PROJECT MANAGEMENT SOFTWARE ACCEPTANCE AND ITS IMPACT ON PROJECT SUCCESS

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Abstract

This study draws upon the technology acceptance model and other relevant research models as the theoretical basis and presents new empirical research findings for the explanation of key factors affecting project management software acceptance by project professionals. The study uses results from a survey of 497 users in project-driven organizations. The study sample was recruited from the Project Management Institute and from virtual interest groups in the project management field. This study examines the relationships among the following constructs: information quality, system functionality, ease of use, project complexity, performance impact, organization size, project size, and user education, training and experience level. The findings indicate that information quality and project complexity are the dominant factors in explaining the levels of system utilization. The results also show that system functionality and ease of use have a significant effect on software usage, but their effects are lower compared to the effects of information quality and project complexity. The results also indicate a strong relationship between usage of the software and project managers' performance. The participants confirmed that the software enhances their effectiveness in their jobs, gives them greater control over their work, and increases the likelihood of successful completion of their projects. Inconsistent with prior research, training level had no influence on project management software usage. However, software experience and education level had a moderate effect on the use of the software. Both organization size and project size had significant effects on the use of the software. Practical implications and recommendations for future research in acceptance of information technologies in the project management field are discussed.

Keywords: Project management software, information technology acceptance, information systems effectiveness, project complexity, systems utilization, information quality, system functionality, ease of use.

Introduction

The adoption and use of Project Management (PM) software solutions have grown and continues to grow at a rapid pace in all industries. Professionals in the project management field have a strong interest in improving their performance by using available Information Technologies (IT) for better project planning and control. The number of PM software offerings has also increased in recent years with wide spectrum of features, functionalities and prices. The investments by organizations on implementing PM software systems and training their employees to use them have amplified (Grevins, Sanders and Suresh 2000, Liberatore, Pollack-Johnson and Smith 2001, Meredith and Mantel 2000). The main purpose of these systems is to facilitate project management processes and to aid project managers in coping with project scheduling, monitoring, controlling, and information sharing. However, there is a lack of empirical studies that focus on the factors that affect the acceptance of PM software and determine its impact on project management success.

The objectives of this study are to develop a model of the determinants of PM software acceptance, examine its impact on performance, and develop a scale to measure the effectiveness of this tool. The factors selected for investigation are based on previous research in information systems success that were deemed to be relevant to the project management context. The research described here uses factor analysis, regression analysis, and analysis of variance to examine the measurement and research model. The findings of this study uncover the factors that promote successful utilization of PM software packages and enhance the awareness of project professionals of their potential impact on their performance.

Scope of the Study

In this paper, cross-sectional and comprehensive research is conducted to measure the patterns of PM software usage in all types of industries. Measuring the value and the extent of PM software utilization in multiple industries enriches the analysis and maximizes the values of the study findings as a result of comparing responses of professionals in PM across industries. The study surveys various types of PM software packages including low-end, high-end and Web-based systems. Evaluation of a wide spectrum of PM software packages helps professionals in PM to find the right package that fits their needs and maximizes gained benefits. The scope of the study population includes project professionals that have been recruited from a Yahoo special interest group on project management and randomly selected project managers from the Project Management Institute membership. The diversity of demographics and work environment of the study participants provides detailed information regarding the effect of personal experience, skills and work setting on utilization of PM software and the assessment of its effectiveness.

The scope of the study's examined constructs includes three main dimensions: user characteristics, software characteristics, and project characteristics. User characteristics are examined by three variables: experience, training, and level of education. Software characteristics are measured through three variables: ease of use, information quality, and functionality. Project characteristics are also measured through three variables: organization size, project size, and project complexity. In addition, the extent of PM software utilization, and its impact on project managers' performance and project success are examined in this study.

Statement of Purpose

The purpose of this study is to identify the factors that affect utilization of PM software and examine the impact of its usage on project managers' performance and project success. The research questions that will be answered by this study are:

1. What are the factors that enhance the use of PM software?
2. What impact does the use of PM software have on project managers' performance and project success?

This study will examine the relationships between the characteristics of the project, software, and user on one hand and the extent of PM software utilization on the other. It will also examine the relationship between utilization of PM software and project managers' performance. Furthermore, the study will construct a new measurement for PM software effectiveness, and extend the previous research in PM software and information technology utilization studies.

Literature review

Project Management Software

The penetration of information technologies into project management is more profound and intense than one might imagine. It has a deep history, strong present, and promising future.

It is manifested in the proliferation of project management software packages and the use of other technologies and solutions such as expert systems, decision support systems, geographic information systems, the Internet and intranet, graphical and design tools, virtual reality, database, cost management systems, and risk management tools. Project-driven organizations increasingly adopt IT solutions to help them deliver high-quality products and services within a short time with fewer costs (Meredith and Mantel 2002).

Project management software tools are based on network analysis and scheduling techniques, a schematic display of the logical relationship of project activities (McGonigle 1992) that reflect project chronology (Project Management Institute 1996). The Critical Path Method (CPM) determines the project completion time and the start and end dates for each activity. Project managers have to closely manage all activities on the critical path because a delay in any of them would delay the entire project (Meredith and Mantel 2002). PM software creates the project network and critical path automatically upon input of project activity sequences and duration. Changing the start date, end date, or duration of any activity on the critical path must be followed by recalculating and possible shifting of the critical path. Doing so is tedious, especially when the project is complex and has hundreds of activities or more, but project management software carries these changes automatically and makes project managers' jobs much easier (Nelson, Coleman and Dolliver 2000). Some project management software tools provide PERT analysis to determine the probabilities associated with project duration. This feature is helpful in answering questions about the probability of a project being completed by a specific date.

Most project management software tools have capabilities to produce a Gantt chart, a graphic display of schedule-related information that shows activity durations along with the percentage of task completion (Ward 1997). This chart helps project managers visualize project tasks so they can see at a glance the overall schedule and progress of the project. Many project management tools provide "resources leveling" that detect conflicts in assigning workers to activities and allow rescheduling them to eliminate over-allocation and inefficient usage of resources. Some project management software tools support the use of the earned value method to integrate cost and schedule control and forecasting.

PM software was initially developed in the 1960s and 1970s to run on large computers. The number of project management software packages jumped to more than 500 in year 2000, with a wide variety of prices and capabilities (Meredith and Mantel 2000). Project management tools are moving at a fast pace, from personal computers (low-end) to the server side and Web-enabled (high-end) with new collaboration and communication capabilities. The high-end tools utilize the Internet and allow organizations to manage concurrent projects in different locations with high resource and equipment allocation. Project systems are moving away from isolated islands of information (low-end software) to integrated data across projects and automated processes that allow multiple users to view and update project data remotely without time and space limitations (Lawton 2000).

The proliferation of PM software packages and the diversity in their types, capabilities and prices make selection of the appropriate software a project in itself. Therefore, a large body of PM software literature has focused on the evaluation of different types of PM software packages and comparing their strengths and weakness to help businesses and project professionals select the appropriate tools that suit their needs. The Project Management Institute (PMI®) publishes a periodic survey of PM software that lists their types and capabilities. Other buyers' guides have conducted tests and comparisons to assist in selecting the right tool (Biggs 2000, Mitchell and Dineley 2000). However, most of these tests and comparisons were limited to small numbers of packages and were subject to software selection bias. In the empirical research arena, the studies that have been undertaken to evaluate the value of PM software and examine the pattern of its usage are limited. Fox (1997) examined the effect of decision style on the use of PM software. He found that a project manager's decision style has a significant correlation with PM software usage. He also tested the effect of user satisfaction and training on the use of PM software and found that project managers seem to be satisfied with their tools and that there is a significant relationship between their level of satisfaction and level of utilization. Several other attempts have been made to study the use of PM software. However, these attempts were limited to descriptive statistics, and some focused on the technical factors and ignored the human and organizational effects (Chambers and Perrow 1997, Christopher 1989, Hegazy and El-Zamzamy 1998, Pollack-Johnson 1998).

Theories of Information Systems Use

Systems utilization is the ultimate goal of a series of financial and economic marketing analyses that have traditionally been conducted by organizations during the process of implementing a new information system. Therefore, system usage has been identified as a proxy of an information system's success, and low usage of installed systems has been identified as a major factor underlying a lack of return from organizational investments in information technologies (Sichel 1997, Venkatesh and Davis 2000). However, usage will not occur unless the users' perspectives have been taken into account, and usage will not continue unless the users are satisfied with the system's performance (Gallion 2000).

The relationship between information technology and individual performance has been an ongoing concern in Information Systems (IS) research (Goodhue and Thompson 1995). Organizations spend large sums of their annual budgets on developing and implementing information technologies (IT) and on training their employees to use them in order to enhance their effectiveness and productivity. However, there is wide concern about a lack of a positive impact of information technology on employees' performance (Zhang 1998).

The main stream of research that has focused on the information systems use can be classified into three subgroups: IT adoption and diffusion, technology acceptance, and user satisfaction. Information technology adoption studies are based on Innovation and Diffusion Theory. Rogers (1995) is a distinguished researcher in this area of research. He defined five variables that have positive relationships with IT adoption. These variables are: relative advantages, compatibility, complexity, trialability, and observability. He finds that these five variables explain 49 to 87 percent of the variation in the rate of information technology adoption.

Davis' (1989) Technology Acceptance Model (TAM), which is based on the Theory of Reasoned Action, has been widely accepted and applied because it is easy to understand and apply. A large number of studies have supported it over a long period of time and through a wide variety of applications (Lucas and Spitler 1999). Ease of use and usefulness are the major constructs in TAM to measure user intention toward the use of technology. These two constructs persist over a wide variety of studies as powerful measures of user attitude toward using IT (Lucas and Spitler 1999, Venkatesh and Davis 2000). Researchers, including Davis himself, recognize other important constructs that have been left out of TAM. Taylor and Todd (1995) incorporate the Theory of Planned Behavior into TAM by adding the following variables: (1) system compatibility with the user work, (2) social influence (peer influence and supervisor influence), (3) user efficiency in operating the system, (4) technical compatibility with other systems or hardware, (5) resource availability, and (6) personal attitude toward the technology (attitude, control, intention) which enhance the power of predicting user intention toward IT usage.

The concept of user satisfaction has played an increasingly important role in MIS research and has been used to measure information systems success (Gelderman 1998). These types of studies measure the subjective level of user satisfaction with a technology, which is generally measured by systems characteristics and other factors such as organizational support. Gallion (2000) and Igbaria, Pavri and Huff (1989) found that user satisfaction has a significant positive relationship with systems usage. Doll and Turkzadeh (1988) developed a popular model to measure computing satisfaction instrument based on analysis of factors found in previous studies. The model has five variables that affect user satisfaction of IT: content, accuracy, format, ease of use, and timeliness. This model has been widely applied and found to be an accurate measure of user satisfaction (Fox 1998).

Testing whether or not IT's capabilities match work demands has been one of the major concerns for both system developers and users. The Task-Technology Fit (TTF) is a popular model that addresses this issue to help users choose those tools that have the required functions that enable users to complete their tasks with the greatest net benefit (Goodhue and Thompson 1995). TTF measures the extent to which the new system could match the work characteristics and task demands. Dishaw and Strong (1999) combine TTF and TAM and find that the combined model holds much promise for helping researchers better understand why individuals choose to use IT for particular tasks.

Theoretical Framework and Hypotheses

Figure 1 presents the research model examined in this study. The research model measures the level of project management software usage by project professionals and the impact of its use on their performance. The model posits that PM software acceptance is a function of perceived information quality, software functionality, ease of use, project complexity, project size, organization size, user training level, education level, and experience. The model also proposes that the use of the PM software has a direct and positive impact on the user's performance.

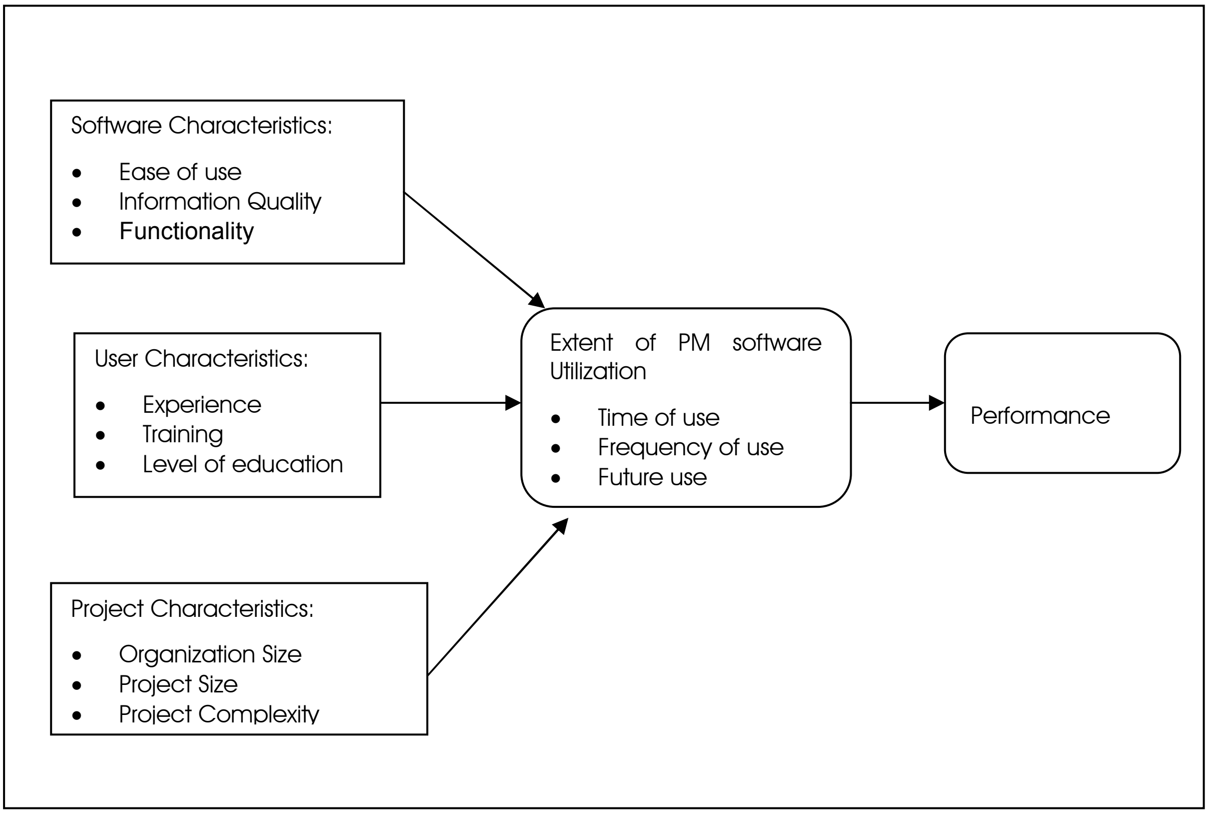

Figure 1: Research Model

The model encompasses Davis' (1985) technology acceptance model (TAM) and other selected constructs from different models as deemed appropriate for a project management setting. Constructing the model this way has two major advantages: (1) putting together a model that best fits using information systems in the project management setting, and (2) testing TAM in project management organizations, which has not been done before. The model can be expressed using the following equations:

PM Software Utilization = F (Software Characteristics, User Characteristics, Project Characteristics)

Perceived Performance = F (PM Software Utilization)

Software Characteristics

Information systems attributes have been the focal point of four main lines of studies in IS literature: information technology acceptance, user satisfaction, systems quality, and task-technology fit. Information technology acceptance studies focus on two main constructs, usefulness and ease of use, and their effects on the user's intention to use a given system (Agarwal and Prasad 1999, Davis 1985, Davis 1989, Dishaw and Strong 1999, Gallion 2000, Venkatesh and Davis 2000). End-user satisfaction studies have focused on five constructs: accuracy, content, timeliness, format, and ease of use to measure the degree of user satisfaction with a given system's performance (Doll and Turkzadeh 1988, Doll and Torkzadeh 1991, Etezadi-Amoli and Farhoomand 1996, Montazemi 1988).

Information quality studies have focused on five dimensions: tangibility, reliability, responsiveness, assurance to measure systems quality and services, and their effects on systems effectiveness and user performance (Dozier, Kitzman, Ingersoll, Holmberg and Schultz 2001, Pitt, Watson and Kavan 1995). Task-technology fit (TTF) studies have focused on technology characteristics such as quality, locatability, authorization, compatibility, reliability, ease of use, training, responsiveness, and consultation to measure the extent to which a given technology fits the task requirements and the effect of the fit on individual performance (Dishaw and Strong 1998, Dishaw and Strong 1999, Goodhue 1998, Goodhue and Thompson 1995). No one has tested these constructs in the project management setting except for Fox (1997 1998) who tested the effect of user satisfaction and training on the use of PM software. Therefore, the following research hypotheses are proposed:

H_1: *The perceived ease of use has a positive relationship with the use of PM software.*

H_2: *The perceived functionality has a positive relationship with the use of PM software.*

H_3: *The perceived information quality has a positive relationship with the use of PM software.*

Project Characteristics

The organizational context in which information systems operate has been one of the major concerns in IS literature. Franz (1986) tested the impact of organizational factors on systems development projects. He found that larger and older MIS departments are associated with lower perceived systems usefulness. In their meta-analysis, Kraemer and Dutton (1991) found that larger organizations end up having more managerial and information workers, larger MIS departments, and more sophisticated IS. Given the nature of a project as an organizational entity inside the parent organization, it is possible that the size of the parent organization and the size of the project will be related to the adoption and use of project management software. However, the pattern of adoption of PM software differs from high-end to low-end packages. The high-end packages have more capabilities and cost more than the low-end tools. Hence the following research hypotheses are proposed:

H_4: *Organization size is positively related to the use of PM software.*

H_5: *Project size is positively related to the use of PM software.*

H_6: *Project complexity is positively related to the use of PM software*

User Characteristics

Evaluation of the impact of the human side on the use of information technology has been an ongoing research question in MIS literature (Szewczak and Snodgrass 2002). In the context of PM software utilization, Fox (1997) recognized the importance of this factor by examining the impact of the level of project manager training on the use of PM software. He found that training is significantly associated with the level of PM software utilization. In this research, the level of a project manager's experience, education and training level were examined to measure their impact on the extent of PM software utilization. Hence the following research hypotheses are proposed:

H_7: Level of project manager training has a positive relationship with PM software usage.

H_8: Level of project manager experience has a positive relationship with PM software usage.

H_9: Level of project manager education has a positive relationship with PM software usage.

Performance Impact

Since its inception in the work place, the computer has been considered a valuable tool for improving the productivity of businesses and employees. Therefore, studying the impact of IT on individual performance has become an important factor in determining the value of information systems. DeLone and McLean (1992) emphasized that the main purpose of IT effectiveness studies is to define IT success and demonstrate that IT does make a difference in the work place. Understanding the performance impact of IT provides a means for practitioners and researchers to measure the impact of millions of dollars spent by organizations to develop and implement information technologies and train their employees to use them (Brynjolfsson 1993).

Due to the difficulty of developing objective measures for Information Systems success, many IS researchers rely on user evaluation of systems' effectiveness as a surrogate measure for IS success. User evaluation refers to the assessment made by computer users of certain qualities of information systems and their impact on performance. According to Goodhue (1995), it seems reasonable that if users give a system "high marks," it must be improving their performance. Linking systems use to end-user performance has been tested in several studies, (e.g. Etezadi-Amoli and Farhoomand 1996, Gelderman 1998, Lucas and Spitler 1999) which exhibit mixed results. Therefore, the following research hypothesis is proposed.

H_{10}: The use of PM software has a positive relationship with project manager performance.

Operationalization of Research Constructs

The definitions and measurements of this study's variables—utilization, performance, ease of use, information quality, functionality, and project complexity—were based on the existing literatures plus new measurements that were developed especially for this study. PM software utilization was defined as the extent to which project managers use PM software to perform their work. Based on several studies, this research includes three indicators of utilization: time of use, frequency of use, and intention to use the software in the next 12 months (Compeau, Higgins and Huff 1999, Igbaria, Zinatelli, Cragg and Cavaye 1997, Kim, Suh and Lee 1998, Pollack-Johnson 1998, Venkatesh and Davis 2000). Usage time refers to the number of hours that a project manager spends using project management software on a daily basis. Frequency of use refers to the number of times that project managers believe they use the software over a period of time. Future use refers to the project managers' intention to use the software in the next 12 months. Performance impact measures the extent to which project professionals believe that PM software enhances performance and increases project success rate. Goodhue and Thompson (1995) use two items to measure performance impact of IT which are: "1.The company computer environment has a large, positive impact on my effectiveness and productivity in my job. 2. Computer systems and services are an important and valuable aid to me in the performance of my job." (p. 236).

However, to accurately measure the impact of information systems on performance as it relates to project management software and project managers' performance, additional items need to be developed to reflect the special nature of the project management field. To accomplish this goal, the authors added additional questions that are carefully identified and acquired from project management software literature (Alvich-LoPinto 1991, Beckert 1992, Berenson, Levine and Goldstein 1983, Caron 1991, D'Ercole 1995, Feldman 1997, Levine 1991, Steinbrecher 1987, Templeton 1990, Vacca 1991, Wheatley 1992). The new measure for PM software performance reflects the impact of the software on identified areas of project management body of knowledge and project management processes such as project scheduling, control, cost management, risk management, information sharing, and overall project success (Project Management Institute 2000).

The PM software functionality variable measures the extent to which project managers believe that the software they use supports all the functions and features that they need to perform their daily tasks. The items for measuring PM software functions are derived from project management software packages' evaluation literature and surveys (Bienkowski 1988, Biggs 2000, Davis and Russell 1985, Hannigan 1993, King 1986, Project Management Institute 1999).

Most project management software packages are equipped with a wide variety of graphics and tabulated representations of project information. A rich representation of project information provides immediate and easy access to critical data that can be used by top management and project managers for project planning, monitoring and control. However, lack of accuracy, consistency, currency, and reliability of this information might mislead decision makers and reduce the value of PM software. Furthermore, complex graphics or reports that are difficult to interpret and understand defeat the purpose of these tools and techniques and slow the process of project progress evaluation and decision making (Kerzner 2003, Lientz and Rea 1998, Meredith and Mantel 2002). Therefore, an information quality variable is incorporated in this study to measure the extent to which project managers believe that PM software provides the right level of information that is accurate, current, and easily understood by other project stakeholders. The measurement items for PM software output quality were based on IS and project management literature (DeLone and McLean 1992, Igbaria et al. 1997, Kriebel and Raviv 1980, Lau and Herbert 2001, Law and Gorla 1996, Timo 1996, Venkatesh and Davis 2000, Wixom and Watson 2001).

From the standpoint of users of project management software, the presence of relevant user-friendly software features is an important issue not only during the learning period but also during daily operation, especially during the data entry, progress reporting and output report generation stages (De Wit and Herroelen 1990). According to a survey conducted by the Institute of Industrial Engineers (1993), ease of use is one of the most sought-after features of project management software after functionality. Ease of use refers to the extent to which project managers believe that using project management software would be free of physical and mental effort (Davis 1985). The measurement scale for ease of use is adopted from Venkatesh and Davis (2000) with appropriate modifications to make it specifically relevant to the project management context.

Project complexity provides a basis for determining the extent of the project's difficulty and dynamics (Baccarini 1996). Several measurements for project complexity have been proposed and used by different researchers, but no single measurement has emerged as being universal for project complexity. Tatikonda (2000) measured project complexity through three different components: technology interdependence, objectives novelty, and project difficulty. However, the scale he developed is inappropriate for this study because it is limited to one industry (manufacturing), whereas the present study targets cross-sectional industries. Another scale, developed by Tatikonda (2000), measures project complexity through four dimensions: multiple outcomes, multiple paths, conflict among alternatives, and uncertainty in decision making. However, the psychometric analysis of the measurement items that was conducted by the author revealed low reliability scores. Therefore, a new measure was developed to measure project complexity in this study which consists of two items. The first item measures the extent to which a project manager deals with new and complex technologies, and the second item measures the overall project complexity.

Results

Survey Pretest and Data Gathering

Since the scales of some key variables of this study are new or combined from different sources and have never been tested in a project management context before, a pretest of the research instrument was performed to check its validity and reliability. The instrument validation procedures started with subject-matter experts in order to check for the items' clarity and readability (i.e., face validity). A total of sixteen experts, mainly professors and doctoral students in a project management program plus some identified professionals from the project management field, were asked to provide comments and suggestions on the clarity, readability, and appropriateness of the questionnaire's items.

Based on the analysis of the instrument face validity data, new items were added, other items were removed, and some other items were reworded. The final instrument was then constructed using a 7-point Likert scale with strongly disagree and strongly agree as the two endpoints. A web-based survey was used as a primary data collection instrument. The design of the survey and communications with the study's sample were carefully thought out to ensure a higher response rate and representative participants. The survey website had a main page that contained a brief description of the study and links to the study's survey, contact information, privacy policy, and research team personal information.

The data was collected using two independent samples. The first sample was recruited from project professionals who subscribed to Yahoo Project Management Specific Interest Group and Planning Planet Virtual Group. 162 project professionals participated in the study with 151 usable responses. The second sample was recruited from the Project Management Institute (PMI®), a non-profit professional association that has been in existence since 1969 and devoted to project management development and advancement. 2,000 project managers were randomly selected from PMI®'s membership list and were invited to participate in the study. 358 responses were received from this sample with 346 usable responses. The response rate was about 21% after subtracting 15% of the sample size to account for the lost, returned and inaccurate mailing addresses.

Two tailed t-tests of independent samples were performed to determine whether there was a significant statistical difference between the subjects who were recruited from the Internet and those who were recruited from PMI®'s Membership list. The tests revealed that there is no significant difference between the two independent samples at a confidence level of 95%. Therefore, the responses from the two samples were combined to increase the statistical power and enrich the analysis. A total of 497 valid responses were used in the data analysis of this study.

Descriptive Statistics of Participants

Eighty percent of those who participated in the study are project managers, and they are well educated: more than 60% of the study participants have doctoral, master or some work at the graduate level. They also have extensive experience in the project management field: about 70% have 10 years or more of work experience in project management, about 80 % of them are certified project managers, and almost 65% of the sample have been using PM software for more than five years. While 45% of the sample interacts directly with the PM software to obtain information for their own purposes, the rest uses the software to provide information to others or have subordinates who interact with the software and provide them with the information. Most of the study sample was male (75%) and their average age was 42.

More than half of the study participants were from the information technology industry. About 30% of the respondents were from software development and about 23% work in high technology and telecommunications firms. Almost 11% of the respondents work in the government sector and about 10% work in the construction industry. 41% of the respondents classified their managerial positions as middle management, about 24% considered themselves as professional staff, and about 13% indicated that they occupy upper management level. About 40% of the study's respondents work in large companies that have 10,000 employees or more. Almost 33% of the respondents manage large projects that have a budget of more than one million dollars.

Consistent with a previous study conducted by Fox (1997), Microsoft® Project is by far the most frequently used PM tool on the market today. More than 75% of the respondents use Microsoft® Project, and about 10% use Primavera Project Management Systems. The rest use different types of software packages such as Web project management software and unconventional PM software such as Timesheet, Excel and database applications. The average time spent by the study's participations in using the software is about two hours a day. The proportion of the study's participants who believe that they will use the software extensively in their work in the next 12 months exceeds 70%.

Factor Analysis

Since most of the measurement items are new and have not been tested before, a factor analysis was conducted to examine their internal consistency and reliability. An initial factor test with Varimax rotation was performed on the 44 items that were originally developed to measure the effectiveness of PM software. Nine factors with Eigenvalues greater than one emerged form the analysis and accounted for 74% of the variation among the items. Factor loadings ranged from .411 to .906. Most loadings occurred well above .50.

In determining the appropriate minimum loadings required for inclusion of an item within a scale, we used Comrey's (1973) guidelines to retain items that loaded highly on their respective measures. Comrey developed the following scale for factor loadings evaluation:

Excellent: >= 0.71(a) (i.e., 50% overlapping variance).

Very Good: >= 0.63 (a) (i.e., 40% overlapping variance).

Good: >= 0.55 (a) (i.e., 30% overlapping variance).

Fair: >= 0.45 (a) (i.e., 20% overlapping variance).

Poor: >= 0.32 (a) (i.e. 10% overlapping variance).

Therefore, we used a .60 as the minimum acceptable factor loading in this study; however, we increased this threshold based on the evaluation of each factor independently to enhance the homogeneity among the measurement items.

The four items measure PM software utilization loaded together on one factor with loading values greater than .60, except one item which measures the number of hours spent by respondents using the software. This item had a loading of .56; project managers seem to have a hard time estimating the actual number of hours they spent using the software on a daily basis. Therefore, we decided to eliminate this item from the analysis leaving three strong items to measure the use of PM software: frequency of use, number of times of use, and future use.

Most of the items that measure performance impact of PM software loaded on one factor and had loading values greater than .60, except four items that loaded on different factors and one item that had a loading of .59. Therefore, we decided to drop these items from the analysis leaving five items that measure performance and have excellent factor loadings ranging from .75 to .80. Also, all the items that measure information quality loaded on one factor with loading values above .60 except for five items. Therefore, we decided to drop these items leaving seven items that measure information quality and have a loading value between .65 and .75 which are considered excellent factor loadings.

All the items that measure software functionality, ease of use, and project complexity loaded on their respective factors with factor loadings exceeding .60. The data show that the measures of these variables are robust in terms of their internal consistency. Therefore, we decided to keep all the measurement items for these three variables.

A second set of similar test was performed after removing the measurement items with weak loading values in an attempt to explain more variance and aid higher internal consistency among the measurement questions. The results of the second factor analysis are shown in Table 1. These results show a considerably better measurement model with a higher factor loading. The revised measurement scale contains 27 questions that measure six distinct factors, as proposed in the study research model. All the measurement items loaded highly on the hypothesized variables. Factor loadings range from a low of .65 to a high of .89. Based on Comrey's (1973) loading interpretation scale, the factor loading of the research model is considered to be an excellent factor loading. In addition, a Cronbach Alpha test was performed to examine the reliability of the measurement scale. All the variables have a high reliability measurement that exceeds 70%.

Table 1. Measurement items for PM software effectiveness

Variable	Measurement Items	Loading
Use of PM Software	1. How frequently do you use PM software?	0.879
	2. How many times do you use PM Software?	0.867
	3. To what extent do you plan to use PM software within the next 12 months?	0.852
Performance Impact	1. PM software enhances my effectiveness on my job.	0.789
	2. PM software makes it easier to do my job.	0.755
	3. PM software gives me greater control over my work.	0.773
	4. PM software increases the likelihood of successful completion of my projects.	0.788
	5. PM software has a positive impact on the results of my projects.	0.809
Functionality	1. The PM software I use supplies all the features that I need for my work.	0.856
	2. The PM software I use meets my work requirements.	0.857
	3. The PM software I use supports all my daily tasks.	0.798
	4. The PM software I use matches my work demands.	0.819
	5. The PM software I use meets my expectations.	0.789
	6. The PM software I use works very well for me.	0.764
Information Quality	1. The PM software I use provides an appropriate level of details that fits my needs.	0.676
	2. The PM software I use provides output that matches what I need.	0.703
	3. The PM software I use provides output that is easy to understand.	0.716
	4. The PM software I use provides output that is easy to communicate to others.	0.688
	5. The PM software I use provides output that is relevant to my work.	0.682
	6. The PM software I use provides output that is current enough to meet my needs.	0.651
	7. The PM software I use provides output that is in an appropriate format.	0.751
Ease of Use	1. Project management software is easy to use.	0.864
	2. Project management software is easy to learn.	0.897
	3. Project management software is user friendly.	0.859
	4. Interacting with the PM software does not require a lot of mental effort.	0.831
Project Complexity	1. The projects I work on deal with new complex technologies.	0.884
	2. Overall, the projects I deal with are complex.	0.871

Testing the Research Hypotheses

The results of the regression tests and analysis of variance (ANOVA) of the research model are presented in Tables 2 and 3. Table 2 contains the results of the regression tests which include values of slope coefficients (β), levels of significance (p), and the values of the coefficient of determination (R^2), i.e., the amount of variation explained by the explanatory variable. Table 3 contains the results of ANOVA tests which include values of F-tests, levels of significance and values of the coefficient of determination. The total variation in the use of the project management software explained by the study's variables was 30% and the variation in project managers' performance explained by using the software was 18%. These results are promising and indicate that the research model is robust and well established.

Table 2. Results of simple regression tests for the interval data

Dependent Variable	**Independent Variables**	**•**	**p**	**R^2**
Use of PM Software	Perceived Information Quality	.28	< .0001*	.06
	Perceived Project Complexity	.25	< .0001*	.05
	Functionality Evaluation by User	.17	< .0001*	.04
	Perceived Ease of Use	.10	.0110*	.01
	Number of Project Team Members	0	.4785	0
	Project Duration	0	.8590	0
Perceived Performance Impact of PM Software	Use of PM Software	.35	< .0001*	.18

* p < .05, one-tail test

Table 3. Results of one-way analysis of variance for the categorical data

Dependent Variable	**Independent Variables**	**F-test**	**p**	**R^2**
Use of PM Software	Organization Size	3.81	.0023*	.03
	Project Budget	2.58	.0090*	.03
	User Software Experience	4.89	.0004*	.04
	User Education Level	1.97	. 0344*	.02
	User Training Level	1.48	.1035	.01
	User Project Management Experience	1.83	.0605	.01

* p < .05, one-tail test

Table 4 shows a summary of the test results for the research hypotheses. Out of ten proposed hypotheses, five were strongly supported, two were moderately supported, two partially supported, and one was not supported. Consistent with research hypothesis 1 (H_1), the software ease of use is positively related to the use of the PM software. For one-unit increase in the ease of use, the use of the software increases by 10%. Software functionally, consistent with H_2, also has a strong and direct relationship with the use of the software. For a one-unit increase in the system functionality, the use of the software increases by 17%. Consistent with H_3, we found that the quality of software information has a strong and positive relationship with the use of the software. In fact, it is the leading factor in estimating the level of software utilization ($\beta = 28\%$, $p < .0001$).

The data analysis confirms our proposition that the organization size is positively related to the use of the software, H_4. It is most likely that project managers who work in large firms use PM software more than those who work in small firms. Our H_5 which argues that the project size is positively related to the use of the software is partially supported. While the project budget size was positively related to the use of the software, project team size and project duration had no relationship on the use of the software. Consistent with H_6, project complexity has a strong, positive and direct relationship with the usage ($\beta = 25\%$, $p < .0001$). For every unit increase in project complexity, usage of PM software increases by 25%. Project complexity has the second leading positive relationship with using the software after information quality.

We found that user training level has no significant relationship with the use of PM software, H_7. We also found mixed results for the effects of user experience on the usage, H_8. Project management experience has no relationship with the use of PM software, but software experience has a strong and direct relationship. Education level demonstrates a moderate relationship with the use of the software, H_9.

The data confirms the importance of using PM software to the performance of project managers. Consistent with H_{10}, we found that software usage has a strong, positive relationship with users' performance ($\beta = 35\%$, $p < .0001$, $R^2 = .18$). Using the software explains 18% of the variation in the performance. For each unit increase in the use of PM software, the performance of the user increases by a 35% unit. This result empirically confirms for the first time that project management software does make a difference in the performance of project managers. It helps them to be more efficient and effective in their work, perform their work easier and faster, practice higher control over their projects, and achieve project success. The impact of using the software on performance can be calculated using the following regression equation:

Performance = 3.88 + 0.35 * Use of PM Software + •.

Table 4. Summary of test results for the research hypotheses

Hypothesis	**Test Result**	**p-Value**
H_1: The perceived ease of use has a positive relationship with the use of PM software.	Strongly Supported	0.0001
H_2: The perceived functionality has a positive relationship with the use of PM software.	Strongly Supported	0.0001
H_3: The perceived information quality has a positive relationship with the use of PM software	Strongly Supported	0.0001
H_4: Organization size has a positive relationship with the use of PM software.	Moderately Supported	0.0023
H_5: Project size has a positive relationship with the use of PM software.	Partially Supported	0.0090
H_6: Project complexity has a positive relationship with the use of PM software.	Strongly Supported	0.0001
H_7: Level of project manager training has a positive relationship with PM software usage.	Not Supported	0.1035
H_8: Level of project manager experience has a positive relationship with PM software usage.	Partially Supported	0.0004
H_9: Level of project manager education has a positive relationship with PM software usage.	Moderately Supported	0.0344
H_{10}: The use of PM software has a positive relationship with project manager performance	Strongly Supported	.0001

To sum up, the tests of the regression and analysis of variance models show that the system characteristics are the dominant factors affecting the extent of PM software usage. Information quality, system functionality, and ease of use have strong, positive, and direct relationships with using the software. However, information quality demonstrates higher explanatory power than the other two factors. In fact, when we used all three factors in one multiple regression test, the effects of information quality moderated the effects of ease of use and functionality. The data also demonstrates that organization contextual factors have positive effects on the use of the software. Project complexity, organization size and project budget size have significant relationships with PM software usage. Project complexity, by far, is the dominant factor affecting system usage followed by the organization size followed by project budget size. Finally, user characteristics also demonstrate moderate effects on the use of PM software. User education level and software experience have a significant relationship with software usage. However, training level and project management experience have no significant relationship with the use of PM software.

Discussion, Limitations, and Directions for Future Research

This study integrated the theoretical perspectives, proposed and tested empirically a research model that examined the role of systems characteristics, project characteristics, and user characteristics in promoting acceptance of PM software. TAM and other relevant research models were integrated and expanded by using organizational factors and work contextual variables. Information systems effectiveness research was also extended to a project management context, whereas most of the previous studies were tested in functional firms or through college students. The results indicate strong support for the proposed research hypotheses and provide interesting insights into the factors that affect the use of PM software. The results demonstrate the influence of software functionality, ease of use, information quality, organization size, user experience, education, and project complexity on the use of PM software by project professionals. Individuals are more likely to use the PM software if they believe that it is easy to use and provides them with high information quality and features that are required for their work.

The effect of information quality has the greatest total effect on the usage of the PM software. This may suggest that project professionals are driven to accept project management tools primarily on the basis of the quality of the software outputs. They are more likely to use the software that provides them with an appropriate level of details that fits their work needs, is free of complexity, and is easy to understand and communicate with the project team. The second driving factor is project complexity. Project managers tend to use the software when they deal with large and complex projects because the software helps them to cope with work difficulty and control project progress. This result suggests that users who deal with less complex projects may be discouraged from using the software because the time they invest in entering and updating the data in the software overcomes the benefits gained from utilizing the system.

Inconsistent with prior research (Igbaria et al. 1997), the effect of ease of use is lower than other proposed factors. A possible explanation is that users' level of experience with PM software may influence the relative importance of system ease of use. The respondents are a group of professionals who have a high level of technical knowledge and experience that may make ease of use less relevant to their decisions to use the software. It should be noted that our survey indicated that the majority of the respondents (65%) reported more than five years' experience using PM software which may make the level of user friendliness less significant in using the system.

Consistent with our proposed research hypothesis, organization size has a relationship with the use of PM software. This is also consistent with Choe (1996) who studied the effect of organization size on the use of information technologies in functional organizations. He found that that organization size has a positive effect on the use of information systems and user satisfaction. He indicated that large organizations have sufficient funds and technical support to implement new information technologies and train their employees to use them effectively. The same argument can be applied to project driven organizations. Additionally, this result might suggest that large organizations usually involve large and more complex projects that require the support of information technologies, resulting in increased PM software usage. This argument is supported by our finding that the size of the project, measured by the project budget, is positively related to the use of PM software.

Inconsistent with what we proposed and with previous research (Fox 1997), no significant relationship was found between training level and software usage. The only personal factor that has a significant relationship with the level of usage is experience with the software. This may suggest that training is not enough by itself to encourage project professionals to use PM software. They need to use and experience the software in order to realize its benefits in performing their tasks. Project managers with more years of experience with PM software are more likely to use the software in managing their projects than those with less experience regardless of the level of their training. It should be noted that a large proportion of the study's participants (more than 50%) reported receiving no training or minimal training of one to two courses which may not be enough to provide the user with the skills needed to use the software effectively.

Consistent with our research hypothesis H_{10}, the use of the PM software has a strong positive relationship with the performance of project managers and overall project success. This research is the first study that examines the impact of information technology represented by PM software on project success. Previous research that studied PM software was limited to the factors that affect its utilization (Chambers and Perrow 1997, Fox 1997, Pollack-Johnson

1998). Additionally, the research that studied project success factors did not evaluate the role of PM software in achieving project success. For example, a famous research study conducted by Pinto and Slevin (1987) examined different critical factors for project success such as project mission, top management support, project schedule and plan, client consultation, leadership and other factors but did not examine how IT could contribute to project success. A more recent research study by Cooke-Davies (2002) clarified the difference among the factors critical to project management success, factors critical to success on an individual project, and factors that lead to consistently successful projects. The study identified 12 factors including risk management, documentation of organizational responsibilities, project or stage duration reduction, scope change control, benefits delivery, portfolio and program management practices, learning from experience, and other factors but did not examine how IT could contribute to project success. Our study bridges this gap by improving our understanding of the role of PM software in enhancing project professionals' effectiveness and how the software assists them to achieve project success.

Although this study provides interesting insights into the factors affecting acceptance and use of PM software in the project management field, the results must be interpreted cautiously. First, the model variables explained a total of 40.52% of the variation in PM software acceptance. The fact that 59.48% of the variation is unexplained suggests the need for additional research incorporating potential variables that were not measured in the current study. Important among these are organization and top management support, user involvement in selection and implementation of the software, computer self-efficacy, and relevant behavioral issues. Cooke-Davies (2002) suggested that since people perform every process and are ultimately responsible for its adequacy, the people side of the success factors is woven into the fabric of the process success factors. Second, although the results of the regression and ANOVA tests support many of our hypotheses, the use of self-reporting scales to measure the study's key variables suggests the possibility that common method variance may account for some of the results obtained (Igbaria et al. 1997). We believe that the results of validity and reliability tests carried out in this study for the data collection instrument have eliminated this type of threat to a large extent, but some authors in similar studies have argued that using hard data such as system logs and financial statements would provide more accurate results. Third, while the findings of this study apply only to project managers in several industries such as construction, software development, high technology and communications, health care, and finance, the generalizability of the findings of this study to other sectors remains to be determined. Finally, a longitudinal research design is recommended to confirm the causal effect among the study variables before complete acceptance of the study's findings. It is also recommended to combine qualitative data such as interviews and open-ended questions to senior experts with the quantitative data to gain more insight and enrich the analysis.

Practical Implications

The findings of this study have a number of implications for research and practice. The results added PM software to project success factors by confirming that PM software has a strong positive relationship with enhancing project professionals' effectiveness, making it easier for them to do their jobs, giving them greater control over their work, increasing the likelihood of successful completion of their projects and providing a positive impact on the results of their projects. The results should encourage project professionals to learn about PM software packages, use them in managing projects and stick with them faithfully throughout the project. The results should also encourage project-driven organizations to implement PM software, train their employees to use them, and provide them with the support they need to ensure better utilization. It has been observed that large organizations have been taking advantage of PM software more than the small ones thereby sending alarm signals to smaller organizations to catch up and reap the advantages of IT to enhance the opportunity of success of their projects, increase the chance of achieving higher productivity, and potential to expand their businesses.

For software developers and funding providers, the study highlights the importance of information quality as the most important factor related to motivating project professionals to use PM software. Users are looking for software that provides them with the appropriate level of detail that is easy to understand and communicate to the project team and matches their work requirements. They are more interested in the software that provides them with output that is relevant to their work, current enough to meet their needs and formatted in an appropriate manner that is free of complexity and errors. Another important factor in determining the acceptance of PM software by project managers is the functionalities and the features that are supported by the tool. They are more willing to use the software that provides them with a full spectrum of features and functions that are relevant to their work. They are looking for the software that allows them to communicate and collaborate with their team members and provides them with the necessary features to plan and control their projects. User friendliness is also an issue for project mangers, but it is not as important as the information quality and functionality. They are more willing to cope with some difficulties if the system provides them with important needed information for their jobs. All these findings provide guidance for software developers for a better understanding of users' requirements to develop more successful software that will be accepted by the end-users.

For senior management and decision makers, education and training programs should aim to increase awareness of potential applications and emphasize the benefits of using PM software. Experience has a positive, direct relationship with use of the software, as well as an indirect relationship with realizing its usefulness and positive impact on performance. Internal experience that helps employees to apply the software as they conduct their work might be particularly useful. A possible strategy could involve consultants as part-time external project IT officers to provide guidance and support on how to apply the tool throughout the project's life cycle. Project-driven organizations should encourage project managers to use PM software especially in managing large and more complex projects. The project's complexity factor has a strong positive relationship with the use of the software. Therefore, we recommend making using PM software mandatory in large projects and making the ability to use the software effectively one of the qualifications for selection of the project managers, where appropriate.

Attention has been devoted in project management literature to the comparison and evaluation of different PM software packages to help organizations select the most appropriate solution. For example, the Project Management Institute (1999) published an extensive survey that compares different software packages in six categories (scheduling, cost management, risk management, resource management, communications management, and process management) which provides a remarkable tool in consolidating information about different PM software packages that have a wide spectrum of features, complexity and prices. However, this type of survey focuses on technical factors and the data represents vendors' viewpoints. This study allows the construction of an index that can be used to measure the effectiveness of the software using four dimensions (information quality, functionality, ease of use, performance impact) to solicit users' perspectives and evaluation of the software based on the users' viewpoints. A possible technique for applying this index could be started by providing appropriate project managers, project team members and project IT officers with trial versions of different potential packages and letting them use them for a period of time. During the trial period, the participants are asked to fill out the index survey, and the effectiveness scores for each software package can be calculated.

Conclusion

This study presents significant progress toward explaining the factors affecting using information technology in the project management field. It aimed at investigating the effects of systems, personal, and work related factors on acceptance and use of PM software by project professionals. It also examined the impact of the use of PM software on performance and overall project success. It proposed an index for measuring PM software effectiveness. The findings are encouraging and provide theoretical and practical insights into information systems in project-driven organizations. The study extended information effectiveness research to the project management context and found considerable support for information systems utilization theories in this field. Information quality was found to be more important than ease of use and personal factors. The results also confirmed the importance of task characteristics as a strong predictor of information technology acceptance in the project management context. Project managers who handle larger and more complex projects are more likely to use PM software and gain more advantages than those who use it in managing small projects. The study found a strong and significant relationship between using the software and project managers' performance. Inconsistent with other studies, training level was not found to be significant for using PM software. This may be due to the fact that most of the study's participants received no courses or few courses that had any effect on their level of system utilization. These findings support the call for more research that investigates the diffusion of information technologies in the project management field and how they can be used to gain competitive advantages.

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