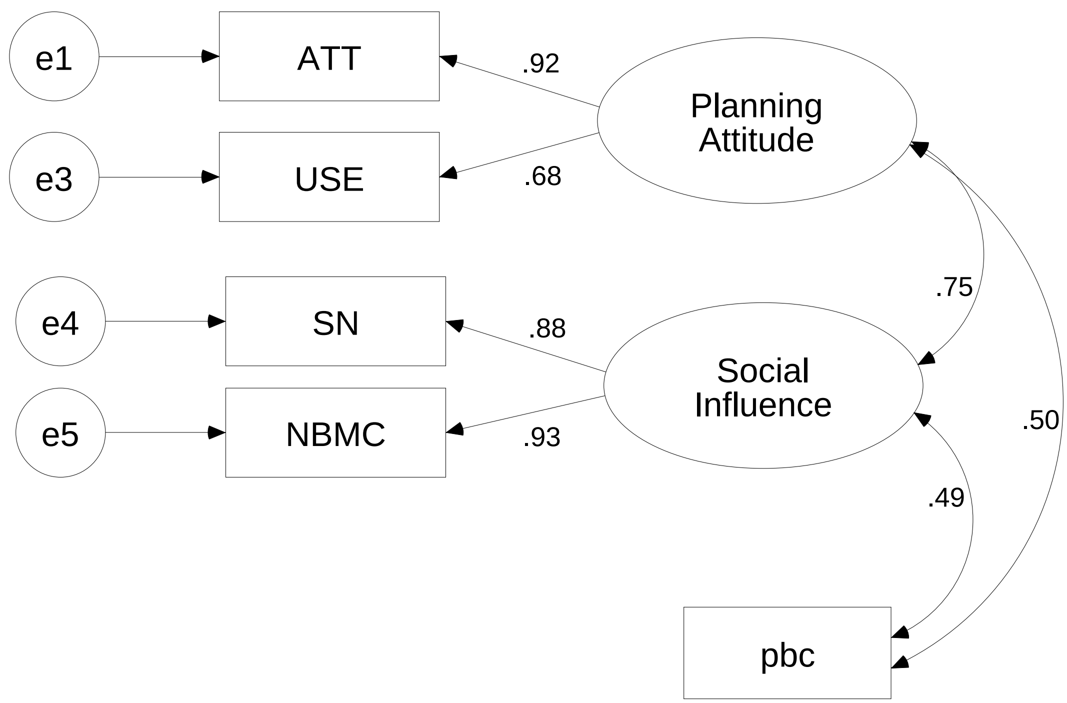

Figure 10. Adjusted Measurement Model of TRA, TPB, and TAM Constructs

With the non-significant paths removed, the evaluation of the fit of this measurement model was accomplished by examining a few important fit indexes (Byrne, 2001). A fit index that provides a quick overview of model fit is the discrepancy statistic (CMIN), which is distributed as X^2, and represents the discrepancy between the sample covariance matrix and the covariance matrix implied by the hypothesized model. More important is the "relative chi-square" [also called the "X^2/df ratio"], which is the ratio of the CMIN and the degrees of freedom. Different researchers have recommended using ratios around 2.00, or as high as 5.00 to indicate a reasonable fit (e.g., Marsh & Hocevar, 1985; cf. Byrne, 1989).

Additionally, similar to the "comparative fit index" (CFI), the "goodness of fit index" (GFI) is a measure of the relative amount of variance and covariance in the sample matrix that is jointly explained by the hypothesized model matrix. It ranges from zero to 1.00, with values close to 1.00 indicating good fit. Next, the "root mean square error of approximation" (RMSEA) takes into account the error of approximation in the population, and provides an index of how well the hypothesized model (with optimally chosen parameter values) would fit the population covariance matrix if it were available. An RMSEA value of about 0.05 or less would indicate a close fit of the model in relation to the degrees of freedom, (exact fit would produce an RMSEA = 0.0). A value of about 0.08 or less indicates a reasonable error of approximation (Byrne, 2001; Browne & Cudeck, 1993). Finally, "modification indices" (MI) are used to detect specific areas of misfit in the hypothesized model, perhaps suggesting where residuals may reflect a patterned relationship. In contrast to the "omnibus" model fit statistics discussed so far, the modification indices can be conceptualized as a X^2 statistic with one degree of freedom. Few meaningful modification indices, therefore, suggest a model that is not plagued by specific misfitting parameters.

As such, overall goodness of fit for the measurement model shown in Figure 10 is very good, with $X^2_{(3)} = 6.43$, a CMIN/df ratio of 2.145, ($p = .092$). The comparative fit index (CFI) = .992, GFI = .986, and RMSEA = .079, which is well within the 90% confidence interval between .000 and .164 (*PCLOSE* = .221). Finally, no theoretically meaningful modification indices were computed for this model, suggesting no meaningfully-patterned residuals. As such, the measurement model shown in Figure 10 not only provides a very good fit to the data, and retains only significant and appropriate parameter estimates, but also retains key constructs from all three of the theories, recognizing that personal control issues may be only weakly involved in explaining project planning practices. This measurement model will serve best to investigate the hypothesized full structural model that includes the measures of project planning behavior, as shown in Figure 11.

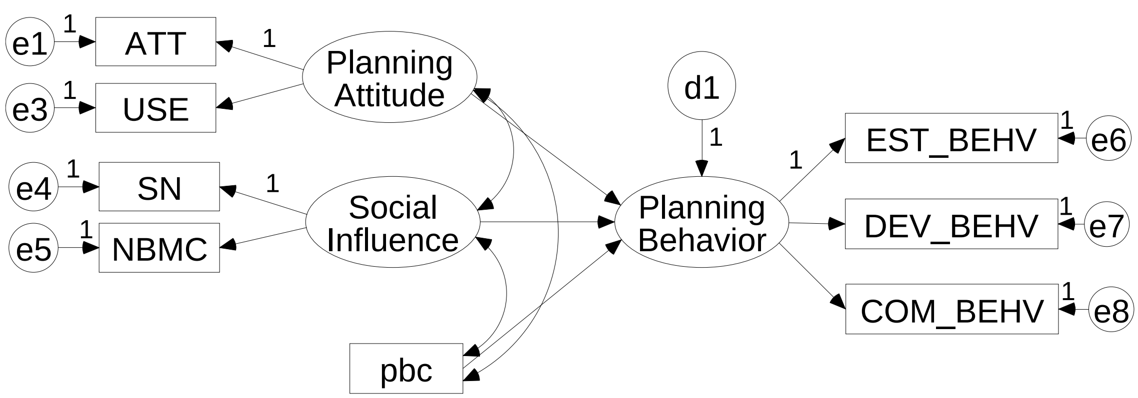

Figure 11. A Hypothesized Latent Variable Full Structural Model

As with the measurement models, the high-level index of overall model fit revealed that this full structural model provided only fair-to-poor overall fit, with $X^2_{(15)}$ = 66.984, a CMIN/df ratio of 4.466, (p < .000), CFI = .924, GFI = .921, and RMSEA =

.137 (*PCLOSE* < .000). A further examination of the covariance as well as the residual covariance matrices, however, suggested some theoretically interesting relationships, as shown in the correlation matrix in Appendix C. The existence of these relationships were also suggested by modification indices computed by the Amos software. Joreskog and Sorbom (1984) describe modification indices as estimates of the amount by which the discrepancy function would decrease if the analysis were repeated with the constraints on a specific parameter removed or with an added path that does not currently appear in a model. In this regard, several of the largest modification indices (and estimated parameter changes) reported by Amos were between the three exogenous variables (Attitude, Social Influence, and perceived behavioral control) and one, but not necessarily all, of the planning indicators (i.e., estimating behavior, plan development behavior, and/or plan commitment behavior).

These patterns are not surprising. According to the CMM/I, these three types of planning activities represent groups of related practices that bring about the three "quality goals" of the project planning key process area. As shown in Table 5, estimating practices include creating a work breakdown structure (WBS) to estimate the scope of the project, estimating the attributes of work products and tasks, defining life-cycle phases, and estimating effort and cost. Plan development practices include such activities as establishing a budget and schedule, identifying risks, resource planning, planning knowledge and skills and related activities. Plan commitment practices involve obtaining involvement of stakeholders planned, understanding project commitments, reconciling available and estimated resources, and obtaining stakeholder commitments for performing and supporting plan execution. As such, this result confirms the conceptual distinction between these three types of planning activities, whereas the correlations between them support the expectation that they are all an important part of the planning key process area.

Overall, the model would fit the data better by removing the latent "planning behavior" construct and allowing the three indicators to serve as three separate, albeit correlated, endogenous variables. Moreover, because the correlations and patterns of residuals suggest that the three types of planning activities – estimating practices, development practices, and commitment practices – are predicted differentially by different exogenous constructs, the removal of the latent variable allows the estimation of more interesting "specialized effects." In short, for the sake of theoretical interest, and because model fit could be improved significantly by separately predicting each of the three types of planning activities, the model was modified and re-estimated, removing nonsignificant parameters to arrive at the "trimmed" model shown in Figure 12.

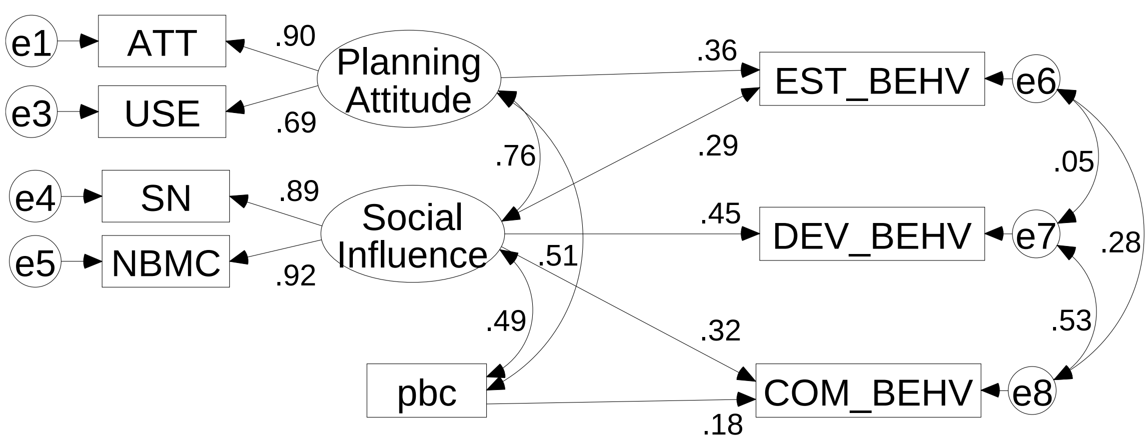

Figure 12. A "Trimmed" Model of Project Planning

The “trimmed” model of project planning provides very good fit: $X^2_{(13)}$ = 18.13, a CMIN/df ratio of 1.395 (p = 0.153); CFI = .992, GFI = .978, and RMSEA = .046, which is well within the 90% confidence interval between .000 and .092 (*PCLOSE* = 0.503). Finally, an examination of the residual covariances suggested no additional patterns, supported by the fact that Amos computed no theoretically meaningful modification indices for this model. Although this model does not include a latent project planning construct, it has the benefit of revealing some informative “specialized effects.” Specifically, estimates of this model resulted in a significant path coefficient between Attitude Toward Planning and Estimating Practices, but not plan Development nor Commitment practices. Likewise, a significant path coefficient was estimated between the one-item measure of perceived behavioral control (from TPB) and Commitment practices, but not Estimating nor plan Development practices. By contrast, overall, all three types of project planning practices were predicted the most by Social Influence, the implications of which will be discussed in the next chapter.

Chapter 8

DISCUSSION AND CONCLUSIONS

The purpose of this study was to increase our understanding of the social psychological factors that are important in improving project management practices. The theory of reasoned action (TRA), the theory of planned behavior (TPB), and the technology acceptance model (TAM) suggest that project planning behavior is influenced by three things: the degree to which project managers have a positive attitude toward project planning; the degree to which people who are important to project managers are perceived to be positively disposed toward project planning; and the degree to which project managers perceive that they have control over project planning. Generally speaking, these relations are confirmed in the current study.

Specifically, Attitude did explain a particular type of project planning behavior – project estimating practices. Project managers who have a positive attitude toward project planning are more likely to carry out the important activities of creating a top-level work breakdown structure (WBS) upon which to estimate the scope of the project; estimate the attributes of the work products and tasks; define project life-cycle phases upon which to scope the project; and estimate project effort and cost according to some estimation rationale. The corollary is that, if project managers are failing to engage in these important estimating practices, managers and consultants would be well-advised to engage in persuasive interventions whereby project managers' attitudes toward estimating are improved.

In doing so, managers and consultants would be wise to leverage social influences (e.g., Cialdini, 1993). Social influence, in the current study, provided the strongest influence on all types of planning practices – estimating, plan development, and plan commitments. This should come as no surprise. Project managers, as leaders of dynamic social groups called “project teams” are engaging in activities in environments that are fundamentally social in nature. As such, they not only leverage social influences to build teams and collaborate with key stakeholders, but they are also strongly influenced by these same social processes. As such, the importance of project managers’ involvement with peers in professional associations such as the PMI cannot be overestimated. Through the networking and career-development opportunities afforded them by these professional associations, project managers are more likely to engage in important project planning practices that can dramatically affect the likelihood of successful project outcomes.

The current results are also consistent with previous research as regards the influence of perceived behavioral control on project managers’ engaging in industry-recognized good practices. Specifically, there remains some question as to whether or not the PBC construct adds significant predictive ability beyond that provided by TRA. According to a meta-analysis conducted by Conner and Armitage (1989), the benefits of adding PBC to TRA seem to add only about 4% to 5% to the variance explained in intention and only about 1% to the variance explained in actual behavior, above that explained by attitude and subjective norm. so it is with the current results. The degree to which project managers perceive that they have control over project planning seems not to predict estimating and plan development practices at all, and only adds very little to predicting the establishment of project commitments. This makes some sense inasmuch as the control project managers typically have over their projects is related to the authorization and commitments they receive from key stakeholders. According to the current results, this appears to be a relatively minor issue.

I also expected that the TRA, TPB, and TAM would integrate well by their indicators loading meaningfully on three latent constructs. This expectation was only partially realized. The measurement model that provided the better fit integrated ATT measures from TRA, and USE measures from TAM, but EOU from TAM and PBC played either no role or a very minor role in the overall model. In this regard, it is particularly noteworthy that only one of the multiplicative, belief-based terms contributed meaningfully in this research - NBMC. Despite the fact that the methodologies followed in the current study were those used in all TPB/TRA studies, neither BBEV nor CBPF provided meaningful indicators of an underlying construct. As such, the resulting measures should have, but did not, support the plausibility of a 3-dimensional structure underlying the antecedents of project planning behavior.

The most likely explanation for these results is that, overall, project managers' perceptions of their personal control over project planning activities may not play a significant role in their actual use of planning practices. This is understandable given that the theory of planned behavior was posited for those conditions in which the behavior of actors is not under their volitional control. The mild degree to which personal control (and ease of use) may be involved in these processes was either appropriately captured in the current study, or was too weak for the power of this design to detect. In the latter regard, although numerous studies have supported the multidimensionality of the factor structure for attitude, subjective norm, and perceived behavioral control, as well as usefulness and ease of use from TAM, a meaningful latent variable integration was not achieved as regards the EOU and PBC constructs from TAM and TPB. Therefore, further research is certainly needed on the validity of these measurement instruments and the approaches to their development.

The study makes several important contributions to research and practice. First, this research provides the basis for the development of measures of integrated theoretical constructs that can be used to predict good practice intentions and behavior. Through this study we learn whether or not an integrated model of the social psychological factors that influence technology acceptance applies not just to traditionally-defined “technology” such as computer software, hardware, and related applications; but it also applies to the prediction of the use of “good practices” as an important form of technology. With improved understanding of the factors that influence the use of good practices, executives, managers, consultants, and other change agents can increase their chances of capitalizing on the benefits of CMM-based process improvement initiatives.

Second, we learn that two of the three key constructs of the integrated model – attitude and social influence – are reliable, parsimonious constructs for prediction in this arena. As such, managers, consultants, and practitioners engaging in process improvement efforts can leverage this model to predict the “readiness” of an organization for adopting specific good practices by administering pre-project questionnaires that assess practitioners' attitudes, social influences, and control beliefs. Based on the results of these preliminary surveys, consultants can plan to mitigate risks to the success of their improvement initiatives by emphasizing techniques that differentially influence practitioner's attitudes, perception of social influences, and or perceptions of personal control. This can be done in a number of ways. For instance, if a consultant determines that attitudes toward a set of good practices are negative, he / she can include persuasive information activities in the project plan to improve attitudes toward the good practices. These messages can emphasize the "usefulness" of the good practices. Similarly, if preliminary surveys indicate social influences that are working against the adoption of good practices, a consultant can build more participative activities into the project approach, perhaps identifying influential members of the practitioner community and recruiting them to serve as key mentors and "power users" of the good practices. He might also provide "testimonials" and other information that indicates the social acceptability and / or popularity of the good practices.

Additionally, unlike most research in this area, this research is not only grounded in three well-established theories, making it the first study of its kind to apply these theories to project management practices, but this study is also a field study of those who actually manage real-world projects. By contrast, most of the previous research has been conducted on samples of undergraduate students, as many comparison and integration studies have been (e.g., Davis et al., 1989, Davis, 1989, Davis, 1986, Mathieson, 1991, Taylor and Todd, 1995). As such, the results of the current study are more likely to tell us something about how these well-established theories work when applied to real-world settings. Hence, whereas a common criticism of academic research is its lack of external validity outside of the academic institutions, this study uses real professionals and has greater external validity.

Some Limitations of the Current Study

Despite the external validity of this study, as with many studies, the results and conclusions are very likely to be limited to the particular sample, variables, and time frame represented by the design. Due to time constraints, sampling procedures involved a convenience sample rather than a randomized, representative sample of the population of project managers. Moreover, the sample size did not allow for cross-validation (Browne & Cudeck 1989). As such, conclusions must be regarded as tentative until further research can confirm or disconfirm similar findings.

As a cross-sectional (rather than longitudinal) design, the current study was limited to a particular occasion of measurement. As such, directional influences posited within the hypothesized models must be interpreted with caution. Gollob and Reichardt (1991) have pointed out that directional effects in structural equation models require three conditions: first, directional effects take some finite amount of time to operate. Second, a variable may be influenced by the same variable at an earlier point in time, an effect called "autoregressive." And finally, the magnitude of an effect may vary as a function of the time lag. Strictly-speaking, then, there is no single true effect of one variable on another with a cross-sectional design. In this regard, subsequent phases of this line of research will provide more longitudinal data for making more appropriate "causal" inferences and assessing the dynamic nature of many of the variables under consideration.

These findings are limited to project managers in Utah. Extrapolating beyond that population must be done tentatively and with care, as the Utah Chapter of the PMI may or may not be strongly representative of the nationwide population of those who manage projects. Additionally, the Utah chapter of the PMI has a relatively larger proportion of its members certified as Project Managment Professionals (PMP). Obtaining such a certification credential requires not only certain experience requirements, but also a strong understanding of the standards and practices described in the "Guide to the Project Management Body of Knowledge" (PMBOK) upon which the certification is based. As such, responses may have been skewed by a population of respondents who are more likely to be familiar with those standards.

The results of the current study may also be limited by the choice of “technology” – general project management practices and, in particular, the “best,” “good,” “conventional,” and “marginal” practices described in the SEI's Capability Maturity framework of models. As such, similar results may not be obtained when measuring project management practices using some other standard for project management practices, or when measuring some other industry standard practices (e.g., Generally Accepted Accounting Practices – GAAP for accountants).

Sample Size

There may be some question as to the adequacy of the sample size for the current study. A rule of thumb suggests that covariance-based SEM requires a sample size of at least 100 (Hair et al., 1998). Other guidelines (for PLS, for instance) insist that the sample should have at least *ten times* more data-points than the number of items in the most complex construct in the model (Barclay et al., 1995). MacCallum and Austin (2000) reviewed recent applications of SEM published in psychology journals and found that about 18% of the studies used samples of fewer than 100 individuals. Interestingly, MacCallum and Austin were explicitly reluctant to recommend rules of thumb regarding sample size in SEM because recent work (MacCallum et al 1999) on the same issue in factor analysis has shown rules of thumb to be generally invalid.

Minimum sample size is highly dependent on characteristics of the models being estimated. The model that can be best supported may depend on sample size, with simpler models favored when sample size is smaller. In this regard, the current study attempted to keep the hypothesized model relatively simple to accommodate the sample size. In subsequent phases of this line of research, sample size will increase to the 200 to 500+ range, supporting analysis of more complex explanations and understandings of the factors that influence project managers to engage in important project management best practices.

Future Research

Continuous process improvement involves more than just project management practices. As such, the CMM/I framework defines a great number of best practices and industry standards that should be investigated in future research. Particularly because the notion of continuous improvement implies that there is an ongoing intention to continue to engage in good practice discipline, the approach taken in the current study to integrate the extant intention models would lend themselves well to longitudinal investigations of process improvement initiatives. This is especially important in light of the fact that the purpose of the current phase of this study is to take a single-occasion snapshot of a system of variables and constructs. As such, the design is cross-sectional (see MacCallum & Austin, 2000), and not designed to allow time during which the formation of intentions can mediate between social psychological constructs and actual behavior. Future research should allow an examination of these relationships over time, including an examination of autoregressive influences (see Gollob & Reichardt 1991; MacCallum & Austin, 2000).

APPENDIX A: FINAL SURVEY INSTRUMENT

[Recruitment email Message]

Brigham Young University

Project Management Practices Survey

Dear Project Manager:

You are invited to participate in a Project Management Practices Survey being conducted by researchers at Brigham Young University.

Why should you participate?

* You would be helping in some very important research to help us understand why project managers do or do not use project management practices.

* You may elect to receive a chance to win one of several free copies of Jim Highsmith's "Agile Project Management" book OR gift certificates to Amazon.com.

* You may elect to receive a report of the results of this important research.

* You may receive 1 or more Professional Development Units (PDU) for your participation and review of the research results [Category 2 SDL].

Please follow the instructions below to participate:

Instructions

Participation in this research is voluntary. You may refuse to participate or withdraw at any time without penalty. Submitting this survey implies your consent to participate.

As you complete the questions in the survey, here are a few things to remember:

* Please give every response your due consideration. Although the survey will probably only take about 15 minutes to complete, do not feel pressured to complete it within any particular time limit.

* Please be sure to complete every item. It is OK if you are not absolutely certain of some answers. Choose the response that comes closest to reflecting your honest beliefs, feelings, or observations. Your best guess is much better than no answer at all.

* Remember that all information collected will be kept strictly confidential. Only aggregated data will ever be disclosed to anyone outside the research team. Individual information will never be disclosed to anyone, including your management.

Please respond to the survey no later than November 5th, 2004. Simply click on the following link to proceed to the first set of questions: http://<url for hosted survey>

If you have any questions or comments about this research, please contact the principal investigator:

Russell Thornley
Department of Psychology
Brigham Young University
Provo, UT 84602-5383
Phone: 801.345.2863
e-mail: russell2@bigplanet.com

If you have questions about your rights as a research participant, please contact:

Robert D. Ridge, PhD
Associate Professor
Department of Psychology
Brigham Young University
Provo, UT 84602-5383
Phone: 801.422.7867

Section I. Project Planning Practices

Instructions

The purpose of **Project Planning** is to establish and maintain plans that define project activities. Project Planning involves developing the project plan, interacting with stakeholders appropriately, getting commitment to the plan, and maintaining the plan.

Answer the questions in this section by clicking the appropriate box to indicate one of the four possible responses:

- Check **Yes** when the practice is well established and consistently performed. The practice should be performed **nearly always** in order to be considered well-established and consistently performed as a standard operating procedure.
- Check **No** when the practice is not well established or is inconsistently performed. The practice may be performed sometimes, or even frequently, but it is omitted under difficult circumstances.
- Check **Does Not Apply** when you have the required knowledge about the project or organization and the question asked, but you feel the question does not apply to the project(s).
- Check **Don't Know** when you are uncertain about how to answer the question.

Please check only one of the boxes for each question, and answer all of the questions.

Please answer the following questions based on your knowledge and experience of projects in which you have participated **within the past 6 months** (regardless of whether or not the projects were completed or cancelled, and including your current projects).

	On your projects over the **past 6 months**…	Yes	No	Does Not Apply	Don't Know
1.	Was a top-level work breakdown structure (WBS) established to estimate the scope of the project?	[ ]	[ ]	[ ]	[ ]
2.	Were estimates of the attributes of the work products and tasks established and maintained?	[ ]	[ ]	[ ]	[ ]
3.	Were the project life-cycle phases defined, upon which to scope the planning effort?	[ ]	[ ]	[ ]	[ ]
4.	Were the project effort and cost for the work products and tasks estimated based on estimation rationale?	[ ]	[ ]	[ ]	[ ]
5.	Was the project's budget and schedule established and maintained?	[ ]	[ ]	[ ]	[ ]
6.	Were project risks identified and analyzed?	[ ]	[ ]	[ ]	[ ]
7.	Was the management of project data planned?	[ ]	[ ]	[ ]	[ ]
8.	Were necessary resources to perform the project planned?	[ ]	[ ]	[ ]	[ ]
9.	Were needed knowledge and skills to perform the project planned?	[ ]	[ ]	[ ]	[ ]
10.	Was the involvement of identified stakeholders planned?	[ ]	[ ]	[ ]	[ ]
11.	Was the overall project plan content established and maintained?	[ ]	[ ]	[ ]	[ ]
12.	Were all plans that affect the project reviewed to understand project commitments?	[ ]	[ ]	[ ]	[ ]
13.	Was the project plan reconciled to reflect available and estimated resources?	[ ]	[ ]	[ ]	[ ]
14.	Were commitments obtained from relevant stakeholders who were responsible for performing and supporting plan execution?	[ ]	[ ]	[ ]	[ ]

Please answer the following questions about your INTENTIONS to do Project Planning on FUTURE projects in which you will participate within the NEXT 6 months.

	On your *future* projects over the **NEXT 6 months**…	Yes	No	Does Not Apply	Don't Know
1.	Will a top-level work breakdown structure (WBS) be established to estimate the scope of the project?	[ ]	[ ]	[ ]	[ ]
2.	Will estimates of the attributes of the work products and tasks be established and maintained?	[ ]	[ ]	[ ]	[ ]
3.	Will the project life-cycle phases be defined, upon which to scope the planning effort?	[ ]	[ ]	[ ]	[ ]
4.	Will the project effort and cost for the work products and tasks be estimated based on estimation rationale?	[ ]	[ ]	[ ]	[ ]
5.	Will the project's budget and schedule be established and maintained?	[ ]	[ ]	[ ]	[ ]
6.	Will project risks be identified and analyzed?	[ ]	[ ]	[ ]	[ ]
7.	Will the management of project data be planned?	[ ]	[ ]	[ ]	[ ]
8.	Will necessary resources to perform the project be planned?	[ ]	[ ]	[ ]	[ ]
9.	Will needed knowledge and skills to perform the project be planned?	[ ]	[ ]	[ ]	[ ]
10.	Will the involvement of identified stakeholders be planned?	[ ]	[ ]	[ ]	[ ]
11.	Will the overall project plan content be established and maintained?	[ ]	[ ]	[ ]	[ ]
12.	Will all plans that affect the project be reviewed to understand project commitments?	[ ]	[ ]	[ ]	[ ]
13.	Will the project plan be reconciled to reflect available and estimated resources?	[ ]	[ ]	[ ]	[ ]
14.	Will commitments be obtained from relevant stakeholders who are responsible for performing and supporting plan execution?	[ ]	[ ]	[ ]	[ ]

Section II. Usefulness of Project Planning

On the scales below, please select the point on each scale that completes each statement in a way that best represents your opinions about project planning.

Planning my projects would improve my job performance.

Unlikely	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Likely**

Planning my projects would enable me to accomplish tasks more quickly.

Unlikely	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Likely**

Planning my projects would allow me to accomplish more work than would otherwise be possible.

Unlikely	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Likely**

Planning my projects would enhance my effectiveness on the job.

Unlikely	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Likely**

Planning my projects would require a lot of mental effort.

Unlikely	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Likely**

It would be easy for me to become skillful at planning my projects.

Unlikely	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Likely**

It would be easy for me to remember how to do project planning on my projects.

Unlikely	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Likely**

Overall, I would find project planning easy to use.

Unlikely	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Likely**

Section III. Opinions About Project Planning

On the scales below, please select the point on each scale that completes each statement in a way that best represents your opinions about project planning.
"It would be ___________ for me to plan my projects over the next 6 months."

Good	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Bad**
Harmful	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Helpful**
Positive	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Negative**
Foolish	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Wise**

"To me, planning my projects over the next six months would be_______"

Easy	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Difficult**
Under my control	[ ] completely	[ ] somewhat	[ ] slightly	[ ] neither	[ ] slightly	[ ] somewhat	[ ] completely	**Out of my control**
Simple to arrange	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Complicated to arrange**

"If I plan my projects over the next six months, it is ___________ that it will…

[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	
extremely unlikely	quite unlikely	slightly unlikely	neither	slightly likely	quite likely	extremely likely	*… reduce overall costs of doing business."*

[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	
extremely unlikely	quite unlikely	slightly unlikely	neither	slightly likely	quite likely	extremely likely	*… improve relationships with my customers/clients."*

[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	
extremely unlikely	quite unlikely	slightly unlikely	neither	slightly likely	quite likely	extremely likely	*… improve communication with customers/clients."*

[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	
extremely unlikely	quite unlikely	slightly unlikely	neither	slightly likely	quite likely	extremely likely	*… allow me to keep pace with the competition."*

Select the descriptor that best expresses, in general, how **negative or positive** you feel about each of the following:

Reducing overall costs of doing business.

Negative	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	**Positive**
	extremely	quite	slightly	neither	slightly	quite	extremely	

Improving relationships with your customers/clients.

Negative	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	**Positive**
	extremely	quite	slightly	neither	slightly	quite	extremely	

Improving communication with customers/clients.

Negative	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	**Positive**
	extremely	quite	slightly	neither	slightly	quite	extremely	

Allowing you to keep pace with the competition.

Negative	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	**Positive**
	extremely	quite	slightly	neither	slightly	quite	extremely	

Possible Obstacles and Barriers

How likely is it that each of the following factors would affect your ability to plan your projects over the next 6 months?

Training it would take to get up to speed.	[ ] extremely unlikely	[ ] quite unlikely	[ ] slightly unlikely	[ ] neither	[ ] slightly likely	[ ] quite likely	[ ] extremely likely
Appropriate tool knowledge/skill.	[ ] extremely unlikely	[ ] quite unlikely	[ ] slightly unlikely	[ ] neither	[ ] slightly likely	[ ] quite likely	[ ] extremely likely
Cooperation and approval of resources/technical people.	[ ] extremely unlikely	[ ] quite unlikely	[ ] slightly unlikely	[ ] neither	[ ] slightly likely	[ ] quite likely	[ ] extremely likely
Cooperation and approval of management.	[ ] extremely unlikely	[ ] quite unlikely	[ ] slightly unlikely	[ ] neither	[ ] slightly likely	[ ] quite likely	[ ] extremely likely

How IMPORTANT to you are each of the following factors regarding your ability to plan your projects over the next 6 months?

Training it would take to get up to speed.

Unimportant	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Important**

Appropriate tool knowledge/skill.

Unimportant	[ ] extremely	[ ] quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Important**

Cooperation and approval of resources/technical people.

Unimportant	[ ] extremely	[ ] quite	[ ] Slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Important**

Cooperation and approval of management.

Unimportant	[ ] extremely	[ ] Quite	[ ] slightly	[ ] neither	[ ] slightly	[ ] quite	[ ] extremely	**Important**

Section IV. Opinions of Others

Using the scales below, please indicate how much each of the following people or groups would **approve or disapprove** of your planning your projects over the next six months.

Upper/top management would…

Disapprove	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	**Approve**
	strongly	somewhat	slightly	neither	slightly	somewhat	strongly	

Other project managers with whom you work would…

Disapprove	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	**Approve**
	strongly	somewhat	slightly	neither	slightly	somewhat	strongly	

Other members of the Project Management Office (PMO) would…

Disapprove	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	**Approve**
	strongly	somewhat	slightly	neither	slightly	somewhat	strongly	

Your immediate supervisor would…

Disapprove	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	**Approve**
	strongly	somewhat	slightly	neither	slightly	somewhat	strongly	

Using the scales below, please indicate how much you agree or disagree with each of the follow statements about project planning.

Overall, people who are important to me would approve of my planning my projects over the next six months.

Disagree	[ ] strongly	[ ] somewhat	[ ] slightly	[ ] neither	[ ] slightly	[ ] somewhat	[ ] strongly	**Agree**

Generally speaking, my stakeholders, customers, and clients would approve of my planning my projects over the next six months.

Disagree	[ ] strongly	[ ] somewhat	[ ] slightly	[ ] neither	[ ] slightly	[ ] somewhat	[ ] strongly	**Agree**

In general, the members of my professional association would be in favor of my planning my projects over the next six months.

Disagree	[ ] strongly	[ ] somewhat	[ ] slightly	[ ] neither	[ ] slightly	[ ] somewhat	[ ] strongly	**Agree**

Using the scales below, please indicate IN GENERAL, how important/unimportant it is to you personally to do what each of the following people or groups think you should do.

*In general, how **important / unimportant** is it to you personally to do what…*

…upper/top management thinks you should do?

Unimportant	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	**Important**
	extremely	quite	slightly	neither	slightly	quite	extremely	

…other project managers with whom you work think you should do?

Unimportant	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	**Important**
	extremely	quite	slightly	neither	slightly	quite	extremely	

…other members of the Project Management Office(PMO) think you should do?

Unimportant	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	**Important**
	extremely	quite	slightly	neither	slightly	quite	extremely	

…your immediate supervisor thinks you should do?

Unimportant	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	**Important**
	extremely	quite	slightly	neither	slightly	quite	extremely	

Please tell us a little about yourself:

Gender:

[ ] Male

[ ] Female

Age: [drop-down list from 18 to 99+]

Which of the following best describes your current position? [drop-down list of:]

Project Leader

Functional Manager

Technical Team Member

Executive

Other (Please specify): [text box]

The State in which you work: [drop-down list of US states]

Comments: <submit to russell2@bigplanet.com>

You have now completed the survey.

THANK YOU FOR YOUR PARTICIPATION!

In appreciation for your participation, if you would like to be entered into a drawing for a chance to win a free copy of Jim Highsmiths' "Agile Project Management: Reliable Innovation" or an amazon.com gift certificate, please enter your email address here: ___________. <submit to russell2@bigplanet.com>

If you would like to receive a summary research report when this research is completed, please enter your email address here: ___________________. <submit to russell2@bigplanet.com>

Note: Be assured that your email address will not be associated with your survey responses, thereby maintaining the confidentiality of your responses.

APPENDIX B

SUMMARY OF EXOGENOUS MEASURES IN THE CURRENT STUDY

Summary of Measures

Latent Construct	Observed Indicator	Item Description
Attitude [TAM / TPB]	ATT01 (r)	It would be [good – bad] for me to plan my projects over the next six months.
	ATT02	[harmful – helpful]
	ATT03 (r)	[positive – negative]
	ATT04	[foolish – wise]
Subjective Norm [TPB]	SN01	Overall, people who are important to me would approve of my planning my projects over the next six months. [disagree – agree]
	SN02	Generally speaking, my stakeholders, customers, and clients would approve of my planning my projects over the next six months. [disagree – agree]
	SN03	In general, the members of my professional association would be in favor of my planning my projects over the next six months. [disagree – agree]
Perceived Behavioral Control [TPB]	PBC01 (r)	To me, planning my projects over the next six months would be [easy – difficult].
	PBC02 (r)	[under my control – out of my control]
	PBC03 (r)	[simple to arrange – complicated to arrange]

Summary of Measures (continued)

Latent Construct	Observed Indicator	Item Description
Usefulness [TAM]	USE01	Planning my projects would …*improve my job performance* (unlikely – likely).
	USE02	…*enable me to accomplish tasks more quickly* (unlikely – likely).
	USE03	… *allow me to accomplish more work than would otherwise be possible* (unlikely – likely).
	USE04	… *enhance my effectiveness on the job* (unlikely – likely).
Ease of Use [TAM]	EOU01 (r)	Planning my projects would require a lot of mental effort (unlikely – likely).
	EOU02	It would be easy for me to become skillful at planning my projects (unlikely – likely).
	EOU03	It would be easy for me to remember how to do project planning on my projects (unlikely – likely).
	EOU04	Overall, I would find project planning easy to use (unlikely – likely).
Belief-based ATT [Sum(bbev);TPB]	BBEV	Expectancy-value conception of ATT, combining behavioral beliefs and evaluations.
Behavioral Beliefs	bb01	If I plan my projects over the next six months, it is [likely – unlikely] that it will …*reduce overall costs of doing business.*
	bb02	… *improve relationships with my customers/clients*.
	bb03	… *improve communication with customers/clients*.
	bb04	… *allow me to keep pace with the competition*.

Summary of Measures (continued)

Latent Construct	Observed Indicator	Item Description
Evaluations	ev01	Reducing overall costs of doing business. [negative – positive]
	ev02	Improving relationships with your customers/clients. [negative – positive]
	ev03	Improving communication with customers/clients. [negative – positive]
	ev04	Allowing you to keep pace with the competition. [negative – positive]
Belief-based SN [i.e., Sum(nbmc); TPB]	NBMC	Expectancy-value conception of SN, combining normative beliefs and motivation to comply.
Normative Beliefs	nb01	*Upper/top management would*…[disapprove – approve] of your planning your projects over the next six months.
	nb02	*Other project managers with whom you work would*… [disapprove – approve]
	nb03	*Other members of the Project Management Office (PMO) would*… [disapprove – approve]
	nb04	*Your immediate supervisor would*… [disapprove – approve]
Motivation to Comply	mc01	In general, how important / unimportant is it to do what…*upper/top management thinks you should do?* [important – unimportant]
	mc02	*Other project managers with whom you work…* [important – unimportant]
	mc03	*Other members of the PMO…*[important – unimportant]
	mc04	*Your immediate supervisor…*[important – unimportant]

Summary of Measures (continued)

Latent Construct	Observed Indicator	Item Description
Belief-based PBC [i.e., Sum(cbpf); TPB]	CBPF	Expectancy-value conception of PBC, combining control beliefs and perceived facilitation.
Control Beliefs	cb01	…affect your ability to plan your projects…? *Training it would take to get up to speed.* [unlikely – likely]
	cb02	*Appropriate tool knowledge/skill.*[unlikely – likely]
	cb03	*Cooperation and approval of resources/technical people.* [unlikely – likely]
	cb04	*Cooperation and approval of management.* [unlikely – likely]
Perceived Facilitation	pf01	*Training it would take to get up to speed.* [important – unimportant]
	pf02	*Appropriate tool knowledge/skill.* [important – unimportant]
	pf03	*Cooperation and approval of resources/technical people.* [important – unimportant]
	pf04	*Cooperation and approval of management.* [important – unimportant]

APPENDIX C

KEY VARIABLES CORRELATION MATRIX

	NBMC	SN	ATT	USE	PBC	EOU	CBPF	BBEV	EST_ BEHV	DEV_ BEHV	COM_ BEHV
NBMC	1.000										
SN	.819	1.000									
ATT	.627	.600	1.000								
USE	.489	.487	.621	1.000							
PBC	.467	.425	.473	.246	1.000						
EOU	.094	.150	.058	-.017	.380	1.000					
CBPF	-.087	-.036	.172	.323	-.024	-.178	1.000				
BBEV	-.217	-.264	-.321	-.242	-.178	.072	-.193	1.000			
EST_BEHV	.493	.526	.525	.435	.410	-.022	.084	-.145	1.000		
DEV_BEHV	.428	.398	.307	.235	.155	-.163	-.020	-.227	.288	1.000	
COM_BEHV	.366	.358	.337	.290	.321	.084	.207	-.112	.462	.596	1.000

Note: Estimates were based on the covariance matrix. This matrix is shown for interpretive convenience. See Table 6 for means and standard deviations of these variables.

REFERENCES

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

Afzaal, H., Seyal, M., Rahman, N., & Mahbubur-Rahim, M. (2002). Determinants of academic use of the Internet: A structural equation model. Behaviour and Information Technology, 21(1), pp. 71 - 86.

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

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

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

Al-Gahtani, S. & King, M. (1999). Attitudes, satisfaction and usage: Factors contributing to each in the acceptance of information technology. Behaviour and Information Technology, 18(4), pp. 277-297.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. Psychological Bulletin, 103(3), pp. 411-423.

Arbuckle, J. L. (1999). Amos 4.0 [computer software]. Chicago: Smallwaters.

Bandura, A. (1982). Self-efficacy mechanisms in human agency. American Psychologist, 37, pp. 122-147

Bentler, P. (1990). Comparative fit indexes in structural models. Psychological Bulletin, 107, pp. 238-246.

Boomsma, A. (2000). Reporting analyses of covariance structures. Structural Equation Modeling, 7(3), pp. 461-483.

Byrne, (2001). Structural Equation Modeling with Amos: Basic Concepts, Applications, and Programming. Mahwah, NJ: Lawrence Erlbaum.

Chau, P. (1996). An empirical assessment of a modified technology acceptance model. Journal of Management Information Systems, 13(2), pp. 185-204.

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

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

Compeau, D., Higgins, C.A., & Huff, S. (1999). Social cognitive theory and individual reactions to computing technology: A longitudinal study. MIS Quarterly, 23(2), pp. 145-158.

Crosby, P. B. (1979). Quality is Free. McGraw-Hill, New York, NY.

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

Davis, F. D. (1986). A technology acceptance model for empirically testing new end-user information systems: Theory and results. Doctoral Dissertation, Sloan School of Management, MIT, pp. 1-291.

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

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

Davis, F. D. (1993). User acceptance of information technology: System characteristics, user perceptions and behavioral impacts. International Journal of Man-Machine Studies, 38(3), pp. 475-487.

Deming, W. E. (1986). Out of the Crisis. MIT Center for Advanced Engineering Study, Cambridge, MA.

Dion, R. (1993). Process improvement and the corporate balance sheet. IEEE Software, 10(4), p. 28-35.

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

Dunaway, D., & Masters, S. (1996). CMM-Based Appraisal for Internal Process Improvement (CBA IPI): Method Description (CMU/SEI-96-TR-007, ADA307934). Pittsburgh, Pa.: Software Engineering Institute, Carnegie Mellon University. http://www.sei.cmu.edu/publications/documents/96.reports/ 96.tr.007html.

Dunaway, D. K., & Baker, M. (2001). Analysis of CMM-based appraisal for internal process improvement (CBA IPI) assessment feedback. (Technical Report CMU/SEI-2001-TR-021). Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA. Available at: http://www.sei.cmu.edu/publications/documents/01.reports/01tr021.html.

Fishbein, M. (1979). A Theory of Reasoned Action: Some Applications and Implications. Nebraska Symposium on Motivation, University of Nebraska Press.

Fishbein, M., & Ajzen, I. (1975). Belief, Attitude, and Behavior: An Introduction to Theory and Research. Reading, MA: Addison-Wesley.

Gefen, D. & Straub, D.W. (2000). The relative importance of perceived ease-of-use in IS adoption: A study of e-commerce adoption. Journal of the Association for Information Systems, 1(8), pp. 65-79.

Goldenson, D. & Herbsleb, J. (1995). After the appraisal: A systematic survey of process improvement, its benefits and factors that influence success. Technical Report, CMU-SEI-95-TR-009, Software Engineering Institute.

Harrison, D. A., Mykytyn, P. P., & Riemenschneider, C. (1997). Executive decisions about information technology and competitive strategy in small business: Theory and empirical tests. Information Systems Research, 8(2), pp. 171-193.

Hendrickson, A.R., & Collins, M.R. (1996). An assessment of structure and causation of IS usage. The Data Base for Advances in Information Systems, 27(2), pp. 61-67.

Herbsleb, J., Carleton, A., Rozum, J., Siegel, J., & Zubrow, D. (1994). Benefits of CMM-based software process improvement: Initial results. (Technical Report CMU/SEI-94-TR-13). Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA.

Hotle, M. (1998). Climbing the CMM: How long can you tread water? Strategic Planning, SPA-04-7761, Research Note, 6 October 1998.

Humphrey, W. S. (1987). Characterizing the software process: A maturity framework. Software Engineering Institute, CMU/SEI-87-TR-11, DTIC Number ADA182895, June 1987.

Humphrey, W. S. (1989). Managing the software process. Addison-Wesley, Reading, MA.

Humphrey, W. S., & Sweet, W. L. (1987). A method for assessing the software engineering capability of contractors. Software Engineering Institute, CMU/SEI-87-TR-23, DTIC Number ADA187320, September 1987.

Jones, C. (1995). Gaps in SEI programs. Software Development, 3(3), p. 31-48.

Igbaria, M. & Iivari, J. (1995). The effects of self-efficacy on computer usage. OMEGA International Journal of Management Science, 23(6), pp. 587-605.

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), pp. 87-114.

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

Igbaria, M., Zinatelli, N., Cragg, P., & Cavaye, A. L. (1997). Personal computing acceptance factors in small firms: A structural equation model. MIS Quarterly, 21(3), pp. 279-305.

Iivari, J. (1996). Why are CASE tools not used? Communications of the ACM, 39(10), October, pp. 94-103.

Imai, M. (1986). KAIZEN: The key to Japan's competitive success. McGraw-Hill/Irwin.

Jackson, C.M., Chow, S., & Leitch, R.A. (1997). Towards an understanding of the behavioral intention to use an information system. Decision Sciences, 28(2), pp. 357-389.

Joreskog, K. & Sorbom, D. (1993). LISREL 8 User's Reference Guide. Chicago, IL: Scientific Software, Inc.

Juran, J. M. (1988). Juran on Planning for Quality. Macmillan, New York, NY.

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

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

Kelman, (1961). Processes of opinion change. Public Opinion Quarterly, 25, 57-58.

Lederer, A.L., Maupin, D.J., Sena, M.P., & Zhuang, Y. (2000). The technology acceptance model and the world wide web. Decision Support System, 29(3), pp. 269-282.

Loch, K. & Conger, S. (1996). Evaluating ethical decision making and computer use. Communications of the ACM, 39(7), pp. 74-83.

Lucas, H. C., & Spitler, V. K. (1999). Technology use and performance: A field study of broker workstations. Decision Sciences, 30(2), pp. 291-311.

MacCallum, R. C. & Austin, J. T. (2000). Applications of structural equation modeling in psychological research. Annual Review of Psychology, 51, pp. 201-226.

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. Psychological Methods, 4, pp. 84–99.

Masters, S. & Bothwell, C. (1995). CMM appraisal framework: Version 1.0. (Technical Report CMU/SEI-95-TR-001). Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA. Available: http://www.sei.cmu.edu/publications/documents/95.reports/95tr001.html.

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

Montazemi, A.R., Cameron, D.A., & Gupta, K.M. (1996). An empirical study of factors affecting software package selection. Journal of Management Information Systems, 13(1), pp. 89-105.

Morris, M. G. & Dillon, A. (1997). How user perceptions influence software use. IEEE Software, 14(4), pp. 58-65.

Orlikowski, W. (1993). CASE tools as organizational change: Investigating incremental and radical changes in systems development. MIS Quarterly, 17(3), pp. 309-340.

Paulk, M. C., Curtis, B., & Chrissis, M. B. (1995). The capability maturity model: Guidelines for improving the software process. Addison Wesley.

Paulk, M. C. (2001). A history of the capability maturity model for software. Software Engineering Institute, CMU/SEI-01-TR-25, September 2001.

Paulk, M. C., Curtis, B., Chrissis, M. B. & Weber, C. V. (1991). Capability maturity model for software, version 1.1. Software Engineering Institute, CMU/SEI-91-TR-24, August, 1991.

Roberts, P. & Henderson, R. (2000). Information technology acceptance in a sample of government employees: A test of the technology acceptance model, Interacting with Computers, 12 (5), pp. 427-443

Segars, A. H., & Grover, V. (1993). Re-examining perceived ease of use and usefulness: A confirmatory factor analysis. MIS Quarterly, 17(4), p. 517-525.

Sheppard, B., Hartwick, J., & Warshaw, P. (1988). The theory of reasoned action: A meta-analysis of past research with recommendations for modifications and future research. Journal of Consumer Research, 15(3), pp. 225-243.

Software Engineering Institute (2001). Annual Report. Available at: http://www.sei.cmu.edu/pub/documents/misc/annual-report/2001/pdf.

Stelzer, D. & Mellis, W. (1998) Success factors of organizational change in software process improvement. Software Process Improvement and Practice, 4, pp. 227-250.

Straub, D., Keil, M., & Brenner, W. (1997). Testing the technology acceptance model across cultures: A three country study. Information and Management, 33(1), pp. 1-11.

Straub, D.W., Limayem, M., & Karahanna-Evaristo, E. (1995). Measuring system usage: Implications for IS theory testing. Management Science, 41(8), pp. 1328-1342.

Subramanian, G. H. (1995). A replication of perceived usefulness and perceived ease of use measurement. Decision Sciences, 25, p. 863-874.

Szajna, B. (1994). Software evaluation and choice: Predictive validation of the technology acceptance instrument. MIS Quarterly, 18(3), pp. 319-324.

Szajna, B. (1996). Empirical evaluation of the revised technology acceptance model. Management Science, 42 (1), pp. 85-92.

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

Taylor, S., & Todd, P. (1995b). Decomposition and crossover effects in the TPB: A study of computer adoption. International Journal of Research in Marketing, 12, pp. 137-155.

Taylor, S., & Todd, P. (1995c). Assessing IT usage: The role of prior experience. MIS Quarterly, 19(4), pp. 561-570.

Thurstone, L. L. (Ed.). (1931). The Measurement of Social Attitudes. Chicago, IL: University of Chicago Press.

Tornatzky, L. & Fleischer, M. (1990). The Process of Technological Innovation. Lexington, Mass: Lexington Books.

Venkatesh, V. & Davis, F.D. (1996). A model of the antecedents of perceived ease of use: Development and test. Decision Sciences, 27(3), pp. 451-481.

Venkatesh, V. (1999). Creation of favorable user perceptions: Exploring the role of intrinsic motivation. MIS Quarterly, 23(2), pp. 239-260.

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

Venkatesh, V. & Davis, F.D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management Science, 46(2), pp. 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), pp. 115-139.

Weber, C. V., Paulk, M. C., Wise, C. J., & Withey, J. V. (1991). Key practices of the capability maturity model. (Technical Report CMU/SEI-91-TR-25), Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA.

Zubrow, D., Hayes, W., Siegel, J., & Goldenson, D. (1994). Maturity Questionnaire. (Special Report CMU/SEI-94-SR-7), Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA.