THE IMPACT OF PLANNING AND OTHER ORGANIZATIONAL FACTORS ON THE SUCCESS OF SMALL INFORMATION TECHNOLOGY PROJECTS

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While extensive empirical research has been conducted in the past to assess the value of project management and planning on large projects and to evaluate the impact of critical success factors (CSFs) and other organizational factors, little research is available on the techniques and factors used on small IT projects, and their influence on project success. This dissertation presents a research study which tests the relationship between the type and level of project planning performed on small Information Technology (IT) projects, and the success of those projects. The research considers the influence of well-documented project critical success factors (CSFs) and other project and organizational characteristics, using empirical data from 79 projects of varying complexity in which the primary objective is to upgrade the operating system on personal computers in corporate systems and networks from Windows XP to Windows 7.

Data was collected via a self-directed on-line survey administered to participants on each of the projects in the study, as well as through analysis of project planning artifacts from each project. This research found that many of the factors that correlate to success on large projects also influence the success of small IT projects. However, it also identified several distinct differences between large and small projects that may inform project practitioners on techniques to apply during the execution of small IT projects to improve their probability of success.

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PREFACE

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1.0 INTRODUCTION

The ability to execute projects effectively has become essential to success in government and business enterprises. Researchers have conducted extensive empirical studies on the organizational factors and project management techniques that influence the success of large projects, but little research has been done to understand the factors that contribute to the success of small Information Technology (IT) projects. Little has been documented on how small IT projects are executed or which planning and project management techniques are most effective, and practitioners continue to fall short of management and customer expectations in successfully delivering quality IT products on time and within budget. A small project, for the purposes of this study, is any task that meets the definition of a project, whether or not it is formally managed as a project, and requires less than one man-year of effort to accomplish. This dissertation begins to fill that gap in knowledge.

Information technology (IT) has increasingly become a driver of overall business success (Melville, Kraemer, & Gurbaxani, 2004). Technology is advancing quickly, enterprise applications and systems are becoming more complex, integrated, and essential to routine business processes, IT budgets are expanding, and IT organizations are seeking ways to optimize the value of their services to the enterprise (Mithas, Tafti, Bardhan, & Mein Goh, 2012). However, research has shown that a high percentage of IT projects continue to exceed their budgets, are completed late, or the delivered products do not meet the needs of their stakeholders (Ewusi-Mensah, 1997; Hartman & Ashrafi, 2002; Mahaney & Lederer, 2006; Shore, 2005; Standing, Guilfoyle, Lin, & Love, 2006). Project management emerged as a formal discipline in the 1950's, and has been considered an essential business practice at most firms since the 1970's (Cleland & Ireland, 2006; Lenfle & Loch, 2010). Studies have shown that improvements in project management produce intangible value to the organization, but tangible measures of success have been more elusive (Thomas & Mullaly, 2008).

In this environment where organizations are striving to improve their IT project effectiveness, recent increases in the level of cybersecurity risk have further complicated that objective (Chen, Kataria, & Krishnan, 2011). Computer systems are subject to increasingly frequent and disruptive security threats. Attacks like Code Red, SQL Slammer, Sasser, and Conflicker, have cost businesses billions of dollars, and security vulnerabilities and attacks on those vulnerabilities continue to rise (August & Tunca, 2011), Businesses and other organizations are imposing stricter requirements on system owners to implement security protections to combat these threats (Bojanc & Jerman-Blažič, 2008). System security requirements include: regular upgrade of computer operating systems, installation of anti-virus software and routine signature updates, implementation of firewall isolation, implementation of complex password requirement controls, appropriate levels of encryption, selection and implementation of appropriate network security settings, and routine upgrade of software versions and installation of operational and security patches developed to address emerging security vulnerabilities. Organizations do not have sufficient IT and security staff to address all new security mandates on their existing computer systems (Bojanc & Jerman-Blažič, 2008), and therefore have to accept some level of risk using cost risk analyses. New methods and techniques are needed to better and more efficiently monitor and maintain systems in compliance with these new mandates.

Companies are expending billions of dollars each year on information technology projects to maintain their computing infrastructure (Luftman & Zadeh, 2011), expand business capability, and to address emerging vulnerabilities (Bojanc & Jerman-Blažič, 2008). A high percentage of those projects are failing or falling short of their objectives, and result in significant wasted expenditures in IT budgets, lost business opportunities, and insufficiently protected computer systems (Ewusi-Mensah, 1997; Hartman & Ashrafi, 2002; Mahaney & Lederer, 2006; Shore, 2005; Standing et al., 2006).

Researchers have identified a wide range of project management Critical Success Factors (CSFs) found to contribute to the overall success of project execution (Fortune & White, 2006; Pinto & Slevin, 1987). Critical success factors (CSFs), such as the clear definition of the project mission, high-level management support, and effective communication, have been consistently identified as important to the success of a wide range of projects. Development of good project plans and the control of projects though the update of those plans has been cited as one of the most important CSFs to project success. Various techniques are emerging that challenge traditional up-front, or waterfall planning techniques, in favor of more flexible planning techniques such as Agile project management, Extreme Programming, etc. Project management researchers are still striving to provide a clear model of planning that will inform decisions on the appropriate types and amount of planning that will deliver optimal project performance.

1.1 FOCUS OF STUDY

This study assesses the type and level of planning, the use of CSFs and other organizational factors, and the degree of project success in 79 small IT projects that were conducted within a large engineering and scientific organization. The primary objective of each project was to upgrade PC operating systems from Windows XP to Windows 7, including the upgrade of hardware, software, network infrastructure, and the training and documentation associated with such an upgrade. These systems ranged in size from a single PC to a small number of complex networks consisting of hundreds of PCs, with various types of commercial and custom developed software, and a variety of hardware peripherals common in technical laboratories.

Data was collected from project plans developed by each of the project leaders, as well as via a self-directed online survey largely adapted from portions of previously validated survey instruments used to collect data on project CSFs, quality of planning, and a range of other variables that could influence project success. Because the focus was on small IT projects, projects requiring more than one man-year of effort were excluded from the sample.

The internal consistency of variable construct scales was examined using coefficient alpha; and data on the main variables was summarized using means, standard deviations and frequency distributions; and relationships between variables were investigated using analysis of variance, parametric and non-parametric correlation, and data visualization techniques.

1.2 RESEARCH QUESTIONS

This study in general seeks to provide answers to the following three questions:

1. **How do project teams execute small IT projects?** How do they staff and execute such projects, what project management techniques are utilized, and what organizational factors influence those projects?
2. **What factors contribute to the success of small IT projects?** What project management techniques and organizational factors influence the success of these projects?
3. **What is the appropriate type and amount of planning to optimize the success of small IT projects?** I approach this question by answering the following questions: How do project teams

plan their work; how do team members perceive the effectiveness of that planning; and what is the appropriate type and amount of planning to optimize project success?

In this research, I demonstrate that there is a statistically significant positive relationship between the level of planning on small IT projects and project success. Additionally, this research evaluated how the application of other project management CSFs affect the overall success of efforts to execute small IT projects, and how these factors might moderate the impact of planning. And lastly, this study assessed various measures of project success, and how successful execution of small IT projects delivers value to organizations.

This research found that many of the factors that correlate to success on large projects also influence the success of small IT projects. However, it also identifies several distinct differences between large and small projects that may inform project practitioners on techniques to apply during the execution of small IT projects that may improve their probability of success.

1.3 SIGNIFICANCE OF RESEARCH

This research introduces a new model that provides insight into the relationship between the level of planning and project success, and discusses the relevant factors inherent in this relationship. It explores which planning techniques are used on small IT projects, which are perceived by practitioners to be most effective, and which can actually be shown to contribute to project success. Secondly, this study fills a research gap in identifying what CSFs best support the success of small IT infrastructure projects. This research may be generalized to all small IT projects. Thirdly, this research explores how CSFs and other project conditions moderate the effect of planning on small IT project success. And finally, this research explores the various measures of project success, and provides insight into the ways that small IT infrastructure projects contribute value to the organization. Overall, this research provides new insights for IT project management practitioners in managing the complexities that result from increased security threats, and techniques for better maintaining secure computing environments within complex organizations; and provide insights that can be generalized to small IT projects.

1.4 DEFINITION OF TERMS

This section provides a list of commonly used terms throughout this document. Definitions are from the Project Management Body of Knowledge (PMBOK®) (PMI, 2013) published by the Project Management Institute (PMI) unless otherwise specified.

Budget **–** The approved cost estimate for the project, or for any work breakdown structure component, or for any schedule activity.

Communications Management Plan – A component of the project, program, or portfolio management plan that describes how, when, and by whom information about the project will be administered and disseminated.

Critical Path – The sequence of activities that represents the longest path through a project, which determines the shortest possible duration.

Critical Success Factors – Levers that project managers can pull to increase the likelihood of achieving a successful outcome for their project (Westerveld, 2003, p. 412).

Duration **–** The total number of work periods (not including holidays or other nonworking periods) required to complete the schedule activity or work breakdown structure component.

Gantt Chart – A bar chart of schedule information where activities are listed on the vertical axis, dates shown on the horizontal axis, and activity durations are shown as horizontal bars placed according to start and finish dates.

Milestone – A significant point or event in the project, program, or portfolio.

Milestone Schedule **–** A summary-level schedule that identifies the major schedule milestones.

Objective – Something toward which work is to be directed, a strategic position to be attained, a purpose to be achieved, a result to be obtained, a product to be produced, or a service to be performed.

Organizational Project Management Maturity – The level of an organization's ability to deliver the desired strategic outcomes in a predictable, controllable, and reliable manner.

Procurement Management Plan – A component of the project or program management plan that describes how a project team will acquire goods and services from outside the performing organization.

Program Evaluation and Review Technique (PERT) – A technique for estimating that applies a weighted average of optimistic, pessimistic, and most likely estimates where there is uncertainty with the individual activity.

Project **-** A temporary endeavor undertaken to create a unique product, service, or result.

Project Leader (Project Lead) – The individual assigned responsibility for the execution of a project.

Project Life Cycle **-** The series of phases a project passes through from its initiation to its closure. Below are three major types of project life cycles:

> ***Predictive Life Cycle (also known as fully plan-driven life cycle)*** **-** Life cycle in which the project scope, and the time and cost required to deliver that scope, are determined as early in the project life cycle as practically possible.
>
> ***Iterative and Incremental Life Cycle*** – Life cycle in which project phases (also called iterations) intentionally repeat one or more project activities as the project team's understanding of the product increases.
>
> ***Adaptive Life Cycle (also known as change-driven or agile methods)*** – Life cycle intended to respond to high levels of change and ongoing stakeholder involvement. Adaptive methods are also iterative and incremental, but differ in that iterations are very rapid (usually with a duration of 2 to 4 weeks) and are fixed in time and cost.

Project Management **-** The application of knowledge, skills, tools and techniques to project activities to meeting the project requirements.

Project Management Body of Knowledge – An inclusive term that describes the sum of knowledge within the profession of project management. As with other professions, such as law, medicine, and accounting, the body of knowledge rests with the practitioners and academics that apply and advance it. The complete project management body of knowledge includes proven traditional practices that are widely applied and innovative practices that are emerging in the profession. The body of knowledge includes both published and unpublished materials. This body of knowledge is constantly evolving. PMI's PMBOK® Guide identifies a subset of the project management body of knowledge that is generally recognized as good practice.

Project Management Plan – The document that describes how the project will be executed, monitored, and controlled.

Project Manager (PM) – The person assigned by the performing organization to lead the team that is responsible for achieving the project objectives.

Project Planning – The process of thinking through and making explicit the objectives, goals, and strategies necessary to bring the project through its life-cycle to a successful termination when the project's product, service, or process takes its rightful place in the execution of project owner strategies (Cleland & Ireland, 2006, p. 265).

Project Schedule – An output of a schedule model that presents linked activities with planned dates, durations, milestones, and resources.

Project Scope – The work performed to deliver a product, service, or result with the specified features and functions.

Project Scope Statement – The description of the project scope, major deliverables, assumptions, and constraints.

Project Team – A set of individuals who support the project manager in performing the work of the project to achieve its objectives.

Quality Management Plan – A component of the project or program management plan that describes how an organization's quality policies will be implemented.

Requirement – A condition or capability that is required to be present in a product, service, or result to satisfy a contract or other formally imposed specification.

Requirements Document – A description of how individual requirements meet the business need for the project.

Resource – Skilled human resources (specific disciplines either individually or in areas or teams), equipment, services, supplies, commodities, material, budgets, or funds.

Risk – An uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives.

Risk Management Plan – A component of the project, program, or portfolio management plan that describes how risk management activities will be structured and performed.

Scope – The sum of the products, services, and results to be provided as a project.

Small Project – A small project, for the purposes of this study, is any task that meets the definition of a project, whether or not it is formally managed as a project, and requires less than one man-year of effort to accomplish.

Work Breakdown Structure (WBS) – A hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables.

2.0 RELATED WORK

This section describes research in the discipline of project management that relates to and supports the hypotheses and assertions evaluated in this study. The section begins by describing projects and project management, and the current status and maturity of project management as a professional and academic discipline. Next, it describes how previous studies have defined and measured project success, then reviews literature on the elements that influence project success including critical success factors, the level of planning, project complexity, project risk, and characteristics of the organizational environment. Finally, this section reviews the relatively limited research that focuses on the management of small projects, as it relates to the factors that influence project success.

2.1 PROJECT MANAGEMENT

2.1.1 What is a Project?

A project is defined as “a temporary endeavor undertaken to create a unique product, service, or result” (PMI, 2013, p. 553). The temporary nature of a project means that it has a clear beginning and an end. A project is ended when its objectives have been met, or it is determined that the objectives will not or cannot be met, or the need for the objective no longer exists. Creation of a unique product, service, or result distinguishes a project from operations work, which is the routine, ongoing work of an organization. A unique product is unlike any other, and includes some level of uncertainty related to the final result.

Alternatively, a project is "...a complex, non-routine, one-time effort limited by time, budget, resources, and performance specifications designed to meet customer needs” (Gray & Larson, 2008). This definition considers the triple constraints on execution of a project; namely time, resources and project requirements, which must be balanced against one another in the execution of a project.

2.1.2 Project Management

Project Management is the application of knowledge, skills, tools and techniques to project activities to meeting the project requirements (PMI, 2013). The PMBOK® defines five groups of processes that are executed in the course of a project as represented in Figure 1: initiate, plan, execute, monitor and control, and close. Figure 2 identifies the ten project management knowledge areas that encompass the skills needed to execute a project, and lists the individual processes within each knowledge area organized by process group.

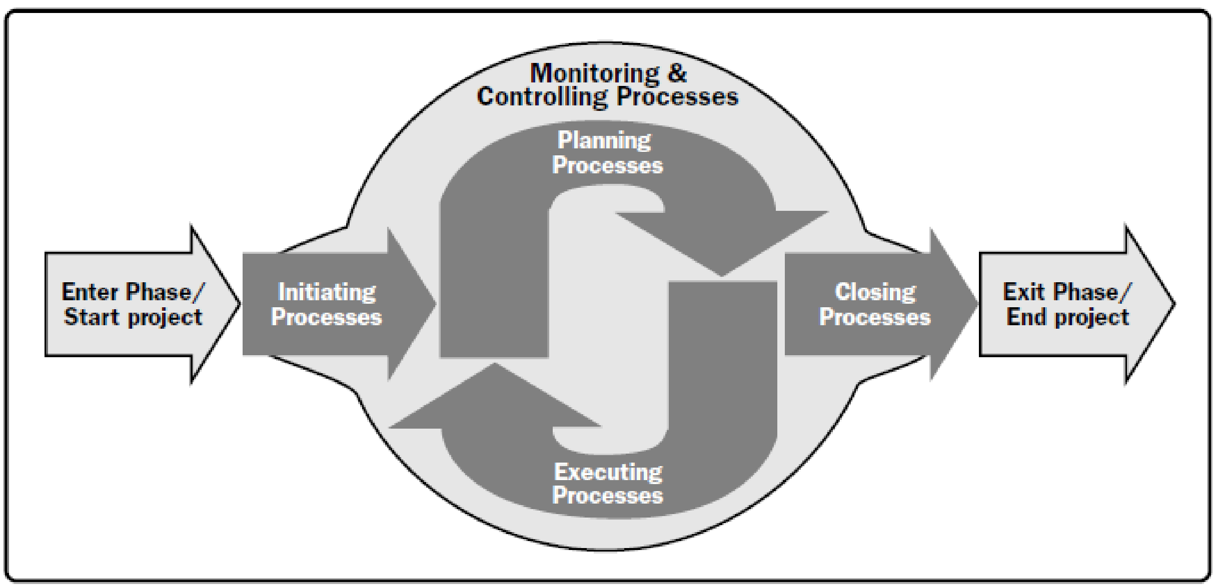


Figure 1 - Project Management Processes (PMI, 2013)

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	Planning Process Group	Executing Process Group	Monitoring and Controlling Process Group	Closing Process Group
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work	4.4 Monitor and Control Project Work 4.5 Perform Integrated Change Control	4.6 Close Project or Phase
5. Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
6. Project Time Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Resources 6.5 Estimate Activity Durations 6.6 Develop Schedule		6.7 Control Schedule	
7. Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Costs 7.3 Determine Budget		7.4 Control Costs	
8. Project Quality Management		8.1 Plan Quality Management	8.2 Perform Quality Assurance	8.3 Control Quality	
9. Project Human Resource Management		9.1 Plan Human Resource Management	9.2 Acquire Project Team 9.3 Develop Project Team 9.4 Manage Project Team		
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Control Communications	
11. Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses		11.6 Control Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	12.4 Close Procurements
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Management	13.3 Manage Stakeholder Engagement	13.4 Control Stakeholder Engagement	

Figure 2 - Project Management Processes vs. Knowledge Areas (PMI, 2013)

2.1.3 The Emergence of Project Management

"Change in a positive sense is caused by the application of management action that results in the consumption of resources to create a desired product, service, or organizational process. … Project management, in whatever form, has been used for centuries to plan for, implement, and meet change" (Cleland & Ireland, 2006, p. 3). Projects have been conducted for thousands of years and consist of endeavors including construction of the great pyramids of Egypt (circa 2700 to 2500 B.C.), the giant cathedrals of Europe (1050 to date), and the Panama Canal (1870 to 1914), to name a few. Project management was first formally recognized as a discipline within general management in the 1950's (Cleland & Ireland, 2006; Fondahl, 1987). The concepts behind many modern-day project management methodologies developed their roots in the Manhattan project and the Polaris Missile project (Lenfle & Loch, 2010).

Project management emerged as a practice from engineering and construction, the defense industry, and more recently the rapid emergence of information technology (IT) in the 1980s (Kwak & Anbari, 2009). The use of formal project management has continued to grow. A partial longitudinal study conducted by Fortune, White, Jugdev, and Walker (2011) reports a significant increase in 2011 from 2002 in the use of project management methodologies and tools among project management professionals. Fortune magazine called project management the profession of the 21st century (Stewart, 1995).

As organizations have become more aware of the importance of project management, there is a corresponding need for a systematic method of implementation and support of project management (Block & Frame, 1998). Project management has evolved from the use of tools and techniques on standalone projects to becoming an organizational capability integrated across multiple projects (Crawford, 2006b). Program Management Offices (PMOs) have been identified as a means to improve project management maturity, create a project management culture in the organization, and lead to improved project success (Crawford, 2006a; Dai & Wells, 2004; Lee, 2006).

2.1.4 Project Management as an Academic Discipline

There has been debate as to whether ''project management" is a practice or an academic discipline. Project management has been a growing area of research since the 1950's. Numerous researchers have conducted reviews of Project Management research to identify trends in the field, and opportunities for future research (Anbari, Bredillet, & Turner, 2008; Betts & Lansley, 1995; Bredillet, 2006; Crawford, Pollack, & England, 2006; Hällgren, 2012; Kloppenberg & Opfer, 2002; Themistocleous & Wearne, 2000). Kwak and Anbari (2009) conducted a review of the leading business and management journals over the last 60 years, and reported a continuous increase in project management research starting in the 1950s, with an explosion in the popularity and interest in project management research starting in the 1980s and continuing through the present. Kwak and Anbari (2009, p. 443) report that "PM is no longer merely a practice to plan, schedule, and execute projects effectively, but it is an academic field and one of the key management disciplines that consist of both practical/empirical research and theoretical research-based on solid academic theories and foundations."

Table 1 identifies the leading academic journals from business and management that regularly publish project management research. They include four major project management journals which have emerged to serve as outlets for project management research, and to consolidate the academic discipline. Project management was embraced early on by the construction industry, so significant research can be found in construction management related journals. Additionally, many business and management journals present project management research or research in closely related fields. Sixteen of the 40 business and management journals that make up the FT40, a listing of leading journals used to evaluate the ranking of business schools, were found to contain project management research articles or articles from related fields, and include journals published by the Academy of Management, INFORMS, practitioner journals from the leading business schools, a journal of the IEEE, and other leading business and management journals (Kwak & Anbari, 2009).

Table 1. Leading Academic Journals from Business and Management that Regularly Publish Project Management Research (Kwak & Anbari, 2009)

Journal	
Project Management Journals	INFORMS Journals
International Journal of Project Management (IJPM)	Operations Research (OR)
Project Management Journal (PMJ)	Management Science (MS)
International Journal of Managing Projects in Business	Organization Science (OS)
International Journal of Project Organization and Management	Information Systems Research (ISR)
Construction Management Journals	Interfaces (INTFCS)
Journal of Construction Engineering and Management	Business and Management Practitioner Journals
Journal of Management in Engineering	Harvard Business Review (HBR)
Construction Management and Economics	California Management Review (CMR)
Technology Management related Journals	Sloan Management Review (SMR)
Technovation	Long Range Planning (LRP)
R&D Management	IEEE Transactions of Engineering Management
Research Policy	Other FT40 Journals
Academy of Management Journals	Journal of Operations Management (JOM)
Academy of Management Perspectives/Executives (AMP)	MIS Quarterly (MISQ)
Academy of Management Journal (AMJ)	Strategic Management Journal (SMJ)
Academy of Management Review (AMR)	

Neither a unified field of project management research nor a unified theory of project management exists today. Project research is therefore in a pre-paradigmatic state (Bredillet, 2010). Attempts to provide overviews to continue the framing of project management as an academic field for study have described it as having different schools. Anbari et al. (2008) conducted an extensive review of academic research literature on project management and organized the literature into nine major schools of thought on the basis of the key premise that drives each one: optimization, modeling, governance, behavior, success, decision, process, marketing, and contingency schools of thought. They pointed out the overlap in research in project management schools of thought and their inevitable interactions.

Hällgren (2012) conducted a review of 61 recent project management papers from the four major project management journals. His findings show that in general the research questions asked identify gaps and extend literature rather than challenge the theoretical assumptions of project management. It is argued that the dominance of "gap spotting" hampers the development of the project field by producing theories that do not challenge long-held, sometimes possibly false, assumptions. Hällgren (2012) challenged researchers to become bolder in their claims and offered suggestions on how to proceed.

According to Kwak and Anbari (2009), Strategic Management, Technology and Innovation, Information Technology/Information Systems, and Performance Management are the four disciplines that show large increases in occurrences in publications. Interest in performance management spiked more than 100% in the 2000s. However, in terms of overall research interest the proportion was very small (7%). This could be interpreted as researchers are beginning to realize the benefits of applying and implementing project management concepts and techniques that measure project progress objectively by combining measurements of technical performance, schedule performance, and cost performance. My research focuses on performance management as it relates to IT projects, two of the emerging areas in the field of project management.

2.1.5 Project Management Standards and Best Practices

Although project management practices and principles are widely researched as an academic discipline, much of the writing and study of project management is performed by practitioners and business consultants. Therefore, many of the primary sources of guidance on project management knowledge and practices exist in the form of textbooks (Cleland & Ireland, 2006; Kerzner, 2013) and professional standards (PMI, 2013).

Several professional organizations exist to advance the profession of project management. The leading such organization in the United States is the Project Management Institute (PMI). Alternatively, the International Project Management Association represents national project management associations throughout Europe and Asia.

PMI publishes and periodically updates the Project Management Body of Knowledge (PMBOK®) (PMI, 2013). The PMBOK® defines project management related concepts and provides guidelines and best practices for managing individual projects. The PMBOK® further publishes the generally recognized standard for project management, which describes the established norms, methods, processes, and practices, as developed and evolved over time by practitioners, and considered to be good practices for most projects most of the time. Good practice means that there is general agreement that the tools, skills, processes, techniques and application of knowledge presented can significantly improve project success. It does not imply that this knowledge can be uniformly applied to all projects; the organization and project team must determine which techniques are appropriate for each given situation using this guidance. **P**rojects **IN** **C**ontrolled **E**nvironments version 2 (PRINCE2) is a widely accepted project management standard, used largely in Europe (Pérez-Ezcurdia & Marcelino-Sádeba, 2012).

Besner and Hobbs (2013) identify three limitations of the project management bodies of knowledge, stating that (1) they lack empirical foundation, (2) they are inventories of best or frequently used practices but don't provide a lot of guidance on the relative importance of individual practices, and (3) they indicate that the practice should be adapted to the specific conditions of the project, but do not provide a lot of guidance on how to match the practice with those conditions to optimize project performance. Their research seeks to identify which project management techniques should be applied in various contexts, and I discuss their findings in several areas of this document.

2.1.6 Information Technology (IT) Projects

Information Technology (IT) projects provide unique challenges to project managers. The success achieved and techniques employed differ from other projects as discussed in this section.

2.1.6.1 Performance of Information Technology (IT) Projects

IT projects, like research and development projects, are typically more complex and less predictable than other types of projects such as construction and engineering (Ewusi-Mensah, 1997; Kapur, 1999; Rodriguez-Repiso, Setchi, & Salmeron, 2007), and therefore have greater risk of failure.

Numerous studies in recent years have addressed the issue of IT projects being over budget, behind schedule, and not meeting stakeholder expectations (Ewusi-Mensah, 1997; Hartman & Ashrafi, 2002; Mahaney & Lederer, 2006; Shore, 2005; Standing et al., 2006). The CHAOS Reports have been published every year since 1994, and present a snapshot of the state of the software development industry. In these reports, the Standish Group has consistently reported that IT projects generally do not meet one or more of their cost (budget), time (schedule), or scope requirements (Standish Group, 2008). The CHAOS study from 2015 (Standish Group, 2015) indicated that 29% of projects are successful, 19% of projects failed, and the remaining 52% were considered challenged; see Table 2. The failure rate of information systems (IS) development and implementation projects has not changed much in the last thirty years (Cecez-Kecmanovic, Kautz, & Abrahall, 2014), with failure rates around 70 percent (Doherty, Ashurst, & Peppard, 2011).

Table 2 - Standish Group CHAOS Report Findings 2015 (Standish Group, 2015)

	2011	**2012**	**2013**	**2014**	**2015**
Successful	29%	27%	31%	28%	29%
Challenged	49%	56%	50%	55%	52%
Failed	22%	17%	19%	17%	19%

In a study of project schedule estimation techniques, Nelson and Morris (2014) established IT project success as shown in Table 3, indicating that 61% of projects were completed late, and 40% over budget.

Table 3 - Project Success Criteria of IT Projects (Nelson & Morris, 2014)

Measure of Success	Percent Responding "Yes"
On Schedule	39%
Within Budget	60%
Acceptable quality and met other product-related specifications, including requirements, usability, ease of use, modifiability and maintainability	90%
Product used by its target constituents	94%
Increased stakeholder knowledge and prepared the organization for future challenges	87%
Improved efficiency and/or effectiveness	89%
Stakeholders were satisfied with the project	91%

One study predicted U.S. IT spending of $572 billion in 2008 and $606 billion in 2009 (Murphy & Kolbasuk McGee, 2008). Considering the poor performance on IT projects discussed in the studies above, coupled with the substantial investments in information technology, US industry would stand to benefit significantly through improved project performance.

Managers utilize various tools to aid in making decisions that will optimize the performance of an organization. Modern firms have become very complex, and changing one element of the enterprise will have cascading and unpredictable impact on other aspects of the business. Project management standards, and project management offices, have been established and are widely employed with varying degrees of success to individual firms (Thomas & Mullaly, 2008). Effective implementation of Information Technology within any business enterprise can have dramatic effect on the productivity and profitability of the firm. Firms are therefore seeking to optimize the performance of their IT operations (Melville et al., 2004).

2.1.6.2 Methods of Executing Information Technology (IT) Projects

Besner and Hobbs (2012) conducted a study to identify and group project management tools and techniques, and to identify how usage of tools and techniques differ across project types. They identified 19 different groups of project management tools and techniques in general use, and identified variances in their use across projects of the following types: business and financial services, engineering and construction, telecommunications and information technology (IT), and software development. The researchers found that IT projects utilize the following techniques more frequently than other categories of projects: initial planning, project ending, basic project management software functionality, business case definition, baseline change management, risk management, and team management. They assessed that because IT projects carry more uncertainty than projects such as those in the construction industry, that business case identification, initial planning, and baseline change management were more essential techniques in managing the anticipated change in an IT project as requirements and specifications evolve and change over the course of the project. Because of this uncertainty, IT projects rely more on communicating and organizing, necessitating the need for more team management and risk management.

2.2 PROJECT SUCCESS

2.2.1 The Evolving Understanding of Project Success

The definition and measurement of project success has been prominent in the research literature for the last 30 years (McLeod, Doolin, & MacDonell, 2012). Pinto and Slevin (1988) clarified project success to support their research in evaluating critical success factors, and Ika (2009) prepared a comprehensive review of project success measurement based on recent literature. Our understanding of project success has continued to evolve and mature over that time (Jugdev & Muller, 2005) as researchers continue to investigate the variety, complexity and ambiguity of project success measures.

2.2.2 Measuring the Degree of Project Success

2.2.2.1 The Iron Triangle

Project success is traditionally defined in terms of meeting the triple constraint of project scope, cost, and time (Schwalbe, 2010), often called the “Iron Triangle” or “Golden Triangle” of project management. Achieving the scope of a project means that the completed product achieves the functionality and performance criteria required by the end users, and defined at the beginning of the project, and as modified during the execution of the project. A project ideally should be completed within the specified budget for the project, and achieve both interim milestones and the final project completion date

(Williams, 2002). In some projects, such as the Year 2000 (Millennium) project, and Windows 7 upgrade projects as studied in my research, completing the project on time assumed primary importance because of the significant problems that would have arisen as a result of not meeting clear deadlines. However, even in these projects, schedule could not be emphasized to the absolute exclusion of project cost or scope.

The Project Management Institute (PMI) Project Management Body of Knowledge (PMBOK®) (PMI, 2013, p. 35) states “since projects are temporary in nature, the success of the project should be measured in terms of completing the project within the constraints of scope, time, cost, quality, resources, and risk as approved among project managers and senior management.”

2.2.2.2 The Iron Triangle Expanded

Although there is nearly universal agreement of the importance of time, budget and scope as essential elements of a project success measure, most now also agree that additional success criteria should be included, and consider project success a complex, multi-dimensional concept encompassing many more attributes. Atkinson (1999) is widely cited for challenging the convention of the “iron triangle” and identified three additional factors to be considered in the project success calculation: the technical strength of the resultant system, the benefits to the resultant organization (direct benefits) and the benefits to a wider stakeholder community (indirect benefits). These three categories could be represented as “The Square Route” to understanding project management success criteria, as presented in Figure 3.

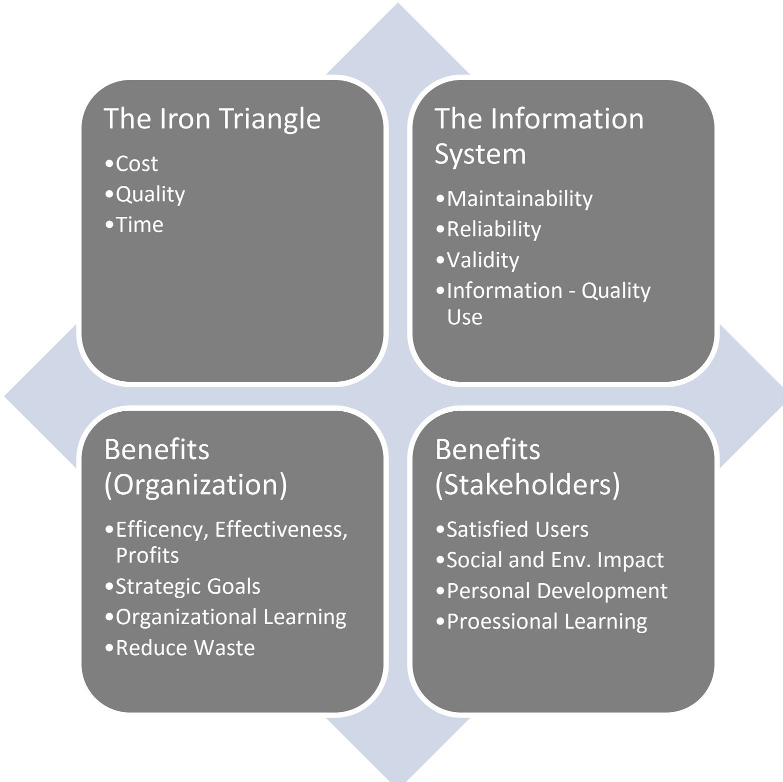


Figure 3 - The Square Route (Atkinson, 1999)

Wateridge (1995) stated that measures of IT project success should be identified by the project manager working with users early in the project. He found that the project manager will often over-emphasize project management success, driven by factors such as planning, to the exclusion of those factors favored by the end user, such as satisfaction with the final product.

2.2.2.3 Models of Efficiency vs. Effectiveness

Traditional measures of project success consider the “iron triangle” of delivering the project on schedule, within budgeted cost, and achieving the approved quality and scope (PMI, 2013). Current researchers (Jugdev & Muller, 2005) often refer to these three metrics together as project efficiency, but also consider other aspects of project success, including the degree to which project objectives and customer needs are met, and call them project effectiveness. Zwikael and Smyrk (2012) similarly distinguish between project management success (efficiency) and project ownership success (effectiveness). Information systems scholars (Rai & Al-Hindi, 2000; Robey, Smith, & Vijayasarathy, 1993) also defined IT project success in terms of process efficiency measuring cost and schedule overruns, and project effectiveness as measured by quality of outcome.

2.2.2.4 Short-Term vs. Long-Term Measures of Project Success

Doherty et al. (2011) proposed the use of benefits-based measures of project success, focusing on the long term benefits delivered by a project and its products, not just the short term measure of project success typically measured. Shenhar, Dvir, Levy, and Maltz (2001) suggested that projects are strategic and project success should be assessed considering both short-term and long-term objectives. The framework they put forth considered four elements: (1) efficiency (schedule and cost); (2) impact on customers (customer benefits from the end product, and meeting customer needs); (3) business success (impact on commercial value of the business and market share); and (4) preparing for the future (creating new technological and operational infrastructure and market opportunities).

Shenhar et al. (2001) presented three examples of projects that suffered extensive delays, cost overruns, or quality shortfalls; that over time proved to be extremely successful efforts. Construction of the Sydney Opera House took three times longer than anticipated and cost almost five times the original budget. The resulting structure however is a national treasure, and its value to the city of Sydney in tourism and prestige has more than overcome the initial project difficulties. Similarly, Microsoft suffered significant delays and required the infusion of additional staff and resources to support the completion and rollout of its first Windows operating system, but because of the success of that first product, Microsoft controls nearly 70% of the personal computer operating system market still today. Finally, prior to deployment of the popular Macintosh, Apple Computers developed the Lisa computer that was a commercial failure. Apple managers later acknowledged that the technological breakthroughs and lessons learned in developing the Lisa were essential to the success introduction of the Macintosh (Guterl, 1984).

2.2.2.5 Models that include Teamwork Effectiveness

Stefanovic and Shenhar (2007) built upon the project success framework proposed by Shenhar et al. (2001), and argued for the inclusion of teamwork effectiveness as proposed in other studies (Bryde, 2008; El-Saboni, Aouad, & Sabouni, 2009; Müller & Jugdev, 2012; Westerveld, 2003). Project team members may consider a project to be a success if they learned a new skill during execution of the project, or were able to overcome a difficult technical challenge, regardless of the overall success of the project (Linberg, 1999).

2.2.2.6 Mid-Project Measurement of Project Success

Because of the significant risk of failure of IT projects and the potentially large impact to the organization (Budzier, 2011), a number of researchers have proposed techniques to assess interim project success to allow adjustments to be made as necessary during the project. Narayanaswamy, Grover, and Henry (2013) emphasized the importance of addressing problems as they occur rather than waiting until the completion of the project. Earned value analysis techniques include the calculation of schedule and cost variance at any point during the project to determine when a project is falling behind schedule or over budget (PMI, 2013). Control-loss techniques (Narayanaswamy et al., 2013) allow the measurement of project progress along three dimensions—people, processes, and resources—and can be evaluated while the project is being executed. Control-loss measures the deviation from achieving project objectives as a result of distortion in communicating expectations. Finally, the CSFs and project success metrics measured in the Project Implementation Profile (Pinto, 1990) were developed to assess the success of the project in mid-course, and the device recommends techniques for getting the project back on track. Because data was collected following completion of all of the projects in the current study, the interim techniques proposed in the above research were not be used in this dissertation.

2.2.3 Scales for Measuring Project Success

In a study that is similar to this research in assessing the relationship between planning and project success, Zwikael, Pathak, Singh, and Ahmed (2014), measured the degree of project success using the constructs of project management success (efficiency) and project ownership success (effectiveness). They measured efficiency with a two item scale consisting of "schedule overrun" and "cost overrun", both measured from actual project records. They measured effectiveness using a scale of 1 (low) to 10 (high) with a two-item scale consisting of "project performance" and "customer satisfaction", both as assessed by the supervisors of the project managers.

Standard scales for measuring overall project success were used by Keith, Demirkan, and Goul (2013) and Tiwana and Mclean (2005). They included measures of over/under budget from actual project records, over/under schedule from project records, use of a 7-point Likert scale by the project manager to assess "overall perceived success", "this project delivers all features and functionality", "this project meets key objectives and business expectations", and "this project is overall very successful."

Aladwani (2002b) operationalized task outcomes using two measures first described by Henderson and Lee (1992). The first scale measures efficiency, and includes measures of: the amount of work produced, adherence to schedules, adherence to budgets, and overall efficiency of operations. The second scale measures the projects' effectiveness using three items related to quality of work and ability of the project to meet its goals. The study also measured psychological outcome, or team members' satisfaction, as an element of project success, using a scale borrowed from Hackman and Oldham (1980), and previously used by Igbaria and Guimaraes (1993) and Igbaria, Parasuraman, and Badawy (1994). The first two questions asked respondents about their level of satisfaction with the project, and the last questioned intentions to quit the project. (Pinto & Mantel, 1990) used the following scale to measure project success, then broke the responses down into three project success variables, client satisfaction (items 4-8, 10), perceived quality (items 6, 7, 11-13), and implementation process (items 2, 3, 9).

1. Knowing what you know now about the status of this project, we would have developed the project.
2. This project has/will come in on schedule.
3. This project has/will come in on budget.
4. The project that has been developed works, (or if still being developed, looks as if it will work).
5. The project will be/is used by its intended users.
6. This project has/will directly benefit the intended users: either through increasing efficiency or employee effectiveness.
7. Given the problem for which it was developed, this project seems to do the best job of solving that problem, i.e., it as the best choice among a set of alternatives.
8. Important clients, directly affected by this project, will make use of it.
9. I am/was satisfied with the process by which this project is being/was completed.
10. We are confident that non-technical start-up problems will be minimal, because the project will be readily accepted by its intended users.
11. Use of this project has/will directly lead to improved or more effective decision making or performance for the clients.
12. This project will have a positive impact on those who make use of it.
13. The results of this project represent a definite improvement over the way clients used to perform these activities.

Aladwani (2002a) evaluated the literature across information systems research, organizational teams research, and project management research, and developed a model for project success that included (1) task outcomes consisting of project effectiveness and project efficiency, (2) psychological outcomes including project team member satisfaction with the project, and (3) organizational outcomes measured by added value to business operations. In a study to measure the impact of accurate project estimation on project success, Nelson and Morris (2014) used the criteria listed below:

1. On schedule
2. On budget
3. Acceptable quality
4. Product being used by its target constituencies
5. Increased stakeholder knowledge
6. Improved efficiency and effectiveness for the client organization
7. Stakeholders were satisfied with the project

2.2.4 Emerging Measures of Project Success

Ika (2009) described the changing perception of project success over time, from reviews of articles in the Project Management Journal and the International Journal of Project Management between 1986 and 2004. The perspective moved from project management success and the “iron triangle” through the 1980’s, to welcoming other criteria of success in a model that included both project and product success in the 1990’s. The 21st century research included success of programs and portfolios, as well as strategic planning success, according to the authors, as well as more narrative descriptions of subjective criteria for defining success.

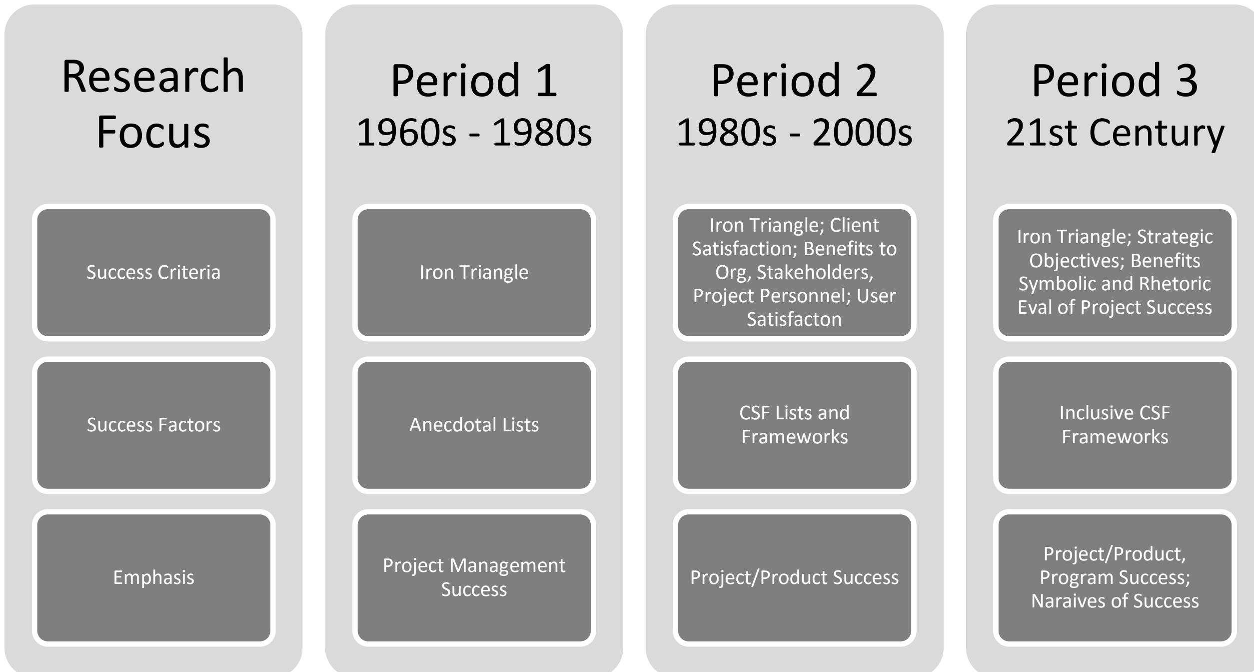


Figure 4 - Measuring Project Success Over Time (Ika, 2009)

McLeod et al. (2012) provide an initial exploration into a subjective evaluation of project success as suggested by Ika (2009). The researchers' findings are based on a single IS project case study. A subjectivist approach to the evaluation of project success requires a commitment to empirical, qualitative, and possibly longitudinal research that requires extensive fieldwork and detailed qualitative data analysis. The researchers suggest that there are multiple and conflicting points of view of project success which can evolve over time as the value of the product produced is realized and the continued success of project team members, stakeholders, and the organization are realized over time as a result of the project. Such an approach makes comparison of project success across multiple projects much more difficult, but may provide a more complete view of project success that will benefit researchers and practitioners in the future as such models are developed. Use of such a subjective approach is not available to support the dissertation proposed here, but is presented to portray the complexity and limitations of assessing the success of individual projects using existing techniques.

Lastly, Cecez-Kecmanovic et al. (2014) provide a performative perspective on information system success, contributing to the emerging sociomaterial literature (Orlikowski & Scott, 2008; Suchman, 2007). The performative perspective advances the notion that IS success or failure as sociomaterial accomplishments performed within continuously changing IS project actor networks, and that the success or failure of IS projects is inherently indeterminate.

2.3 CRITICAL SUCCESS FACTORS

A wide range of factors can influence whether an IT project is successful. Extensive research has been done to identify the critical success factors (CSFs) related to project success (Bellasi & Tukel, 1996; Cooke-Davies, 2002; Fortune & White, 2006; Pinto & Slevin, 1987; Westerveld, 2003), and conversely, the early warning signs (EWSs) of project failure (Kappelman, McKeeman, & Zhang, 2006; Pinto & Mantel, 1990).

2.3.1 Definitions

Rockart (1979) described a process developed by a research team at MIT's Sloan School of Management called the "Critical Success Factor (CSF) method," and defined CSFs as follows:

> "Critical success factors thus are, for any business, the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization. They are the few key areas where "things must go right" for the business to flourish. If results in these areas are not adequate, the organization's efforts for the period will be less than desired. As a result, the critical success factors are areas of activity that should receive constant and careful attention from management. The current status of performance in each area should be continually measured, and that information should be made available" (p. 85).

Stated differently, CSFs can be defined as "the levers that project managers can pull to increase the likelihood of achieving a successful outcome for their project" (Westerveld, 2003, p. 412).

2.3.2 Identifying Critical Success Factors (CSFs)

In an empirical study conducted at the University of Pittsburgh, Pinto and Slevin (1987) surveyed part time MBA students related to projects that they participated in within the last two years as part of their full time jobs, to identify what factors contributed most to the success of their projects. From this research emerged the Project Implementation Profile (PIP) (Pinto, 1990), which has been used extensively (Aladwani, 2002a, 2002b; Hyvari, 2006) to measure the degree to which project managers are executing the factors found most critical to project success. Measures of the degree of execution of Critical Success Factors (CSFs) were obtained using a 7-point Likert scale. Pinto (1990) identified the top ten CSFs to project success, with definitions provided in Table 4.

Table 4 - Top Ten Critical Success Factors Defined (Pinto, 1990)

CSF	Definition
Project Mission	Clearly defined goals and general direction of the project.
Top Management Support	Willingness of top management to support the project, provide the necessary resources, and apply the necessary power and authority for success.
Project Schedule / Plan	Development of a detailed schedule containing individual action steps for project implementation.
Client Consultation	Communication and consultation among all affected parties.
Personnel	Recruit and train the needed personnel for the project team.
Technical Tasks	Use of the required technology and expertise to accomplish the specific technical actions.
Client Acceptance	"Selling" the final project to the intended end users.
Monitoring and Feedback	Providing comprehensive control information at each stage of the project.
Communication	Providing the needed communication channels and data to all involved parties in the project.
Trouble-shooting	Handling unexpected crises and deviations from the project plan.

Pinto and Slevin (1987) found their proposed CSFs to be generalizable to a wide variety of project types and organizations, and from this data developed a measurement instrument, the Project Implementation Profile (PIP) (Pinto, 1990) that can be used to assess the level of success of an ongoing project. Because each factor is related to issues over which the project team or its parent organization can exert some level of control, conducting a PIP review allows the team to address problem areas and improve the probability of project success during its execution.

Fortune and White (2006) conducted a review of 63 publications that focus on project Critical Success Factors (CSFs). Although the authors found that there is only limited agreement among researchers on the factors that influence project success, the three most cited factors are: senior management support of the project; development of clear and realistic objectives; and producing a strong/detailed plan that is kept up to date. Fortune and White (2006) developed a listing of CSFs identified in that literature, which is summarized and presented in order of importance in Table 5.

Table 5 - Critical Success Factors (CSFs) (Fortune & White, 2006)

Critical Factor	# of Occurrences
Support from Senior Management	39
Clear, Realistic Objectives	31
Strong and Detailed Plan – Kept up to Date	29
Good Communication and Feedback	27
User and Client Involvement	24
Skilled, Suitably Qualified, Sufficient Staff / Team	20
Effective Change Management	19
Competent Project Manager	19
Strong Business Case, sound Basis for Project	16
Sufficient, Well Allocated Resources	16
Good Leadership	15
Proven, Familiar Technology	14
Realistic Schedule	14
Risks Addressed, Assessed, Managed	13
Project Sponsor or Champion	12
Effective Monitoring and Control	12
Adequate Budget	11
Organization Adaptation, Culture, Structure	10
Good Performance by Suppliers, Contractors and Consultants	10
Planned Close Down, Review and Acceptance of possible failture	9
Training Provision	7
Political Stability	6
Correct Choice from past experience of project management methodologies and tools	6
Environmental Factors	6
Learning from Past Experience	5
Project Size (large, level of complexity (high)); number of people involved (too many), duration (over 3 years)	4
Appreciating Different Viewpoints	3

Research related to project CSFs continues to emerge. Ika (2009) identified and summarized eight articles in the Project Management Journal (PMJ) and the International Journal of Project Management (IJPM) between 1986 and 2004 that define CSFs (Atkinson, 1999; Baccarini, 1999; Diallo & Thuillier, 2004; Freeman & Beale, 1992; Lim & Mohamed, 1999; Pinto & Slevin, 1988; Shenhar, Levy, & Dvir, 1997; Wateridge, 1998).

Hyvari (2006) conducted a study to assess the impact of different organizational conditions on overall project success as perceived by project managers in regard to their most recent project. The study considered organizational context in project management, critical success factors in project management, and dependencies between these two factors. In the study, the researchers compared the ranking of critical success factors in order of importance from previous studies (Delisle & Thomas, 2002; Finch, 2003; Hyvari, 2006; Pinto & Prescott, 1988; Pinto & Slevin, 1987), and compared them to their findings as shown in Table 6.

Table 6 - Comparison of rankings of CSFs related to project success from previous studies (Hyvari, 2006)

	Hyvari (2006)	Finch (2003)	Delisle and Thomas (2002)	Pinto and Prescott (1988)	Pinto and Slevin (1987)
Project Mission	**6**	**7**	**1**	**1**	**1**
Top Management Support	**4**	**6**	**9**	**7**	**2**
Project Schedule/Plans	**5**	**5**	**5**	**9**	**3**
Client Consultation	**2**	**1**	**2**	**2**	**4**
Personnel	**9**	**10**	**10**	**10**	**5**
Technical Task	**7**	**9**	**4**	**3**	**6**
Client Acceptance	**3**	**4**	**6**	**4**	**7**
Monitoring and Feedback	**10**	**3**	**3**	**5**	**8**
Communication	**1**	**2**	**8**	**6**	**9**
Trouble-Shooting	**7**	**8**	**7**	**8**	**10**

Doherty et al. (2011) conducted a study to determine the CSFs that best support successful development of Information Systems. They found that despite the large number of CSF studies over a substantial period of time, and the wide variation in technologies utilized, there is a high degree of consistency in their findings. In particular, they found that nearly all studies have emphasized the importance of active user involvement; senior management commitment and support; appropriate staff training; the proficiency of IT staff, and clear identification of project objectives. They further found that CSFs are highly interdependent and should be managed as a whole, and not independently.

2.3.2.1 Causes of IT Project Failure

As a logical extension to the identification of CSFs, researchers have similarly studied suboptimal or failed projects, and sought to identify the causes of those failures, so that project managers may avoid those pitfalls in the future.

Pinto and Mantel (1990) conducted a study of 97 projects identified as failures by the projects' managers or parent organizations. Using the same CSFs developed for the Project Implementation Profile (Pinto, 1990), the researchers identified which CSFs, if not applied successfully, most contributed to the failure of projects, to validate the CSFs. In a similar study, Whittaker (1999) identified that common reasons for project failure were: (1) poor project planning (in most cases either risks were not addressed or the project plan was weak); (2) the business case for the project was weak or missing components, and (3) a lack of management involvement and support.

Kappelman et al. (2006) identified 53 "early warning signs" of project failure. They defined a warning sign as "an event or indication that predicts, cautions, or alerts one of possible or impending problems. Early warning signs (EWSs) provide an indication of manifesting risks and thereby an assessment of a project's propensity to future difficulties and failure" (p. 31). The 53 early warning signs were derived from a literature review, as well as from the input of 19 project experts. The 53 items were then rated on a 7 point Likert scale by 55 IT project managers, including the 19 experts. The top 12 EWS's derived from this list are provided in Table 7, combining similar items where appropriate, and resulting in 6 people-related EWSs, and 6 process-related EWSs.

Table 7 - The Dominant Early Warning Signs of IT Project Failure (Kappelman et al., 2006)

Risks	Related Items / Ranking
PEOPLE-RELATED RISKS	
Lack of top management support	1
Weak project manager	3
No stakeholder involvement and/or participation	5, 10
Weak commitment of project team	8
Team members lack required knowledge or skills	11
Subject matter experts are overscheduled	17
PROCESS-RELATED RISKS	
Lack of documented requirements and/or success criteria	2, 7
No change control process	4
Ineffective schedule planning and management	6, 14, 15, 16
Communication breakdown among stakeholders	9
Resources assigned to a higher priority project	12
No business case for the project	13

2.3.3 How Important Critical Success Factors Influence Project Success

As discussed above, researchers have identified dozens of CSFs that can influence the success of a project. This section summarizes research into the most generally accepted CSFs over time, and across industries and technical disciplines, to explore how and why these factors influence project success.

2.3.3.1 The Correlation between Clarity of Project Mission and Project Success

Pinto and Slevin (1987) found that a clear mission that establishes initial goals and general directions was the leading indicator of project success. According to Morgan and Bowers (1995), clear definition and a common understanding of project goals can help project team members communicate more effectively and develop strategic solutions to problems. In addition, goal clarity is found to have an impact on job satisfaction of workers (Sawyer, 1992). Aladwani (2002a) stated that task goal setting influences performance by focusing attention on the task, and increasing motivation and satisfaction among project members.

Thamhain (2004), in an empirical analysis of 76 project teams in high-technology environments identified the following five factors as most associated with project team success: (1) professionally stimulating and challenging work environments, (2) opportunity for accomplishments and recognition, (3) the ability to resolve conflict and problems, (4) clearly defined organizational objectives relevant to the project, and (5) job skills and expertise of the team members appropriate for the project work. The researchers concluded that these factors integrated the goals of the organization with the needs of the individual team members, and provide an environment for cross-functional communication, information sharing, and integration of the project team focused on the project results.

2.3.3.2 Correlation between Top Management Support and Project Success

Top management support refers to the willingness of management to provide the required resources and authority for project success (Pinto & Slevin, 1987). Aladwani (2002a) stated that management approval to proceed with IS project work and the commitment and advocacy for this work can make money and personnel resources more readily available, enhancing the problem solving environment. The strong management backing provides guidance to team members, resources, and the power to deal with the organizational change associated with IS projects and essential to their success.

Doherty et al. (2011) investigated the extent to which senior managers actively led information systems development projects; going beyond providing resources, but actively managing organizational change and the delivery of business benefits. They found that this level of involvement truly enhanced the value of the projects studied.

2.3.3.3 Correlation between Availability of Skilled Team Members and Project Success

The collective level of experience and knowledge of project team members can be an important determinant of project success (Aladwani, 2002a). A project with experienced and diversely skilled staff is more likely to solve problems better than a less experienced staff. Systems developers often encounter problems and situations they have dealt with in the past (Swanson, McComb, Smith, & McCubbrey, 1991). Team members with extensive experience are more likely to have faced the same problem before (Prietula & Simon, 1989), and be in a better position to perform at a higher level than less experienced colleagues.

2.3.3.4 Correlation between Trouble-Shooting Skills and Project Success

Pinto (1990) defined the CSF of trouble-shooting as the "ability to handle unexpected crises and deviations from plan." Problems emerge throughout projects and require adjustment and fine tuning along the way to address these trouble spots. This CSF reflects the value of having project team members, as well as processes, to deal with emerging issues quickly to keep the project moving forward (Pinto, 1990).

Nah, Lau, and Kuang (2001) conducted research on the implementation of Enterprise Resource Planning (ERP) systems, and found troubleshooting to be critical to the success of these types of projects. Troubleshooting errors is critical (Holland, Light, & Gibson, 1999). Rosario (2000) found that quick response, patience, perseverance, problem solving and firefighting capabilities are important to ERP system implementation success.

2.4 PLANNING

2.4.1 What is planning?

Planning research is largely conducted in the field of psychology (Caughron & Mumford, 2008). Much of this research focuses on cognitive aspects of planning as experienced by individuals, and includes problem recognition, and the development, refinement, and implementation of personal plans (Berger, Karol, & Jordan, 1989; Patalano & Seifert, 1997; Simons & Galotti, 1992). In this regard, planning is often defined as “a mental simulation of future actions used to organize effort towards goal attainment” (Caughron & Mumford, 2008, p. 204; Osburn & Mumford, 2006).

Research on planning has also been conducted by scholars studying project management. In this context, project planning is “the process of thinking through and making explicit the objectives, goals, and strategies necessary to bring the project through its life-cycle to a successful termination when the project’s product, service, or process takes its rightful place in the execution of project owner strategies” (Cleland & Ireland, 2006, p. 265). With this definition, less emphasis is placed on the cognitive aspects of planning and more on examining interdependencies among tasks and the individuals and groups within organizations that must perform them, and emphasized the planning techniques used by project managers.

2.4.2 Elements of Project Planning

The PMBOK® (PMI, 2013) lists the processes that should be performed by a project manager, shown in Table 8. Of the 47 processes identified by the PMBOK®, 24 (51%) are planning processes. In other words, a significant portion of the project manager’s work is of a planning nature (Zwikael & Globerson, 2004).

Table 8 - Project Management Processes vs. Knowledge Areas (PMI, 2013)

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	Planning Process Group	Executing Process Group	Monitoring and Controlling Process Group	Closing Process Group
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work	4.4 Monitor and Control Project Work 4.5 Perform Integrated Change Control	4.6 Close Project or Phase
5. Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
6. Project Time Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Resources 6.5 Estimate Activity Durations 6.6 Develop Schedule		6.7 Control Schedule	
7. Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Costs 7.3 Determine Budget		7.4 Control Costs	
8. Project Quality Management		8.1 Plan Quality Management	8.2 Perform Quality Assurance	8.3 Control Quality	
9. Project Human Resource Management		9.1 Plan Human Resource Management	9.2 Acquire Project Team 9.3 Develop Project Team 9.4 Manage Project Team		
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Control Communications	
11. Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses		11.6 Control Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	12.4 Close Procurements
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Management	13.3 Manage Stakeholder Engagement	13.4 Control Stakeholder Engagement	

Pinto and Slevin (1987) identified "project schedule / plan" as the third most important CSF following "clear definition of project mission" and "top management support." The "project schedule / plan" CSF pertains to the development of detailed plans in support of project execution, specifically the degree to which schedules, labor and material resource requirements are specified. Pinto and Slevin (1987) cited Nutt (1983) who broke down project planning into four stages: formulation, conceptualization, detailing, and evaluation. Pinto and Slevin (1987) indicated that the plan should include satisfactory means for monitoring schedule and cost performance.

2.4.3 Measuring the Level of Planning

Various techniques have been used in recent studies to measure the level and quality of planning in projects. The Project Management Planning Quality (PMPQ) model was defined by Zwikael and Globerson (2004) and utilized extensively in subsequent research (Masters & Frazier, 2007; Papke-Shields, Beise, & Quan, 2010; Rees-Caldwell & Pinnington, 2013; Zwikael & Ahn, 2011; Zwikael & Globerson, 2006b; Zwikael et al., 2014; Zwikael & Sadeh, 2007). This scale asks project managers whether typical planning deliverables (e.g., are project activities defined as part of the project plan?) related to each of the planning processes defined in the Project Management Body of Knowledge (PMI, 2013) were developed and used effectively using a five-point Likert scale.

The PMPQ model was originally developed to assess the quality of planning performed by project managers by asking how frequently sixteen different project planning products were developed for recent projects within the organization, with the following text (Zwikael & Globerson, 2004):

> For each planning product written below, please circle the most suitable answer referring to the latest completed projects you were recently involved in, according to the following scale:
>
> 1 – The product has never been obtained
> 2 – The product has seldom been obtained
> 3 – The product has sometimes been obtained
> 4 – The product has frequently been obtained
> 5 – The product has always been obtained
> A – The product was irrelevant to the project I was involved in
> B – I do not know whether the product was obtained

Planning was one of the CSFs originally identified in (Pinto & Slevin, 1987), and a five item scale was used to measure project schedule/plan, requesting responses on a 7 point Likert scale that ranged from 1 – Strongly Disagree to 7 – Strongly Agree. This model was subsequently used by Aladwani (2002b), who calculated a Cronbach alpha for the five-item scale of 0.86.

(1) We know which activities contain slack time or slack resources that can be utilized in other areas during emergencies.
(2) There is a detailed plan (including time schedules, milestones, manpower requirements, etc.) for the completion of the project.
(3) There is a detailed budget for the project.
(4) Key personnel needs (who, when) are specified in the project plan.
(5) There are contingency plans in case the project is off schedule or off budget.

Other researchers identified other planning tools used in projects. Besner and Hobbs (2013) surveyed over 800 project participants to assess the level of usage of 17 project management tools, with results shown in Table 9.

Table 9 - Level of Project Management Tool Use (Besner & Hobbs, 2013)

Toolset Name	Level of Usage
Initial Planning	3.27
Project Closure	2.95
Basic Project Management Software	2.95
Business Case Definition	2.94
Bid and Fixed-Price Contracts	2.81
Progress Monitoring	2.76
Baseline Change Management	2.72
Financial Evaluation	2.71
Project Analysis	2.71
Risk Management	2.68
Team Management	2.37
Multi-project Management	2.32
Network Planning	2.13
Business Benefits Measures	2.12
Databases	2.10
Variable Price Contract	1.96
Advance Project Management Software Functionality	1.91

2.4.4 Correlation between Project Management and Project Success

Recent studies have been conducted that show that use of project management techniques have a positive correlation with project success. The PMI sponsored study (Thomas & Mullaly, 2008) identified that all organizations that implemented formal project management realized some level of value for that investment; with about half of the organizations reporting tangible benefits, and all organizations reporting intangible benefits. Specific drivers of value were reported.

Improved project management maturity; consistent standards, practices, training and support for the use of project management tools and techniques within an organization; has a positive correlation with project success (Crawford, 2006a). Mir and Pinnington (2014) conducted a survey of 154 projects and similarly concluded that there is a positive correlation between project management performance and project success.

2.4.5 The Cost and Value of Project Planning

2.4.5.1 The Correlation between Project Planning and Project Success

Project scheduling problems and planning techniques such as Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM) have been an intense area of study for decades (Ika, 2009). Intuitively, this effort implies a strong sense among researchers and project practitioners that development of improved scheduling techniques would lead to more successful projects (Bellasi & Tukel, 1996). Additionally, numerous researchers and studies have identified planning as a critical success factor to project success (Fortune & White, 2006; Murphy, Baker, & Fisher, 1974; Pinto & Slevin, 1987). In an empirical study of IT projects, Aladwani (2002b) found that project planning can significantly influence the variation in the success of organizational IT projects. Conversely, failure to document milestone deliverables and due dates in project plans (Kappelman et al., 2006), failure to reconcile project schedule deadlines with project plans, and ignoring early project delays without revision to the overall project schedule (McKeeman, 2001), were all found to be significant contributors to IT project failure.

Yeo (1995) stated that in pre-project planning, the planning and learning process undertaken is more important that the plans actually produced. Yeo (1995) noted that during the planning process, participants and participating organizations are constructing mental models of the complex economic, technological, social and political variables that will influence the project. Although the project plan may continue to change and evolve, the knowledge gained through the process of planning will allow improved teaming and decisions throughout the duration of the project. With this same notion in mind during the planning of the World War II D-Day invasion of Europe, General Dwight D. Eisenhower is famously quoted as saying: *"Plans are nothing, planning is everything."*

One experiment by Dvir, Raz, and Shenhar (2003) found that project success was not influenced by the level of implementation of traditional project management processes and procedure. However, they found that the development of both functional requirements and technical specifications did result in improved project success. Saarinen (1990) found that IT projects that have problems with requirements specification are more likely to fail than those that do not.

2.4.5.2 Limitations and Disadvantages of Planning

Numerous studies found no correlation between the level of project planning and project success, despite the apparent advantages and necessity of project planning to project success found in other studies. This section discusses some of the limitations and encumbrances that project planning may produce to explain this phenomenon.

Dvir et al. (2003) examined the relationship between project planning efforts and project success using data from more than a hundred defense research and development projects. They found that project success is insensitive to the level of implementation of management processes and procedures, including project planning. The researchers concluded that because such processes are readily supported by modern computerized tools and project management training, the deviations in planning quality had no effect on project outcome. The researchers did find, on the other hand, that project success is positively correlated with the investment in requirements' definition and development of technical specifications.

2.4.5.3 Appropriate Types of Planning

In many cases, planning is not optimal because project managers lack the knowledge to plan most effectively given the circumstances of the project. This section discusses research that points out situations where project managers should make use of different, more effective project planning techniques.

Zwikael (2009) conducted a study of over 800 projects to assess the amount of effort applied to each of the PMBOK® knowledge areas during the planning phase of the project. He then calculated the correlation between the effort applied to planning activities in each knowledge area, and the success of the project.

Table 10 - Extent of Use and Contribution to Project Success of Planning Processes based on PMBOK® Knowledge Areas (Zwikael, 2009)

Knowledge Area	Extent of Use Ranking	Contribution to Project Success Ranking
Integration	1	3
Time	2	1
Scope	3	2
HR	4	4
Cost	5	5
Risk	6	7
Quality	7	9
Communications	8	6
Procurement	9	8

Zwikael (2009) found that project managers spent time on activities that they have traditionally considered most effective in supporting the project. The level of their efforts are also influenced by the availability of project management tools such as project scheduling tools, and therefore spend more time on those planning processes that are best facilitated by available tools (Zwikael & Globerson, 2006b).

The PMBOK® (PMI, 2013) defines three major types of project life cycle, and the conditions in which they are most effectively applied: (1) the predictive life cycle (also known as fully plan-driven life cycle or waterfall lifecycle) is used on projects where there is little uncertainty or risk; (2) the iterative project life cycle is used for projects with more uncertainty, and users do not know up front what they want or need; and (3) the adaptive life cycle (also known as change-driven or agile method) is largely used for projects with a high level of uncertainty, such as Information System development projects where users traditionally do not know what they need until they see a working prototype application. Selection of the optimal project lifecycle for the project being undertaken can have a significant effect on the success of that project (Rahrovani, Chan, & Pinsonneault, 2014).

Mirchandani and Lederer (2012) found that projects that are run in environments with high levels of uncertainty, complex markets, rapid change, and strong competition, can influence the type and amount of IS planning that is appropriate in various stages of the project. They called for more situational awareness planning, and less detailed strategy conception and strategy implementation planning early in the project than is generally conducted.

Andersen (1996) found that project planning is an important part of project management, but argued against the commonly used practice of detailed activity planning. It claimed that such detailed planning early in the project is not possible or highly ineffective, proposing instead the use of milestone planning.

Bart (1993) indicated that the traditional approach to planning and controlling of uncertain and evolving R&D projects is ineffective because of overly restrictive formal control. Creativity is compromised in an overly structured lifecycle management process, and the authors suggest reduction of formal planning and control to a minimum for such projects.

2.4.5.4 Correlation between Planning and Project Success Mediated by Other Factors

Zwikael et al. (2014) found that in low-risk projects, where efficient output delivery is more assured than in high-risk projects, overly detailed planning can increase project duration without noticeable contribution in other elements of project success. A primary benefit of planning is to reduce uncertainty (Shenhar, 1993). The effectiveness of planning is contingent upon the context of the project and environment in which it is performed (Dvir & Lechler, 2004). A number of researchers have investigated project contingencies that influence the effect of planning on project success. Zwikael et al. (2014) found no direct effect of project planning on project success; nor on the discreet components of project success which they broke down into efficiency (as measured by project schedule and cost performance) or effectiveness (as measured by “project performance” and customer satisfaction.) The study did, however, find that the level of perceived risk by the project manager at the start of the project had a moderating effect on the influence of planning on project success. Their results indicate that planning is positively related to the project efficiency component of project success when the risk level was higher, and planning is positively related to the project effectiveness component of project success when the risk level is lower.

Similarly, Pinto and Prescott (1990) found that planning has a stronger impact on what they termed external success (consisting of the perceived value of the project and customer satisfaction) than on project efficiency (as measured by project schedule and cost performance). Hyvari (2006) investigated the success of projects in different organizational conditions, and found that various contingencies influenced the effect of critical success factors on project success.

Aladwani (2002b) found that IT project success was correlated with project planning, and that project size (as measured by the number of people on the project) was a significant predictor of project planning, but that project size was not correlated with IT project success. Finally, they found that project uncertainty (as a function of project size, project structure, and project newness) was correlated with IT project success when mediated with project planning. They concluded that the increase in project size likely complicates the planning process. Similarly, Hackman and Morris (1974) found that project size can influence IT project success through task strategies such as project planning. Conte, Dunsmore, and

Shen (1986) concluded that the number of communication paths in a large project can be vast and result in ineffective coordination.

Dvir and Lechler (2004) analyzed a sample of 448 projects and the interactions between three project planning variables (the quality of planning, goal changes, and plan changes) and project success. The results showed that the positive total effect of the quality of planning is almost completely overridden by the negative effect of goal changes.

2.4.6 Appropriate Levels of Planning

Project managers, in collaboration with their project teams, should determine the appropriate degree of rigor that is appropriate for each project management process, given the specific nature and requirements of each individual project (PMI, 2013). Dvir et al. (2003) stated that there is no argument that at least a minimum level of planning is necessary to achieve project success. They found that although high quality planning does not guarantee project success, lack of planning will probably guarantee failure.

2.4.6.1 Non-linear, Inverted-U Function of Level of Planning vs. Project Success

Newkirk, Lederer, and Srinivasan (2003) conducted a survey of 161 executives to investigate hypotheses about the relationship between the comprehensiveness of strategic information systems planning (SISP) and the effectiveness of that planning. The researchers found that one of the five planning phases of SISP demonstrated a non-linear, inverted-U function as graphed in Figure 5. As implied in the title of the article, both too much and too little planning may negatively affect SISP effectiveness. The optimal level of SISP was found to be in the mid-range of the levels of thoroughness practiced by the organizations studied.

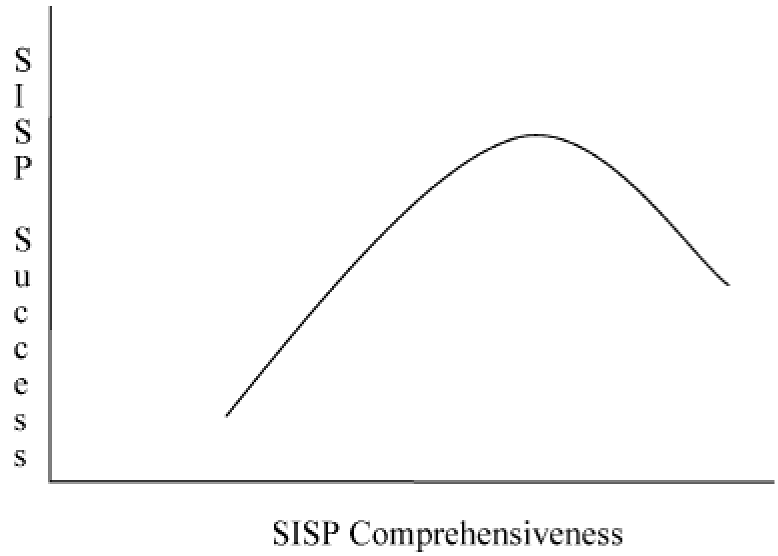


Figure 5 - Relationship between SISP Comprehensiveness and SISP Success (Newkirk et al., 2003)
Reprinted from Journal of Strategic Information Systems 12 (2003) 201–228, Newkirk, H. E., Lederer, A. L., & Srinivasan, C.,). Strategic information systems planning: too little or too much?, pg. 202, Copyright (2003), with permission from Elsevier

Newkirk et al. (2003) provided the following explanation of this phenomenon. Too little strategic planning could result in inadequate analysis and insufficient understanding of emerging information technologies, and the internal and external forces that will influence the organization and its decisions (Premkumar & King, 1991). Inadequate analysis might result in the development of insufficient business strategies, which would not allow the organization to achieve its objectives as effectively as it otherwise might. Too much SISP could cost too much, or take too long, and therefore not allow the organization to be nimble enough to keep up with changes in the environment. New technologies might emerge before those proposed in the plan could be implemented.

Newkirk et al. (2003) provided three theoretical explanations of this non-linear phenomenon that can be applied to strategic planning, as well as a range of other endeavors that might exhibit the same behavior. First, the law of diminishing returns states that as one factor of product is increased while others remain the same, the extra output generated by the additional input will eventually fall (Spearman, 1927). Related to the level of planning, if additional personnel were applied to the planning task, the quality of the plan and organizational success would initially increase. At some point, however, continued increases in planning would no longer increase the value to the organization, and the overall success of the project would level off or decline. Secondly, in the field of psychology, the Yerkes-Dodson Law (Yerkes & Dodson, 1908) states that moderate levels of motivation produce performance more effectively than either high or low levels of motivation. Thirdly, in information processing theory, information processing will rise to a maximum, then decrease as a function of task complexity (Schroder, 1967). Related to planning, as more and more planning information is prepared and compiled, increases in complexity make it difficult for the organization to process and make good use of the information.

2.5 PROJECT COMPLEXITY

2.5.1 Measuring Project Complexity

Silver (2010) provided guidelines for determining the cost of running a Windows 7 project, and identified the primary tasks and considerations that drive the cost and complexity of such a project. Major items identified in the article included automating operating system (OS) deployment, commercial and custom application remediation, hardware upgrades, backing up, migrating and restoring PCs, and documentation. Baccarini (1996) defines project complexity in terms of differentiation, the number of varied elements; and interdependence, the degree of interrelatedness between the elements. Besner and Hobbs (2013) measured project complexity as a function of the number of technical disciplines involved in the project, and the number of project interfaces.

Xia and Lee (2005) provide a standard scale for measurement of Information System Development Project (ISDP) complexity that has been tested for validity and reliability, and has been used extensively in subsequent research (Keith et al., 2013). Items making up the complexity scale in that study included the following:

- The project team was cross-functional.
- The project involved multiple external contractors and vendors.
- The project involved coordinating multiple user units.
- The system involved real-time data processing.
- The project involved multiple software environments.
- The project involved multiple technology platforms.
- The project involved a lot of integration with other systems.
- The end-users' organizational structure changed rapidly.
- The end-users' business processes changed rapidly.
- Implementing the project caused changes in the users' business processes.
- Implementing the project caused changes in the users' organizational structure.
- The end-users' information needs changed rapidly.
- IT architecture that the project depended on changed rapidly.
- IT infrastructure that the project depended on changed rapidly.
- Software development tools that the project depended on changed rapidly.

2.5.2 Correlation between Project Complexity and Project Success

Thamhain (2004) conducted an empirical study of 76 complex projects and found that there was not a strong correlation between project size / project complexity and project team success. They concluded, contrary to other research, that the scope and size of the project and the magnitude of implementation challenges by themselves do not translate into lower team or project performance. Xia and Lee (2005) identified project complexity to be an important variable in the level of project success.

Curtis, Sheppard, Milliman, Borst, and Love (1979) generally describe software complexity as the characteristics of data structures and code in an application that make it difficult to understand and change. Banker, Davis, and Slaughter (1998) investigated software complexity, and its impact on the ability to maintain software over its lifetime, and found that software enhancement effort was significantly related to software complexity, as well as the size of the project functionality and application size. Espinosa, Slaughter, Kraut, and Herbsleb (2007) hypothesized that both task and team familiarity would be of benefit to IT teams as complexity increased, but found that task familiarity was less beneficial to software development when the projects are complex, whereas team familiarity is more beneficial to software development teams as projects become more complex. They concluded that team familiarity was of more benefit, because it made complex interactions with others more efficient; whereas task familiarity did not help in complex organizational situations, because the challenges in those environments are not as dependent on individual capability or competency, but more on the ability to work efficiently with others.

2.6 PROJECT RISK

This dissertation deals with project risk in two ways; the amount of risk present in a project, and the degree of risk management performed during the execution of the project. First, it assesses the correlation between the levels of project risk (both schedule and cost risk) at the start of the project; and project success. Secondly, it assesses the level of project risk management that is performed, how project participants perceive that effort to contribute to project success, and the actual contribution to project success.

2.6.1 Definitions

Uncertainty exists, and dealing with it presents a project management challenge in most projects (Thamhain, 2013). The risk due to project uncertainty can introduce challenges throughout the project lifecycle and negatively impact project schedule, cost, and quality (Zhang, 2011). To achieve project success, management must deal with risks effectively despite these difficulties (Patil, Grantham, & Steele, 2012; Shenhar, 2001; Srivannaboon & Milosevic, 2006).

Zhang (2011) identified that risk research can be generally categorized into two distinct perspectives: risk as an objective fact and risk as a subjective construction. In analyzing the first perspective, researchers consider risk to be epistemologically probabilistic, generally adhering to a model of identifying risks as distinct events, assessing the probability and impact of each risk event (typically on a scale of 1-5), and developing mitigating factors to reduce the probabilities of each risk and contingency plans to be executed in the event of risk realization (Chapman, 2001; Royer, 2000; Zhang, 2007). Risks are prioritized within a project using the product of risk impact and probability to evaluate the importance of the risk (Baccarini & Archer, 2001; Chapman & Ward, 2000).

The second paradigm of risk analysis, subjective perception, is based on the notion that different people and different organizations can have different assessment and prioritization of risk (Adams, 2008;

Ward & Chapman, 2003). In this model, risk analysis is not purely objective and probabilistic, but is richer in texture and nuance (Zhang, 2011).

2.6.2 Measuring Project Risk

IT project risk was evaluated in Zwikael et al. (2014) by asking the project manager to assess the level of risk at the start of the project. Managing project uncertainty is important because it can lead to failure in meeting the project's schedule, cost, and quality objectives (McLain, 2012). McLain (2012) proposed two methods to quantify project uncertainty as measured by Activity Interdependency, Imprecision and Rework; and Variety and Activity Unfamiliarity.

Baccarini and Archer (2001) developed a model for measuring the overall risk associated with procurement projects for the government of Australia. They developed a table of specific criteria associated with risks to project cost, time and quality that project managers could use to assess and develop a quantitative measure of overall project risk. Practitioners would assess the consequence of each risk on a scale of 1 to 5, and the probability of the occurrence of each risk on a scale of 1 to 5, then average the total consequence and probability of risks across each of the three elements; time, cost and quality. The consequence and probability of each category were then multiplied together, and the area with the highest risk defines the total risk of the project.

2.6.3 Correlation between Project Risk and Project Success

De Bakker, Boonstra, and Wortmann (2010) conducted a meta-analysis of 29 studies to determine the correlation between risk management and IT project success. They concluded that project management practitioners paying attention to project risk is likely to have more impact on IT project success than if they follow the steps prescribed in formal risk management processes. Thamhain (2013) conducted a study of 35 major product developments within 17 high-tech companies, and found that significant management involvement and complex techniques are necessary to effectively manage risk in complex projects.

2.6.3.1 The Level of Use and Perceived Value of Project Risk Management

Kutsch and Hall (2009) researched the degree to which project risk management is performed, and the conditions that prevent project managers from using that tool. They found that about one-third of IT projects investigated did not use project risk management because of cost constraints. They argued that many project managers perceive the utility of not using project risk management as being higher than using project risk management, and that that is a rational decision.

2.7 ORGANIZATIONAL ENVIRONMENT

2.7.1 Definitions

Organizational factors include characteristics of the organization within which a project is executed. This section discusses and defines factors in the organizational environment that may influence the success of projects.

2.7.1.1 Organizational Project Orientation

Organizations are often structured based on their focus and orientation to managing projects (Cleland & Ireland, 2006; Kerzner, 2013; PMI, 2013). A strongly-matrixed organization grants significant power to project managers to assign and use resources in their projects. In a weakly-matrixed organization, project managers have less authority than functional managers to allocate resources, and must work closely with the functional managers to get the resources they need to execute their project. In a functional organization, projects are managed within the functional organizations, and project managers, if assigned, generally have very limited authority in allocating resources.

In non-project centered organizations, small projects are often not recognized as projects, are begun quickly with no or little planning, and as a result often fail (Larson & Larson, 2009). Besner and Hobbs (2013) developed a variable called "performing-maturity", which measures the level of project management maturity within an organization, and is derived from the following four elements:

- The level of project management maturity of the organization (measured on the well-known CMMI scale);
- The level of support for the use of tools and techniques provided by the organization (training, procedures, instructions, templates);
- The availability of competent project personnel; and
- The respondents' perceived rate of project success of their organizations compared with competitors' organizations in the same sector of activity. This global measure of success was revealed to be quite robust by Cooper, Edgett, and Kleinschmidt (2004).

Other researchers have proposed constructs that assess the level of project management maturity; (Skulmoski, 2001), Hartman and Skulmoski (1998), and Frame (1999) proposed a model that combined project management competency and maturity. The concept of project management maturity is widely used in the project management community among practitioners, professional associations, and researchers (PMI, 2013), and models are often based on the Software Engineering Institute's Capability Maturity Model scale in five levels. Maturity is measured as a function of the formality and consistency of use of project management processes (Besner & Hobbs, 2013). More mature organizations use project management tools, techniques, and practices more often and more effectively than less mature organizations.

2.7.1.2 Measuring Project Team Size

Aladwani (2002a) measured project team size using a single survey question by asking the project leader to indicate the number of people working within the project. Besner and Hobbs (2013) measured project size as a combination of the project budget and duration.

2.7.2 Correlation between Organizational Factors and Project Success

This section discusses research that has investigated the correlation between organizational factors and the success of projects. Many of these factors cannot be influenced by the project manager, but should be considered when determining how to manage and execute the project.

2.7.2.1 Correlation between Project Team Size and Project Success

Intuitively, project managers seek additional resources to staff their projects, to provide a bank of experience and resources to draw upon to better execute the project. However, continuing research indicates that there are significant challenges and disadvantages of working as part of a large project team. Shaw (1981) found that project team size negatively influences the amount and distribution of efforts within the team. Latane, Williams, and Harkins (1979) explained that as the number of individuals on a project team increases, pressure on any individual to perform well is reduced, making it easier for any individual on the team to become a "free-rider."

Koushik and Mookerjee (1995) found that productivity of IS project teams is diminished as project team size increases. In a study of Information Systems development projects, Aladwani (2002a) found that project team size negatively influences problem solving. Some researchers have found that project team size at a certain level may cause project productivity to decrease (Shaw, 1981) and increase project team members' dissatisfaction (Mullen, Symons, Hu, & Salas, 1989).

2.7.2.2 Correlation between Organizational Project Orientation and Project Success

Pérez-Ezcurdia and Marcelino-Sádeba (2012) observed that project management discipline is often not practiced because a task is not recognized as a project. Everyday work may not be distinguished from project work, so the effort may not be appropriately planned, team member roles not assigned, and risks are not identified (Larson & Larson, 2009). Similarly, Rowe (2006) found that companies often find that a task or an assignment should be managed as a project, which provides the opportunity to define expectations and the best use of resources.

The relationship between project management maturity and project success is continuing to be evaluated by researchers (Thomas & Mullaly, 2008). Besner and Hobbs (2013) found a slight correlation between maturity and success, but concluded that many other factors influence success.

2.8 MANAGING SMALL PROJECTS

The research literature related to managing small projects is very limited. A small project, for the purposes of this study, is any task that meets the definition of a project, whether or not it is formally managed as a project, and requires less than one man-year of effort to accomplish. This section discusses the nature and significant findings from that literature, and highlights the need for additional research in this area.

2.8.1 Limitations of Small IT Project Management Research

Alojairi and Safayeni (2009) categorize project management literature into five main streams: technical, social, cookbook, critical success factor, and socio-technical. There is little empirical research on small IT projects or small projects in general, and much of that literature falls in the category of cookbook references, which in general lack academic creditability. Although many of these types of references may be beneficial and accessible to project management practitioners, most do not provide a conceptual framework or references to empirical studies, for example (Heerkens, 2005; Portny, 2006), and often fail to identify how suggested techniques and rules were developed. Cook (2005) posits the interesting rule of thumb that five percent of the project duration should be devoted to planning, but does not provide any reference for how such a rule was derived. In view of these limitations of past literature and research on small projects, the generally accepted best practices for small projects are summarized below and inform the empirical analysis provided in this research.

2.8.2 Best Practices for Managing Small Projects

Buehring (2006) proposes several essential project management practices that should be applied to small projects. A simple rule of thumb related to project documentation presented in this article is: "if it isn't useful in helping us to deliver the business objectives of the project then don't waste time to produce it," (pg. 1) and proposes the following best practices be applied to small projects:

1. Define objectives and scope. The project manager, and the success of the project, will be judged by whether the project meets the objectives defined and documented at the beginning of the project. By defining the scope, the project manager establishes the boundary for the project, and establishes a baseline against which changes can be managed. Without such a document, there is no clear understanding of the bounds of the project, and when and whether it has been completed successfully.
2. Define Deliverables. Even if the deliverables of the project are small and don't take much time to produce, they should still be written down, so that they can be reviewed, with errors in understanding corrected to prevent rework later.
3. Project planning. Minimum elements of a project plan include:
   - Define the activities required to produce a deliverable.
   - Estimate how long the activities will take
   - Work out how many staff and resources are required to complete the activities
   - Assign activities and responsibilities to staff
   - Document the major milestones on the project and the dates by which they will or need to be completed.
   - Document the responsibilities of each project member in the project plan.
4. Use of project management software such as Microsoft Project, or the development of professional looking Gantt charts is not necessary. Such tools are often used to develop elaborate project schedules at a start of a project, but are abandoned because they are cumbersome to maintain as the project proceeds. Development of a bar chart in MS Excel is adequate.
5. Communication. Assign tasks and responsibilities to the team members, share the written plan, or call a meeting to review the plan, and communicate changes to the plan with the team as they occur.
6. Tracking and reporting progress. Daily email detailing the work completed, the work still left to do, and a list of any issues/problems; or a short daily 15 minute face-to-face to catch up. The

Project Manager needs to be aware of the status of the work so the project can be managed effectively.

7. Change Management. The project manager should carefully assess the impact of accepting any changes to the project before accepting them. Failure to manage change results in scope creep and jeopardizes the ability to deliver the project to the original budget and schedule.
8. Risk management. Think through all the potential risks at the beginning of the project, monitor the top ten risks each week, and keep looking out for new risks. Failing to manage risk properly is one of the main causes for projects to fail (Patil et al., 2012; Shenhar, 2001; Srivannaboon & Milosevic, 2006).

Payne and Turner (1999) stated that minimal project planning elements should include a project definition report, milestone plan, and project responsibility chart, and state that further, more detailed planning, may not be required.

Project management discipline is often not observed because a job to be done is not recognized as a project. In both small and large organizations, employees perform both operational work, and work that should be classified as projects because of their unique, one-time, limited duration nature. If projects are not recognized as such, they are not planned, they are not formally managed, roles are not clearly established, and risks are not managed (Larson & Larson, 2009). Work that may often be called a task or an assignment should more appropriately be managed as a project. Making this distinction up front initiates a level of formality the work would not otherwise be subject to, and resources can be assigned, and progress monitored and controlled, to optimize the opportunity for success (Rowe, 2006). Pérez-Ezcurdia and Marcelino-Sádeba (2012) identified a listing of simple criteria for identifying work as a project:

1. Is more than one organization involved?
2. Are there more than two types of people involved?
3. Has it been assigned a budget?
4. Is external financing required?
5. Does the effort rely on personnel resources from other parts of the organization?
6. Does the effort rely on technical resources from other parts of the organization?
7. Do the resources need additional training?
8. Is there a deadline?
9. Are the tasks going to be controlled, or should they be controlled periodically?
10. Are any of the following task aspects going to be modified?
    a. Products
    b. Company methods / processes
    c. Management systems

In reviewing the project management practices of small organizations, Simu (2007) found that respondents had minimal education in risk management techniques. Use of risk management procedures was very low, and procedures were informal and inconsistently applied. Additionally, that research found that project staffs rely on their own intuition, experience and personal judgment to control and manage their projects, and formal management systems are seldom utilized.

In a study of IT projects, Whittaker (1999) found the failure rate of IT projects to be astounding, with small IT projects, those scheduled to take 12 months or less, having the weakest results. Nearly all respondents (92%) with small projects reported that these projects went over schedule.

Payne and Turner (1999) found that in organizations with a portfolio of projects, applying a common approach for the management of projects had the following benefits: improved allocation of resources that enable the sharing of resources; consistent project reporting; and a familiar management approach for employees as they move to new projects. They further found that it is advantageous to tailor these requirements to the specific project. For example, in small projects, the emphasis is on the prioritization of resources across projects. Additionally, small projects generally cannot afford the bureaucracy of procedures designed for larger, more complex projects.

Besner and Hobbs (2013) conducted a study of a wide range of different types of projects, and broke them into archetypes using cluster analysis, with the purpose of determining which project management tools and techniques are "best practices" for each type of project. In this research, one of the categories was described as small, internal projects in large organizations. This category included a large percentage of IT projects, and characterized them as non-innovative, similar projects. This group corresponds well to the types of projects being analyzed in my research. The researchers found that practitioners of this type of project do more initial planning, financial evaluation and business benefits measurement than projects in other categories. Initial planning was the most extensively used toolset for this type of project. Table 11 shows the most widely used tools, and "best practice" tools both for all of the projects evaluated as well as for the group that best aligns with the projects in my study.

Table 11 - Project Management Toolset Usage and Best Practices (Besner & Hobbs, 2013)

All Projects	Small Internal Projects in Large Organizations
Highest Usage Project Management Toolsets	
Initial Planning	Initial Planning
Project Closure	Basic Project Management Software
Basic Project Management Software	Business Case Definition
Business Case Definition	Project Closure
Bid and Fixed Price Contracts	Baseline Change Management
Tools as Best Practices	
Initial Planning	Databases
Databases	Project Closure
Business Case Definition	Projectized Structure
Project Closure	Initial Planning
Baseline Change Management	Business Case Definition

Of the tools and critical success factors considered in my study, Besner and Hobbs (2013) assert that initial planning and business case definition are “best practices” for small, internal projects within large organizations.

2.8.3 Correlation between Project Size and Use of Tools

Besner and Hobbs (2013) found that the size of the project and of the organization running the project are both correlated with a higher level usage of project management toolsets. Larger projects benefit from the formality of project management because of the increased need for coordination among team members and organizations involved.

2.8.4 Correlation between Project Size and Project Success

Table 12 shows the outcomes of projects, by size, from the 2015 CHAOS report (Standish Group, 2015), indicating that a higher percentage of small software development projects are successful, as related to their larger counterparts. This research reveals, however, that there remains a great deal of room for improvement in planning and project management techniques.

Table 12 - Results of Projects by Project Size from the CHAOS Report FY11 - FY15 (Standish Group, 2015)

	Successful	**Challenged**	**Failed**
Grand	2%	7%	17%
Large	6%	17%	24%
Medium	9%	26%	31%
Moderate	21%	32%	17%
Small	62%	16%	11%
Total	**100%**	**100%**	**100%**

3.0 RESEARCH DESIGN

This chapter describes the research that was conducted, including the environment in which the projects were executed, the method of data collection and details about each variable, and the hypotheses to be evaluated. Results of the analysis of the hypotheses proposed here are discussed in the next chapter.

3.1 ORGANIZATIONAL CONTEXT

This study was conducted within a large scientific and engineering organization with offices at various locations throughout the United States. Data was collected from 79 IT projects and the project participants associated with those projects. The primary objective of each project was to upgrade the PC operating systems from Windows XP to Windows 7. These systems range in size and complexity from one personal computer that only requires upgrade of the operating system, to large networks of computers that require procurement, installation and configuration of Windows 7 compatible hardware and software, the revision of custom software to function properly on Windows 7, and the associated testing, documentation, and security accreditation of those changes. Because the focus of this study is small IT projects, data from projects requiring more than one man-year of effort were excluded from the sample analyzed.

Microsoft announced that it would no longer provide operational and security patches to the Windows XP operating system after April 8, 2014, so continuing to operate Windows XP after that date would have introduced both operational and security risks to the system and to the organization. A team of individuals within the IT Department were chartered in February 2012 to guide and facilitate the appropriate upgrade of systems to Windows 7. The team consisted of a dedicated personnel manager, a project manager, a technical lead, and ten IT professionals with various backgrounds including programming, systems analysis, and network management. Individuals from throughout the IT organization augmented the team as necessary to support the project. This team is hereafter referred to as the Windows 7 team. In March of 2012, all system owners were notified by the Windows 7 team of the risk of continuing to operate an unsupported operating system, and were advised to upgrade systems to a supported operating system by October 31, 2013. On July 27, 2012, the owners of the twenty most sensitive systems were notified by Cyber Security authorities within the organization of the requirement to upgrade their systems to a supported operating system by April 8, 2014. Finally, on July 3, 2013, all system owners were notified by Cyber Security authorities that they must retire or upgrade their systems to Windows 7 by April 8, 2014, or submit and obtain an approved variance that would allow them to continue operating Windows XP beyond that date. Any systems that did not upgrade or have an approved variance would be shut down on April 8, 2014. Associated with requesting a variance was the requirement to identify an upgrade plan and schedule, and the identification of measures to be taken to minimize the risk of running an unsupported operating system.

On November 5, 2013, all system owners were requested to identify which strategy for being Windows 7 compliant they would pursue for each system; whether they would retire their system, upgrade to a supported operating system, or request approval of a variance that would allow continued operation of an unsupported operating system beyond April 8, 2014. All systems that were to be retired or upgraded were requested to provide a plan of action and milestones (POAM) specifying the plan for achieving that strategy. Approximately 200 systems were identified with a strategy to retire or update to Windows 7, and all had posted POAMs by December 6, 2013. The Windows 7 team tracked the progress of upgrade of each system based on the plan provided in the POAM, and recorded when each system was completed. Systems that had been upgraded prior to December 6, 2013 did not have a POAM prepared.

3.2 DATA COLLECTION

This research analyzes the impact that the level of planning conducted on a given project has on the degree of that project's success. To support this overall objective, data related to the quality of planning applied to each project and the degree of project success was compiled. Additionally, because there are many factors in addition to project planning that influence project success, data related to critical success factors that are relevant to Windows 7 upgrade projects, project complexity measures, other demographic information about each project and the personnel involved in the project, and the organizational environment in which the project is being conducted was also compiled. This data allowed identification of the variables that influence project success, and allowed the level of planning to be controlled for these other significant factors.

3.2.1 Data Sources

Data was collected from three sources to support this research:

1. Plans of Action and Milestones (POA&Ms) developed for each project.
2. A project tracking database maintained and updated by the Windows 7 team to record information about the nature and progress of each project.
3. A survey instrument that measures various characteristics of the project, and filled out by the project manager or other individual involved in each project.

Specific data collected from each data source is specified in Table 13 and 14 in section 3.2.2, and detailed data descriptions and actual survey instruments are provided in the Appendices.

3.2.1.1 Project Artifacts – Plans of Action and Milestones

This research reviewed the plans of action and milestones (POAMs) developed by the system owners for each project, and analyzed that data regarding the level and degree of planning that was conducted on each project, using a set of written guidelines. This procedure and the specific data elements obtained from the POAM are provided in Appendix A. An independent individual reviewed a sampling of ten POAMS using the same written criteria, and the results obtained from each survey were compared to confirm the validity of the data evaluation procedure.

3.2.1.2 Project Artifacts – Project Tracking Database

A project tracking database was maintained by the Windows 7 team to record information about the nature and progress of each project. This database was updated by individual project participants or by the Windows 7 team monitoring the progress of individual efforts. Details about the data available from this source are provided in Appendix B.

3.2.1.3 System Owner On-Line Survey

An on-line survey about each project was completed by the project manager, system owner, or other individual close to the project with detailed knowledge regarding its execution. The survey was completed for all Windows 7 upgrade projects that were recently finished, or were planned to be completed by December 31, 2014. This survey solicited information to complement the data from other sources, and obtain data on other factors that were expected to influence the success of the project not available from those sources. A long-form survey was developed for systems with ten or more personal computers. The actual survey document, with text of the forwarding email, is provided in Appendix C. A short-form survey, which contains a subset of the questions on the long form sufficient to provide all of the variables needed to support evaluation of each of the hypotheses, was developed for smaller systems that required the upgrade of fewer than ten PCs. The actual short form survey document, with text of the forwarding email, is provided in Appendix D.

To help optimize the reliability and validity of the data to be collected, most elements of data to be collected are supported by previous research, and utilize or are adapted from well-established scales wherever available. Explanation and support from previous research regarding the method of data collection is provided below. Data was collected from all projects in the target organization undergoing the upgrade to Windows 7. Because project artifacts were available for the Windows 7 upgrade of all systems in the population, a census survey was conducted, as opposed to a sampling survey of the projects.

3.2.2 Variables

Tables 13 and 14 identify each of the variables and their variable constructs that will be used in this study, and lists the individual items that make up those constructs. The column in which they are found indicates the source of the data for each variable.

Table 13 - Variables related to Large Projects only

Variable	Large Project Survey	Project Tracking DB	POAM	Source
Level and Effectiveness of Planning				
Overall Level of Planning	Average of LOP F1-F18			(Zwikael & Globerson, 2004)
Level of Planning - POAM			Subjective evaluation of POAM plan complexity	
Project Management Plan	LOP-F1, E1			(Zwikael & Globerson, 2004)
Project Scope Document	LOP-F2, E2			(Zwikael & Globerson, 2004)
Requirements Document	LOP-F3, E3			(Dvir et al., 2003)
Design Specification	LOP-F4, E4			(Dvir et al., 2003)
Work Breakdown Structure	LOP -F5, E5			(Zwikael & Globerson, 2004)
Project Schedule / Activities List	LOP -F6, E6			(Zwikael & Globerson, 2004)
Project Schedule / PERT Chart	LOP -F7, E7			(Zwikael & Globerson, 2004)
Project Schedule / Activity Duration Estimates	LOP -F8, E8			(Zwikael & Globerson, 2004)
Project Schedule / Activity Start and End Dates	LOP -F9, E9		Dates Identified	(Zwikael & Globerson, 2004)
Project Staff Assignments	LOP -F10, E10			(Zwikael & Globerson, 2004)
Project Schedule / Role and Responsibility Assignments	LOP-F11, E11			(Zwikael & Globerson, 2004)
Project Schedule / Active Resource Requirements	LOP-F12, E12		Resource Identified	(Zwikael & Globerson, 2004)
Activity Cost Estimates	LOP-F13, E13			(Zwikael & Globerson, 2004)
Time-phased Budget	LOP-F14, E14			(Zwikael & Globerson, 2004)
Quality Management Plan	LOP-F15, E15			(Zwikael & Globerson, 2004)
Communications Management Plan	LOP-F16, E16			(Zwikael & Globerson, 2004)
Risk Management Plan	LOP-F17, E17			(Zwikael & Globerson, 2004)
Procurement Management Plan	LOP-F18, E18			(Zwikael & Globerson, 2004)
Project Complexity				
Overall Complexity	Computed			
Size of Team	PI-6			(Aladwani, 2002b; Hyvari, 2006; Xia & Lee, 2005)
# of Man-Hours	PI-7			(Hyvari, 2006; Xia & Lee, 2005)
# of Standard Windows 7 Project Elements	PI-8			(Silver, 2010)
# of PCs		x		(Baccarini, 1996)
Sensitivity of Data		x		
Project Risk				
Overall Risk	Average of PI-3,4			
Scheduler Risk at Start of Project	PI-3			(Zwikael et al., 2014)
Technical Risk at Start of Project	PI-4			(Zwikael et al., 2014)

Table 13 (Continued)

Project Critical Success Factors (CSF)				
CSF - Project Mission	CSF1-2			(Pinto, 1990)
CSF - Top Management Support	CSF3-5			(Pinto, 1990)
CSF - Personnel	CSF6-8			(Pinto, 1990)
CSF - Technical Tasks	CSF9-11			(Pinto, 1990)
CSF – Monitoring and Feedback	CSF12-14			(Pinto, 1990)
CSF – Communication	CSF15-17			(Pinto, 1990)
CSF – Troubleshooting	CSF18-20			(Pinto, 1990)
CSF – Vendor Performance	CSF21-23			(Fortune & White, 2006)
CSF – External Support	CSF24-25			
Project Success				
Overall Project Success	Computed by averaging “Project Success (Efficiency) – Large Projects” and “Project Success (Effectiveness) – Large Projects”			(Zwikael et al., 2014)
Project Success (Efficiency)	Computed from PS-1-3 and Deviations from Completion Dates			(Zwikael et al., 2014)
Deviation between Actual Completion Date (ACD) and Estimated Completion Date (ECD)		x	x	(Zwikael et al., 2014)
Deviation between Actual Completion Date (ACD) and April 8, 2014		x		(Zwikael et al., 2014)
Project Success (Effectiveness)	Average PS-4-7			(Jugdev & Muller, 2005)
Organizational Project Orientation				
Organization Performs Planned vs. Emergent Work	PI-2			(Hyvari, 2006)
Work Managed as a Project?	PI-9			(Hyvari, 2006)
Project Information				
Project Role of Responder	PI-1			
Project Start (Date Range)	PI-5			
Actual Remediation Date		x		
Estimated Remediation Date			x	

Table 14 - Variables across All Projects

Variable	Large Project Survey	Small Project Survey	Project Tracking DB	POAM	Source
Level and Effectiveness of Planning					
Overall Level of Planning	Average of LOP-F2,F6,F9,F11,F15,F17	Average of S-LOP-F1, F4-F8			(Zwikael & Globerson, 2004)
Level of Planning - POAM				Subjective evaluation of POAM plan complexity	
Project Scope Document	LOP-F2, E2	S-LOP-F1, E1			(Zwikael & Globerson, 2004)
Requirements Document	LOP-F3, E3	S-LOP-F2, E2			(Dvir et al., 2003)
Design Specification	LOP-F4, E4	S-LOP-F3, E3			(Dvir et al., 2003)
Project Schedule / Activities List	LOP-F6, E6	S-LOP- F4, E4			(Zwikael & Globerson, 2004)
Project Schedule / Activity Start and End Dates	LOP-F9, E9	S-LOP-F5, E5		Dates Identified	(Zwikael & Globerson, 2004)
Project Schedule / Role and Responsibility Assignments	LOP-F11, E11	S-LOP- F6, E6		Resource Identified	(Zwikael & Globerson, 2004)
Quality Management Plan	LOP-F15, E15	S-LOP-F7, E7			(Zwikael & Globerson, 2004)
Risk Management Plan	LOP-F17, E17	S-LOP-F8, E8			(Zwikael & Globerson, 2004)
Project Complexity					
Overall Complexity	Computed	Computed			
Size of Team	PI-6	S-SPI-6			(Aladwani, 2002b; Hyvari, 2006; Xia & Lee, 2005)
# of Man-Hours	PI-7	S-PI-7			(Hyvari, 2006; Xia & Lee, 2005)
# of Standard Windows 7 Project Elements	PI-8	S-PI-8			(Silver, 2010)
# of PCs			x		(Baccarini, 1996)
Sensitivity of Data			x		
Project Risk					
Overall Risk	Average of PI-3,4	Average of S-PI-3,4			
Scheduler Risk at Start of Project	PI-3	S-PI-3			(Zwikael et al., 2014)
Technical Risk at Start of Project	PI-4	S-PI-4			(Zwikael et al., 2014)

Table 14 (Continued)

Project Critical Success Factors (CSF)					
CSF - Project Mission	CSF-1	S-CSF-1			(Pinto, 1990)
CSF - Top Management Support	CSF-4	S-CSF-2			(Pinto, 1990)
CSF - Personnel	CSF-7	S-CSF-3			(Pinto, 1990)
CSF - Technical Tasks	CSF-10	S-CSF-4			(Pinto, 1990)
CSF – Monitoring and Feedback	CSF-13	S-CSF-5			(Pinto, 1990)
CSF – Communication	CSF-15	S-CSF-6			(Pinto, 1990)
CSF – Troubleshooting	CSF-19	S-CSF-7			(Pinto, 1990)
CSF – Vendor Performance	CSF-22	S-CSF-8			(Fortune & White, 2006)
CSF – External Support	CSF-24	S-CSF-9			
Project Success					
Overall Project Success	Average of Project Success – Efficiency; and Project Success – Effectiveness	Average of Project Success – Efficiency; and Project Success – Effectiveness			
Project Success (Efficiency)	Average of PS-1 and PS4	Average of S-PS-1 and S-PS-2			(Zwikael et al., 2014)
Deviation between Actual Completion Date (ACD) and Estimated Completion Date (ECD)			x	x	(Zwikael et al., 2014)
Deviation between Actual Completion Date (ACD) and April 8, 2014			x		(Zwikael et al., 2014)
Project Success (Effectiveness)	Average PS-4,5,7	Average S-PS-2-4			(Jugdev & Muller, 2005)
Organizational Project Orientation					
Organization Performs Planned vs. Emergent Work	PI-2	S-PI-2			(Hyvari, 2006)
Work Managed as a Project?	PI-9	S-PI-9			(Hyvari, 2006)
Project Information					
Project Role	PI-1	S-PI-1			
Project Start (Date Range)	PI-5	S-PI-5			
Actual Remediation Date			x		
Estimated Remediation Date				x	

3.2.2.1 Level of Planning

Data was collected to assess the quality of planning in each project using both an analysis of the Plans of Action and Milestones (POAMs) developed for each project, as well as the System Owner Survey Instrument. The Project Management Planning Quality (PMPQ) model was defined by Zwikael and Globerson (2004) and utilized extensively in subsequent research (Masters & Frazier, 2007; Papke-Shields et al., 2010; Rees-Caldwell & Pinnington, 2013; Zwikael, 2009; Zwikael & Ahn, 2011; Zwikael & Globerson, 2006b; Zwikael et al., 2014; Zwikael & Sadeh, 2007). This scale asks project managers whether typical planning deliverables (e.g., Are project activities defined as part of the project plan?) related to each of the planning processes defined in the Project Management Body of Knowledge (PMI, 2013) were developed and used effectively, using a five-point Likert scale. The PMPQ model was originally developed to assess the quality of planning performed by project managers by asking how frequently sixteen different project planning products were developed for recent projects within the organization (Zwikael & Globerson, 2004).

A similar technique for assessing the degree of use of project management tools and techniques was utilized by Besner and Hobbs (2013), who identified techniques from the PMBOK® (PMI, 2013) and other project management standards, and used a 5-point Likert scale with the question: "How extensively do you use this tool or technique?" Similarly, in (Zwikael, 2009), the survey respondents were asked to report the actual extent of use of planning processes on a 5-point Likert scale ranging from one (lowest extent of use) to five (highest extent of use).

Although the PMPQ model was used in recent studies to assess the planning quality of individual projects, the nature of the questions posed left ambiguity about how to assess the planning quality of individual projects. Following brief consultation with Dr. Ofer Zwikael, the developer of the PMPQ model, via email, I adjusted the model in this study to specifically measure the level of planning quality for one distinct project at a time. The survey was also modified from the PMPQ to solicit the respondent's perception of the effectiveness of each planning tool in supporting the success of the project, as follows:

For each of the project planning tools identified below, please indicate in the first column whether the tool was used and its formality. In the second column indicate how effective that tool was in supporting the success of the project.

Formality	**Effectiveness**
o Not Used	o Not Used
o Briefly considered	o Ineffective
o Discussed with Others	o Marginally Effective
o Informally Documented	o Effective
o Formally Documented	o Very Effective

The survey used all of the same planning products from the original model, but some of the names and descriptions were modified to align better with the latest version, version 5, of the PMBOK® (PMI, 2013), and to be more understandable by the community of system owners who are the subject of this study. In general, the leaders of the projects in this study have some basic project management training, but are not professional project managers.

The 16 questions in the PMPQ model were included in the System Owner Survey Instrument for large projects, provided in Appendix C, as modified as discussed above. For the Survey Instrument for small projects, only the six planning tools deemed to be used most widely were included in the survey.

Data extracted from the POAMs was informed by the PMPQ model, and this data served as a cross validation of the survey instrument data. Using data from the POAMs, the level of planning of each project was determined using objective factors, as well as a subjective determination by the researcher in reviewing the plan developed for each project. Project management standards (PMI, 2013) define best practices for developing and maintaining effective project plans, and researchers (Zwikael et al., 2014) have identified the elements of project plans that are most effective on supporting the success of a project. The following characteristics of quality project plans that were compiled from the POAM for each project are specified below, and support the variables collect in the PMPQ model and other instruments as follows:

1. # of Tasks in the Project Plan – Supports PMPQ measure of 'activity definition'

2. # of Lines of Clarifying Text – May support various planning deliverables, such as project plan, project deliverables, quality management plan, project staff assignments, risk management, communications management plan, risk management plan, and procurement management plan.

3. Existence and number of clarifying documents or drawings – Supports various variables.

4. Were completion dates identified for individual tasks in the project schedule (Yes or No)? – Supports PMPQ questions on ‘activity start and end dates’

5. Were resources identified for individual tasks in the project schedule (Yes or No)? – Supports ‘activity required resources’ question from the PMPQ

6. Number of elements characteristic of a Windows 7 upgrade project present in the project plan – Supports ‘project activities defined’ from the PMPQ.

7. Researcher’s subjective judgment of the level of effort applied in developing the POAM project plan – Supports the ‘Total Level of Planning’ variable computed from the PMPQ.

8. Researcher’s subjective judgment of the complexity of the project based on evaluation of the planning and descriptive data provided in the POAM – Supports the complexity construct computed from various variables in the survey instrument.

3.2.2.2 Project Complexity

Project complexity was evaluated based on responses to the following questions in the system owner survey instrument:

1. How many individuals make up your project team?
2. Approximately how many man-hours of work did this project require?
    a. Under 40
    b. 41-200
    c. 201-1000
    d. 1001-2000
    e. Over 2000

3. Specify which project elements existed in your project:
    a. Obtain security approval or accreditation to proceed with changes
    b. Network infrastructure upgrades
    c. Procure and install new hardware to be Windows 7 compatible
    d. Procure and install software upgrades to be Windows 7 compatible
    e. Upgrade custom software to be Windows 7 compatible
    f. Significant other non-Windows 7 improvements to the system
    g. Backup or restore system data

In addition to survey elements of complexity, the following data was considered in the overall complexity construct:

1. # of PCs in the system (Obtained from the project tracking database)
2. Sensitivity of the data (Systems with personal or company proprietary data will be classified as "high", and systems that process only non-sensitive, non-proprietary data will be classified as "low")

Silver (2010) provided guidelines for determining the cost of running a Windows 7 project, and identified the primary tasks and considerations that drive the cost and complexity of such a project. Major items identified in the article included automating operating system (OS) deployment, commercial and custom application remediation, hardware upgrades, backing up, migrating and restoring PCs, and documentation. In addition to these major drivers, additional elements of complexity were identified by the researcher in reviewing POAMs that were developed by project managers, which included network infrastructure upgrades such as server replacement, and procurement and installation of new software and equipment. The data sensitivity of the system is available in the project tracking database, and was considered in an overall complexity assessment for each project. An objective algorithm was established to determine an overall degree of project complexity, by including a weighted value of each of the above data variables.

3.2.2.3 Project Risk

IT project risk was evaluated by Zwikael et al. (2014) by asking the project manager to assess risk at the start of the project. This study similarly assessed risk with the following questions evaluated on a 7-Point Likert scale with 1 equal to "strongly disagree" and 7 equal to "strongly agree".

1. My project contained significant scheduler risk at the start of the project.
2. My project contained significant technical risk at the start of the project.

A value of overall project risk was computed for each project by averaging the reported scheduler and technical risk values.

3.2.2.4 Critical Success Factors

In an empirical study conducted at the University of Pittsburgh, Pinto and Slevin (1987) surveyed part time MBA students related to projects that they participated in within the last two years as part of their full time jobs, to identify what factors contributed most to the success of their projects. From this research emerged the Project Implementation Profile (PIP) (Pinto, 1990), which has been used extensively (Aladwani, 2002b; Hyvari, 2006) to measure the degree to which project managers are executing the factors found most critical to project success.

Data associated with the degree of execution of Critical Success Factors (CSFs) for each project was obtained using 7-point Likert scale questions drawn from the PIP, and included in the system owner survey instrument. Pinto (1990) identifies the following as the top ten CSFs to project success:

1. Project Mission
2. Top Management Support
3. Project Schedule/Plan
4. Client Consultation
5. Personnel
6. Technical tasks
7. Client Acceptance
8. Monitoring and Feedback
9. Communication
10. Trouble-Shooting

Two of the CSFs, “client consultation” and “client acceptance”, which are related to ensuring that the client is involved in the development, testing, and acceptance of user requirements, do not apply to the projects being studied here, and have been excluded from the survey. Additionally, questions associated with “Project Schedule/Plan” from the PIP have been excluded because that area is sufficiently covered by the project management planning quality (PMPQ) model discussed previously. Finally, one additional CSF construct identified by Fortune and White (2006) to assess the performance of suppliers and contractors was added to the survey.

In developing the system owner survey instrument, I selected the two or three questions from each CSF construct that best aligned with a Windows 7 upgrade project, and excluded those that did not apply to this type of project. This reduction allowed the survey to be completed more easily, resulted in a higher percentage of survey completion, and afforded more diligence in answering the questions that remained. Disadvantages of not using the instrument in its original form is that the validity and reliability claims from previous research cannot be invoked in this study, and standards established that would allow comparison to other projects cannot be utilized. This study, however, does compare the relative ranking of the value of CSFs within this study with other historical projects.

In order to reduce the survey to an acceptable length for small projects, only one question is presented for each CSF on the Systems Owner Survey instrument for small projects shown in Appendix D. These questions were deemed to be the most representative of the overall construct for each CSF. When computing a value for the CSF from the data in the large project survey instrument, a simple unit weighted sum of raw scores (Warner, 2008, p. 846) from the Likert scale was used. When assessing the data from the small projects, or when both small and large projects are considered together, only the value from the single question for each CSF was used.

3.2.2.5 Project Success

Traditional measures of project success consider the iron triangle of delivering the project on schedule, within budgeted cost, and achieving the approved quality and scope (PMI, 2013). Current researchers (Jugdev & Muller, 2005) often refer to these three metrics as project efficiency, but also consider other aspects of project success, including the degree to which project objectives and customer needs are met, and call them project effectiveness. Zwikael and Smyrk (2012) similarly distinguish between project management success (efficiency) and project ownership success (effectiveness).

In a similar study assessing the relationship between planning and project success (Zwikael et al., 2014), the authors measured the degree of project success using the constructs of project management success (efficiency) and project ownership success (effectiveness). They measured efficiency with a two item scale consisting of “schedule overrun” and “cost overrun”, both measured from actual project records. They measured effectiveness using a scale of 1 (low) to 10 (high) with a two-item scale consisting of “project performance” and “customer satisfaction”, both as assessed by the supervisors of the project managers.

Standard scales for measuring overall project success were used in (Keith et al., 2013) and (Tiwana & Mclean, 2005). They included measures of over/under budget from actual project records, over/under schedule from project records, use of a 7-point Likert scale by the project manager to assess “overall perceived success”, “this project delivers all features and functionality”, “this project meets key objectives and business expectations”, and “this project is overall very successful.”

No single scale meets the specific needs of this study, so I drew from a range of previous literature for measures of project success as follows. Data used to gage the degree of project success related to efficiency were collected in the project tracking database for each project and included:

1. Number of days deviation between actual completion date in the project tracking database and estimated completion date from the POAM provided for each project.

2. Number of days deviation between the actual completion date in the project tracking database and April 8, 2014.

Additionally, data to gage the efficiency component of project success was solicited via questions in the project success portion of the system owner survey instrument as follows:

1. * The project was completed: (7 point Likert scale: 1 – Significantly Behind Schedule, 7 – Significantly Ahead of Schedule).

2. * Identify the number of project objectives completed (None, Less than Half, About Half, Most, All)

3. Usage of personnel resources on the project was: (7 point Likert scale: 1 – Significantly More than Budgeted, 7 – Significantly Less than Budgeted)

4. The Cost of the project was: (7 point Likert scale: 1 – Significantly More than Budgeted, 7 – Significantly Less than Budgeted).

Measures of project effectiveness are solicited in the system owner survey instrument using a 7-point Likert scale using the following questions as informed by project success factors utilized in (Mir & Pinnington, 2014) that include measures of long-term benefits to the organization, customers and the project team.

1. * Identify the number of project objectives completed (None, Less than Half, About Half, Most, All)

2. * The quality of this system was improved as a result of this project.

3. As a result of executing this project, the organization will be able to better support the users of this system in the future.

4. * I personally consider the project a great success.

For the short project survey instrument, only the items marked with an asterisk are included in the survey, but will still allow a construct of each of the needed variables to support each of the hypotheses proposed. Variables of "Project Success – Efficiency", and "Project Success – Effectiveness" were computed using the items specified above. An overall Project Success value was derived for each project by averaging the two constructs of project success, to support analyses of the hypotheses that require a single project success value.

3.2.2.6 Organizational Project Orientation

Organizations are often structured based on their focus and orientation to managing projects (Cleland & Ireland, 2006; Kerzner, 2013; PMI, 2013). A strongly-matrixed organization grants significant power to project managers to assign and use resources to their projects. In a weakly-matrixed organization, project managers have less authority than functional managers to allocate resources, and must work closely with the functional managers to get the resources they need to execute their project. In a functional organization, projects are managed within the functional organizations, and project managers, if assigned, generally have very limited authority in allocating resources.

In non-project centered organizations, small projects are often not recognized as projects, are begun quickly with no or little planning, and as a result often fail (Larson & Larson, 2009). The Organizational Project Orientation variable measures the experience and proficiency of the organization in formally managing a work task as a project. Two survey questions are presented in both the long and short project surveys to capture this variable:

1. My organization generally performs the following mix of unplanned emergent work vs. planned project work.

    a. Nearly 100% Emergent Work
    b. Mostly Emergent Work
    c. Equal Mix of Emergent and Planned Work
    d. Mostly Planned Project Work
    e. Nearly 100% Planned Project Work

2. Was this effort formally managed as a project?

    a. Managed as its Own Project
    b. Managed as Part of a Larger Project
    c. Not Managed as a Project

An overall organizational project orientation variable was derived from an average of the values from the two survey questions, and was assessed separately as they related to other variables in this study, as was done by Hyvari (2006).

3.2.2.7 Other Demographic Information

Team and project demographic data was collected in the system owner survey. Information included the following:

1. Project Team Role of Respondent
2. Project Start

3.2.3 Survey Development and Administration

The section above discusses the variables needed to support the hypotheses of this research. This section discusses the process and key decisions made in the development of the survey instrument to obtain the data to support those variables. The steps involved in development of a survey instrument may include the following (Fowler, 2014):

1. Focus group discussions
2. Drafting a tentative set of questions
3. Critical review to detect common flaws
4. Individual cognitive interviews
5. Putting questions into a survey instrument
6. Pretesting using an approximation of proposed data collection procedures

I received support from my dissertation committee chair and other committee members, as well as the following individuals in the development and testing the survey instrument for this research: (1) the coordinator responsible for supporting and monitoring each of the Windows 7 upgrade projects in this study, (2) an IT manager who oversaw the completion of four of the Windows 7 upgrade projects included in this study, (3) a project manager who led the execution of the largest of the upgrade efforts, and (4) a statistician and expert in survey and research methods.

The process began with the identification of research questions and hypotheses to be evaluated, which are discussed elsewhere in this document. Clear definition of the hypotheses established the specific variables for which data was to be collected. I developed the first draft survey using the variables needed to support the hypotheses, and obtaining existing survey instruments from prior project management and planning research.

Researchers should seek to make use of existing survey instruments, in whole or in part, in favor of developing their own (Punch, 2003). It is acceptable to use a part of an existing survey, and is often necessary to adapt questions to local conditions (Punch, 2003). A significant portion of the survey instrument used for this study was derived and adapted from a survey instrument on Critical Success Factors (Pinto, 1990), and an instrument on the Quality of Planning (Zwikael & Globerson, 2004); as well as individual or small groups of questions derived from other research. Sources of all survey questions are specified in Tables 13 and 14 and in the discussion of individual variables above.

Keeping the questions and response options similar throughout the survey reduces confusion and makes it easier for the respondent to answer each question (Fowler, 2014). Wherever it made sense, and allowed the collection of the appropriate data, I chose to ask questions with response options on a consistent 7-point Likert Scale with 1 being "Strongly Disagree" and 7 being "Strongly Agree". When asked the number of man-hours expended on a project, I provided a broad range of values to choose from, instead of asking for a specific number, and also provided the insight that 40 man-hours is equivalent to a man-week, and 2000 man-hours is equivalent to a man-year.

An open ended question was provided at the end of the survey, asking the respondent to "Please elaborate on any of your above answers, or identify actions or conditions that contributed to the success or difficulty of this project." Respondents like the opportunity to answer some questions in their own words. To never have the opportunity to say what is on their mind can be a frustrating experience (Fowler, 2014). With this question, I also gained insights into areas that could not have been anticipated and planned for with a 'closed' question with fixed responses.

A critical systematic review of each of the survey questions was conducted, and identified several flaws with specific questions, such as asking compound questions that had to be separated into two questions, and making it easier for users to answer questions. For example, the questions on planning tools were grouped by category, so system owners could more easily distinguish the differences between each question because they were grouped together.

The on-line survey was developed using an electronic form tool from Microsoft called InfoPath that stores survey responses in a SharePoint list. The tool allows creation of a nicely organized survey, with features that allow the skipping of questions that do not apply, and automatic entry of data that can be determined from other responses. The tool, however, because of system validations that require a response for every question, requires that the respondent complete the entire survey before it can be submitted. Respondents were notified of this fact in advance in the email that requested completion of the survey.

A pilot test of the nearly completed survey was conducted by a project manager and an IT manager. Results of that pilot pointed out several unnecessary questions, and led to the decision to create a short form survey for respondents who completed very small Windows 7 upgrade projects. Feedback indicated that the proposed survey of 57 questions was too long for individuals who completed relatively small Windows 7 projects, such as the upgrade of a single, or just a few PCs from Windows XP to Windows 7. Additionally, because these projects were very small, none or few of the formal planning tools queried about in the survey were used in the project, causing frustration for the subject completing the survey, and potential non-response. Because excessive length of a survey can result in non-response or lower quality data (Punch, 2003), it was deemed necessary to create a survey that could be completed in less than ten minutes and eliminate questions that largely wouldn't apply to smaller systems, yet capture all of the variables necessary to support each of the hypotheses well.

Non-responses to a survey can introduce significant bias into a survey (Fowler, 2014). The most important difference between good mail surveys and poor mail surveys is the extent to which researchers make repeated contact with non-respondents (Fowler, 2014). They found that the steps for ensuring good response rates on mail surveys are likely to produce similar benefits in on-line surveys; specifically: identifiable sponsors, well designed instruments, financial incentives, and repeated contacts, including phone requests to those who don't respond to an initial email request.

The survey was advertised to all system owners and their managers via email on April 18, 2014, representing 175 systems that had been upgraded to Windows 7 to support Microsoft's April 8, 2014 end of Windows XP support date. System owners were requested to complete the survey by April 30, 2014. I followed up with all non-responders via email on April 25 and had received 88 survey responses by April 30, 2014.

Microsoft terminated support of the Windows XP operating system on April 8, 2014. Systems running Windows XP after that date are now vulnerable to viruses and attacks for which no patches are available, making systems vulnerable to corruption or compromise of sensitive data. Projects being evaluated in this study were planned and executed with the goal of completion before April 8, 2014. Project managers of all projects in this study were surveyed after project completion, and within 12 months of project completion. Recency is important for subjects to be able to respond reliably about the data of interest (Kirsch, Sambamurthy, Ko, & Purvis, 2002).

3.3 HYPOTHESES

I evaluated the following hypotheses in this study. Related research in the evaluation of similar hypotheses for other sizes and types of projects is presented for comparison and perspective.

3.3.1 The Correlation between Project / Organizational Factors and IT Project Success

The series of hypotheses presented in this section investigate the correlation between project and organizational factors, and the success of projects. Project success is measured in terms of efficiency, effectiveness, and overall project success, and all three elements of success are examined.

Hypothesis 1.1 – There is a statistically significant correlation between IT Project Success (Success) and Performance on Individual Critical Success Factors (CSFs).

$$H_{1.1-0}\text{:}\ \rho_{Success,\ CSFs} = 0$$

$$H_{1.1-1}\text{:}\ \rho_{Success,\ CSFs} \neq 0$$

A wide range of factors can influence whether an IT project is successful. Extensive research has been done to identify the critical success factors (CSFs) related to project success (Fortune & White, 2006; Pinto & Slevin, 1987; Westerveld, 2003), and conversely, the early warning signs (EWSs) of project failure (Kappelman et al., 2006; Pinto & Mantel, 1990). Hypothesis 1.1 asserts that high performance on critical success factors can predict project success.

Hypothesis 1.2 – The ranking of the contribution of critical success factors to project success of Small IT Projects is significantly correlated with other researchers' findings.

$$H_{1.2-0}\text{:}\ \rho_{CSF\ Ranking_{Laird},\ CSF\ Ranking_{Other\ Studies}} = 0$$

$$H_{1.2-1}\text{:}\ \rho_{CSF\ Ranking_{Laird},\ CSF\ Ranking_{Other\ Studies}} \neq 0$$

Hyvari (2006) conducted a study to assess the impact of different organizational conditions on overall project success as perceived by project managers in regard to their most recent project. The study considered organizational context in project management, critical success factors in project management, and dependencies between these two factors. In the study, the researchers compared the ranking of critical success factors in order of importance from previous studies, and compared them to their findings. To evaluate Hypothesis 1.2, CSFs will be ranked in regard to the level of impact on project success, and those rankings compared with results from previous studies (Delisle & Thomas, 2002; Finch, 2003; Hyvari, 2006; Pinto & Prescott, 1988; Pinto & Slevin, 1987) in order to draw conclusions about how these factors may differently affect small IT projects.

Table 15 - Comparison of rankings of CSFs related to project success from previous studies (Hyvari, 2006)

	Hyvari (2006)	Finch (2003)	Delisle and Thomas (2002)	Pinto and Prescott (1988)	Pinto and Slevin (1987)
Project Mission	**6**	**7**	**1**	**1**	**1**
Top Management Support	**4**	**6**	**9**	**7**	**2**
Project schedule/plans	**5**	**5**	**5**	**9**	**3**
Client Consultation	**2**	**1**	**2**	**2**	**4**
Personnel	**9**	**10**	**10**	**10**	**5**
Technical task	**7**	**9**	**4**	**3**	**6**
Client acceptance	**3**	**4**	**6**	**4**	**7**
Monitoring and feedback	**10**	**3**	**3**	**5**	**8**
Communication	**1**	**2**	**8**	**6**	**9**
Trouble-shooting	**7**	**8**	**7**	**8**	**10**
Note: Numbers in the above table indicate relative rankings of different factors in individual studies.					

Hypothesis 1.3 – There is a statistically significant correlation between IT Project Success (Success) and Various Project and Organizational Factors (Project Factors).

$$H_{1.3-0}\colon\ \rho_{Success,\ \ Project\ Factors} = 0$$

$$H_{1.3-1}\colon\ \rho_{Success,\ \ Project\ Factors} \neq 0$$

Aladwani (2002b) found that project size was not correlated with IT project success. Hypothesis 1.3 will investigate whether other project or organizational conditions measured in this study influence project success.

The variables to be assessed for correlation with project success include the following:

1. Overall Complexity
2. Individual Variables that Make up the project complexity construct
    a. Size of the Project Team
    b. # of Man-hours
    c. # of Standard Windows 7 Project Elements completed on the project
    d. # of PCs
    e. Sensitivity of Data
3. Overall Project Risk
4. Individual Elements of Project Risk
    a. Schedule Risk
    b. Technical Risk
5. Organizational Project Orientation
6. Individual Elements associated with Organizational Project Orientation
    a. % of Organization's Work that is Emergent vs. Planned
    b. Project Managed as a Project?
7. Project Start Date

Hypothesis 1.4 – The Level of IT Project Success (Success) is Significantly Improved if an IT task is Formally Managed as a Project (Managed as Project).

$$H_{1.4-0}: \ \mu_{Success:\ Managed\ as\ a\ Project} = \mu_{Success:\ Managed\ as\ Part\ of\ a\ Project} = \mu_{Success:\ Not\ Managed\ as\ a\ Project}$$

$$H_{1.4-1}: \ Means\ are\ not\ all\ equal$$

Pérez-Ezcurdia and Marcelino-Sádeba (2012) observed that project management discipline is often not practiced because a task is not recognized as a project. Everyday work may not be distinguished from project work, so the effort may not be appropriately planned, team member roles not assigned, and risks not identified (Larson & Larson, 2009). Similarly, Rowe (2006) found that companies often call an effort that should be managed as projects, a task or an assignment. Formal management of such tasks as a project would provide the opportunity to define expectations and better use resources.

3.3.2 The Correlation Between Planning and Project Success

PMBOK® (PMI, 2013) identifies the standard processes that should be performed by a project manager. Of the 47 processes identified in the PMBOK®, 24 (51%) are planning processes. Project planning is generally accepted to be at the core of project management, and an essential activity for project success (Zwikael & Globerson, 2004).

Hypothesis 2.1 – There is a statistically significant correlation between IT Project Success (Success) and the Overall Level of Planning of a Project (Planning).

$$H_{2.1-0}\colon\ \rho_{Success,\ Planning} = 0$$

$$H_{2.1-1}\colon\ \rho_{Success,\ Planning} \neq 0$$

Numerous researchers and studies have identified planning as a Critical Success Factor to project success (Fortune & White, 2006; Murphy et al., 1974; Pinto & Slevin, 1987). Failure to document milestone deliverables and due dates in project plans (Kappelman et al., 2006), failure to reconcile project schedule deadlines with project plans, and ignoring early project delays without revision to the overall project schedule (McKeeman, 2001), were all found to be significant contributors to IT project failure. This evidence that planning contributes to project success, and that the lack of planning elements contribute to IT project failure, all support Hypothesis 2.1.

Hypothesis 2.2 – Critical Success Factors and other Project Factors (Project Factors) significantly influence the correlation between IT Project Success (Success) and the Overall Level of Planning of a Project (Planning).

$$H_{2.2-0}\colon\ \rho_{Success,\ Planning} = \rho_{Success,\ Planning-\ controlling\ for\ Project\ Factors}$$

$$H_{2.2-1}\colon\ \rho_{Success,\ Planning} \neq \rho_{Success,\ Planning-\ controlling\ for\ Project\ Factors}$$

Because many factors influence the degree of project success, the correlation between the level of planning and project success will also be controlled for the CSF and organizational factor variables identified in Hypotheses 1.1 and 1.3 above, which most strongly influence project success individually. For example, project complexity is known to be an important variable in the level of project success (Xia & Lee, 2005), so levels of planning will be compared across equivalent levels of project complexity in determining its impact on project success.

A primary benefit of planning is to reduce uncertainty in the execution of projects (Shenhar, 1993). The effectiveness of planning is contingent upon the context of the project and environment in which it is performed (Dvir & Lechler, 2004). A number of researchers have investigated project contingencies that influence the effect of planning on project success. Zwikael et al. (2014) found no effect of project planning on project success; nor on the discreet components of project success which they broke down into efficiency (as measured by project schedule and cost performance) or effectiveness (as measured by project performance and customer satisfaction.) The study did, however, find that the level of perceived risk by the project manager at the start of the project had a moderating effect on the influence of planning on project success. Their results indicate that planning is positively related to the project efficiency component of project success when the risk level was higher, and planning is positively related to the project effectiveness component of project success when the risk level is lower.

Similarly, Pinto and Prescott (1990) found that planning has a stronger impact on what they termed external success (consisting of the perceived value of the project and customer satisfaction) than on project efficiency (as measured by project schedule and cost performance). Hyvari (2006) investigated the success of projects in different organizational conditions, and found that various contingencies influenced the effect of critical success factors on project success.

Aladwani (2002b) found that IT project success was correlated with project planning, that project size (as measured by the number of people on the project) was a significant predictor of project planning, but that project size was not correlated with IT project success. Finally, they found that project uncertainty (as a function of project size, project structure, and project newness) was correlated with IT project success when mediated with project planning. They concluded that the increase in project size likely complicates the planning process. Similarly, Hackman and Morris (1974) found that project size can influence IT project success through task strategies such as project planning. Conte et al. (1986) concluded that the number of communication paths in a large project can be vast and result in ineffective coordination.

Much of the analysis within this dissertation is based on bivariate correlations. The small number of projects in the sample of this study makes it difficult to partial out a large number of factors. This is an exploratory hypothesis to identify which factors significantly influence the effect of planning on project success.

Hypothesis 2.3 – There is a statistically significant correlation between IT Project Success (Success) and the Level of Usage of Individual Planning Tools (Planning Tools).

$$H_{2.3-0}\text{:}\ \rho_{Success,\ Planning\ Tools} = 0$$

$$H_{2.3-1}\text{:}\ \rho_{Success,\ Planning\ Tools} \neq 0$$

Payne and Turner (1999) state that as a minimum, project planning elements should include a project definition report, milestone plan, and project responsibility chart, and state that further, more detailed planning may not be required. Hypothesis 2.3 investigates which project planning tools contribute to project success.

Hypothesis 2.4 – There is a statistically significant correlation between IT Project Success (Success) and the Level of Usage of Functional Requirements Documents (Requirements Documents).

$$H_{2.4-0}:\ \rho_{Success,\ \ Requirements\ Documents} = 0$$

$$H_{2.4-1}:\ \rho_{Success,\ \ Requirements\ Documents} \neq 0$$

Hypothesis 2.5 – There is a statistically significant correlation between IT Project Success (Success) and the Level of Usage of Design Specifications (Design Specifications).

$$H_{2.5-0}:\ \rho_{Success,\ \ Design\ Specifications} = 0$$

$$H_{2.5-1}:\ \rho_{Success,\ \ Design\ Specifications} \neq 0$$

One experiment by Dvir et al. (2003) found that project success was not influenced by the level of implementation of traditional project management processes and procedures. However, they found that the development of both functional requirements and technical specifications did result in improved project success. Saarinen (1990) found that IT projects with problems with requirements specification are more likely to fail than those that do not. Hypotheses 2.4 and 2.5 will evaluate whether these same findings hold true among small IT projects.

3.3.3 Non-Linear Inverse U-Shaped Correlation between Planning and Project Success

The hypotheses in this section investigate the idea that there is an optimal amount of planning that should be performed to achieve project success; too little planning may result in poor team coordination or the completion of tasks out of sequence, requiring rework; and too much planning may waste time better spent on project execution. It is hypothesized that this concept may be partially revealed in a non-linear relationship between the level of planning and the degree of project success.

Hypothesis 3.1 – There is a statistically significant change in slope (beta) in the best fit curve relating the Level of Planning (LOP) with the various components of Project Success (Success).

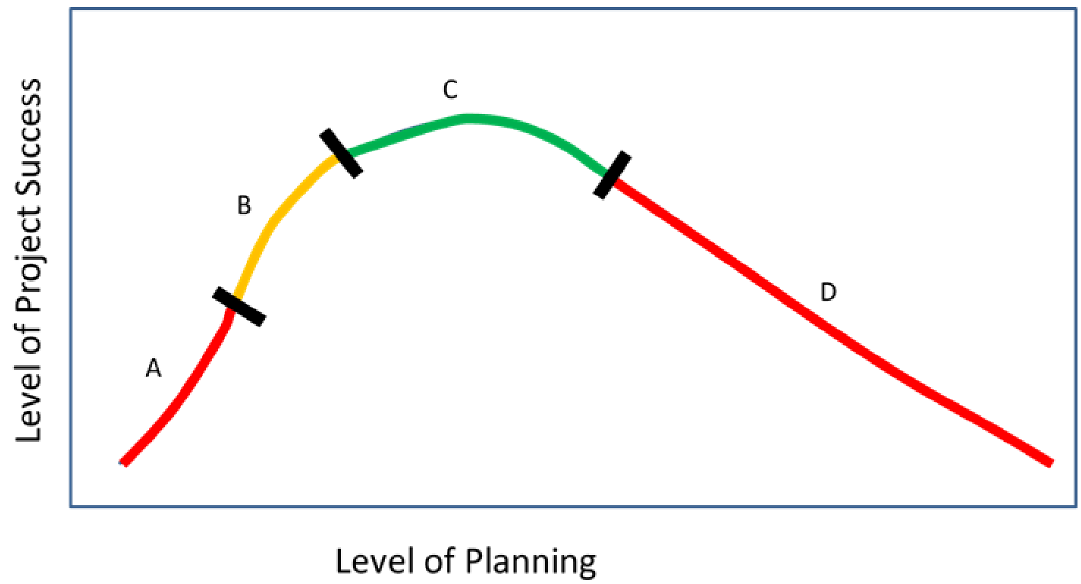
$$H_{3.1-0}:\ beta = 0$$

$$H_{3.1-1}:\ beta \neq 0$$

Recent studies of Agile project management have demonstrated that for projects with certain characteristics, including high uncertainty or project risk, extensive up-front planning typical of the more traditional project-based frameworks are too cumbersome to address complex IT project issues within acceptable timeframes (Leybourne, 2009). In a study of the relationship between the comprehensiveness of Strategic Information Systems Planning (SISP) performed and the success of that planning (Newkirk et al., 2003), the researchers hypothesized that a non-linear inverse-U function relationship existed between the comprehensiveness of each of the five phases of SISP, and SISP success in the organization. Regression analysis found, however, that such a relationship existed only for the Strategy Implementation Planning Phase of SISP, and a linear relationship existed for the other four phases.

This study will investigate a more complex, non-linear relationship between planning and project success, to identify the point where project planning is optimized, and beyond which it produces negative returns in project value. A non-linear inverse U-shaped correlation between planning and project success is asserted. Project planning is not a guarantee against project failure and too much planning may curtail creativity (Ika, Diallo, & Thuillier, 2010), but there is evidence to support the claim that a minimum level of planning is required (Andersen, 1996; Bart, 1993). Per Dvir et al. (2003): "In fact, although planning does not guarantee project success, lack of planning will probably guarantee failure" (p. 89).

Figure 6 provides a visual representation of the hypothesized relationship between the level of planning and project success, with an explanation of the level of success envisioned at the different levels of planning. This model speculates that some minimal level of planning is necessary for IT project success, that simple plans developed for non-complex IT projects deliver significant value to project success, that increasing levels of planning produce marginally increasing benefits, and that there is a point where additional planning detracts from the success of the project.



A - Insufficient Planning – Planning is inadequate for project success

B - Minimum Required Planning – This range represents the minimum required planning to achieve adequate acceptable project success. Given scarce resources and higher organizational priorities, this level may be the target level to deliver optimal organizational efficiency.

C - Optimal Level of Planning – Level of planning that achieves the best balance of resource allocation and project success.

D - Excessive Planning – Levels of planning are a burden on the organization, and may cause inflexibility in incorporating technical advances and responding to changing business conditions.

Figure 6 - Non-Linear Correlation between Project Success and Level of Planning

Expanding on Hypothesis 3.1, this research investigated the assertion that even simple plans developed for non-complex IT projects deliver significant value to project success. I then investigated the assertion that some minimal level of planning is necessary for IT project success. Further analysis investigated the assertion that there is an optimal level of project planning, beyond which the project begins to experience negative results in terms of project success.

3.3.4 The Effect of System Upgrades on the Various Measures of Project Success

Traditional measures of project success consider the iron triangle of delivering the project on schedule, within budgeted cost, and achieving the approved quality and scope (PMI, 2013). Current researchers (Jugdev & Muller, 2005) often refer to these three metrics as project efficiency, but also consider other aspects of project success, including the degree to which project objectives and customer needs are met, and call them project effectiveness. Zwikael and Smyrk (2012) similarly distinguish between project management success (efficiency) and project ownership success (effectiveness).

Hypothesis 4.1 – Upgrade of a system or network to Windows 7 will improve the Perceived System Quality.

$$H_{4.1-0}:\ \mu_{System\ Quality} \leq 4$$

$$H_{4.1-1}:\ \mu_{System\ Quality} > 4$$

Maintenance projects such as the Windows 7 upgrade projects in this study are hypothesized to deliver unanticipated value beyond the requirement to discontinue use of an unsupported operating system. This enhancement may result in improved systems for users, and strengthen project teams such that they are in a position to better support and maintain systems in the future.

3.3.5 Assessing the Type and Level of Planning Done for Small IT projects.

The hypotheses in this section seek to evaluate the types and level of planning that is done on small IT projects. This research first seeks to understand existing practices on small IT project, and later to explore the value of those practices to the organization.

Hypothesis 5.1 – Project Practitioners Prefer to Use Some Planning Tools More Than Others

$$H_{5.1-0}\text{: } \mu_{Schedule} = \mu_{Start\ and\ End} = \mu_{Tasks\ Assigned} = \mu_{Scope} = \mu_{Requirements} = \mu_{Design} = \mu_{Risk} = \mu_{Quality}$$

$$H_{5.1-1}\text{: } Means\ are\ not\ all\ equal$$

Payne and Turner (1999) state that minimal project planning elements should include a project definition report, milestone plan, and project responsibility chart, and state that further, more detailed planning, may not be required. This hypothesis seeks to identify which project planning tools are used most frequently on small IT projects.

Hypothesis 5.2 – There is a statistically significant difference between the rank of the mean usage of a planning tool (Usage), the rank of the mean of its perceived value (Perceived Value), and the rank of the correlation between Success and the Use of that Tool (Actual Value).

$$H_{5.2-0}\text{: } \rho_{Usage,\ \ Perceived\ Value,\ \ Actual\ Value} = 0$$

$$H_{5.2-1}\text{: } \rho_{Usage,\ \ Perceived\ Value,\ \ Actual\ Value} \neq 0$$

Besner and Hobbs (2012) identified a listing of tools and techniques generally used by project management practitioners, which included initial project planning and risk management, and assessed which are used more frequently based on the type of the project, including IT projects. They continued this research (Besner & Hobbs, 2013) by identifying more specific groupings of projects, which included small, internal projects performed by large organizations like the Windows 7 projects studied in this dissertation; identified the most frequently used tools and techniques, and then conducted an analysis of which were "best practices" based on how well each tool or technique supported the "performing-maturity" measure that they had developed.

Zwikael (2009) went a step further and compared the level of use of project planning processes across industries, and compared that to the contribution each planning process contributed to project success. He found that project managers would be able to execute their project more effectively if they spend more time on the processes that most contributed to project success, and less time on those planning processes that provide a less significant contribution.

De Bakker et al. (2010) conducted a meta-analysis of 29 studies to determine the correlation between risk management and IT project success. They concluded that project management practitioners paying attention to project risk is likely to have more impact on IT project success than if they follow the steps prescribed in formal risk management processes. Buehring (2006) proposes the essential project management practices that should be applied to small projects. A simple rule of thumb related to project documentation presented in this article is: "if it isn't useful in helping us to deliver the business objectives of the project then don't waste time to produce it" (p. 1).

Hypothesis 5.3 – There is a statistically significant correlation between the Level of Planning performed on a Project (LOP) and various Project and Organizational Factors (Project Factors).

$$H_{5.3-0}:\ \rho_{LOP,\ Project\ Factors} = 0$$

$$H_{5.3-1}:\ \rho_{LOP,\ Project\ Factors} \neq 0$$

The purpose of this hypothesis is to evaluate which project teams and organizations do more formal planning than others and why. What conditions exist that allow or facilitate organizations to conduct more formal planning than other organizations? What type and level of planning do practitioners of small projects pursue and consider effective in achieving project success?

Hypothesis 5.4 – There is a statistically significant correlation between the Level of Planning performed on a Project (LOP) and the Project Orientation of the Organization Performing the Project (Project Orientation).

$$H_{5.4-0}:\ \rho_{LOP,\ Project\ Orientation} = 0$$

$$H_{5.4-1}:\ \rho_{LOP,\ Project\ Orientation} \neq 0$$

A common problem with small projects is that they may not be recognized as such, begun quickly with little or no planning, and as a result may have poor results (Larson & Larson, 2009). Hypothesis 5.4 assesses the correlation between the organization's project orientation with the level of planning performed on projects.

3.3.6 Summary of Hypotheses

Figure 7 graphically represents the correlations between variables that were evaluated as part of this dissertation. Numbers in text boxes associated with arrows are hypothesis numbers. Dashed lines indicate that these factors were evaluated on how they influence the impact of planning on project success.

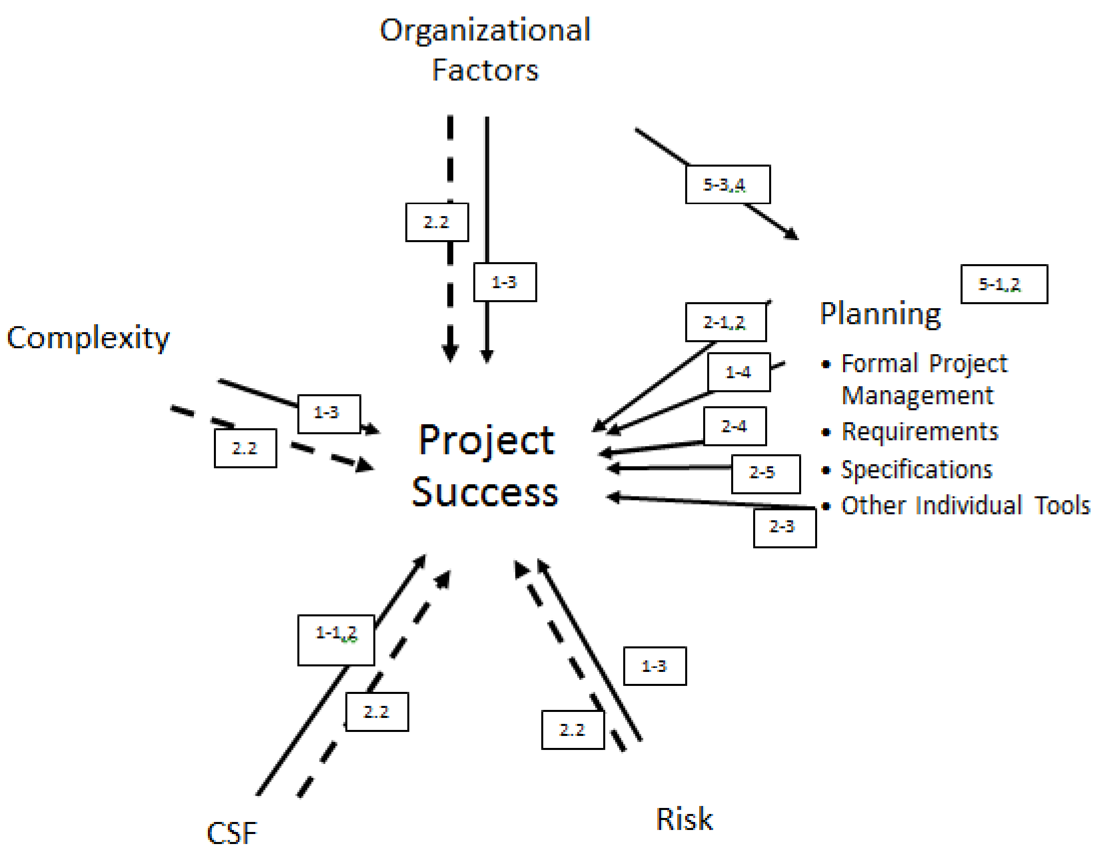


Figure 7 - Correlation Hypotheses

4.0 RESULTS

This section describes the collection of data, evaluates the validity of the data collected, and presents the statistical analysis of that data in evaluating the hypotheses and assertions in the research design described in Section 3.0. Statistical results are presented here, and discussion of the significance of these findings is explored in Section 4.5.

4.1 SURVEY SAMPLE

Surveys were distributed to participants on 179 Windows 7 projects, and surveys were completed for 79 of those projects. Long survey forms were distributed to participants in projects involving the upgrade of 10 or more PCs to Windows 7. All other project participants received the short survey form to complete. Fourteen of the projects were assessed using the long survey, and 69 with the short survey. All of the questions present in the short form are also in the long form.

Surveys were completed for five of the projects by two different individuals. Responses received from multiple individuals for a single project were averaged to derive a single record for each project. Because the focus of this research is small IT projects, four projects identified as requiring more than one man-year of effort were also excluded from the results that were analyzed.

4.2 PROJECT DEMOGRAPHICS

This section provides descriptive statistics regarding the survey participants and the projects that were the subjects of their survey responses. As seen in Figure 8, surveys were predominantly completed by individuals identifying themselves as Subject Matter Experts (40), Technical Leads (18), and Team

Members (11) associated with each system, indicating limited project management formality because of the paucity of project managers and managers directly involved in individual efforts.

Figure 8 - Role of Survey Respondents

Figures 9 through 15 provide histograms to show the degree of normality and skewness of each of the ordinal variables assessed in this study. Assessing the degree of normality of variables is important in determining whether parametric or non-parametric statistics are most appropriate in evaluating correlations between variables, as discussed in greater detail in the sections below. This information also provides insight into the nature of the projects evaluated in this study. The degree that each of the critical success factors (CSFs) were present in the projects studied were generally normal and skewed slightly toward the positive end of the scale, with the value of "6 – Agree" being the most frequent response for each of the CSFs.

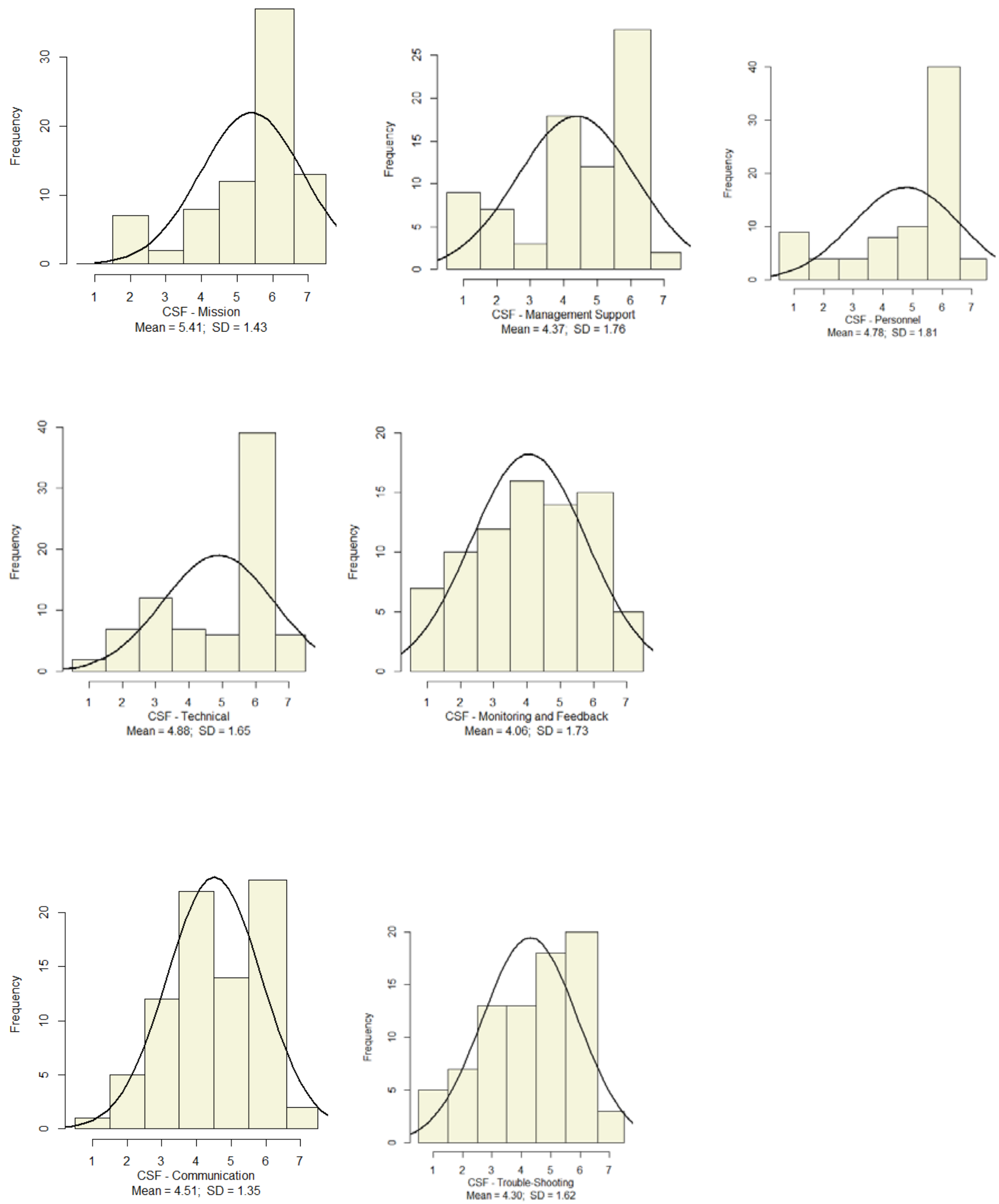


Figure 9 - Assessment of Normal Distribution and Skewness of CSF Variables

Histograms of the Success variables represented in Figure 10 indicate normality of distribution. The efficiency component of success has a mean of 3.88 on a scale of 1 through 7 indicating that projects on average were completed slightly later than planned. The effectiveness component of success was approximately normal, and has a mean of 4.86, which represents a higher than average perception of success in the softer measures of success. Overall project success, and average of the two components of success also is normal, with mean of 4.37.

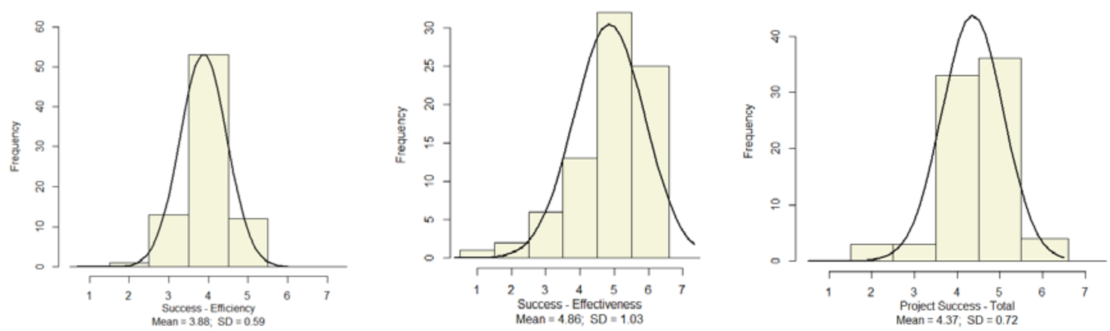


Figure 10 - Assessment of Normal Distribution and Skewness of Success Variables

A histogram of the level of overall planning presented in Figure 11 indicates a weakly normal distribution with a mean of 2.15; strongly skewed to the right, indicating that projects had a low level of planning in general.

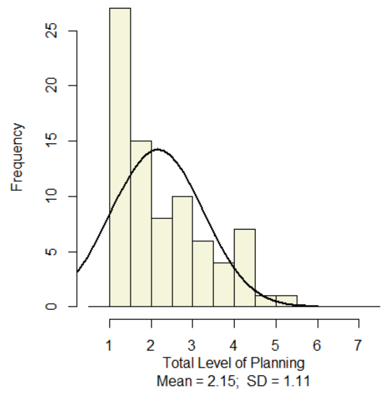


Figure 11 - Assessment of Normal Distribution and Skewness of Planning Tool Variables

The histograms of the usage of individual planning tools, shown in Figure 12, was not normal, and strongly skewed to the right, with the most frequent response indicated that the planning tool in question was not used. The distribution of the perceived effectiveness of individual planning tools, however, were roughly normal with a mean approximately 4 or “Effective”, when the “Not Used” responses are removed.

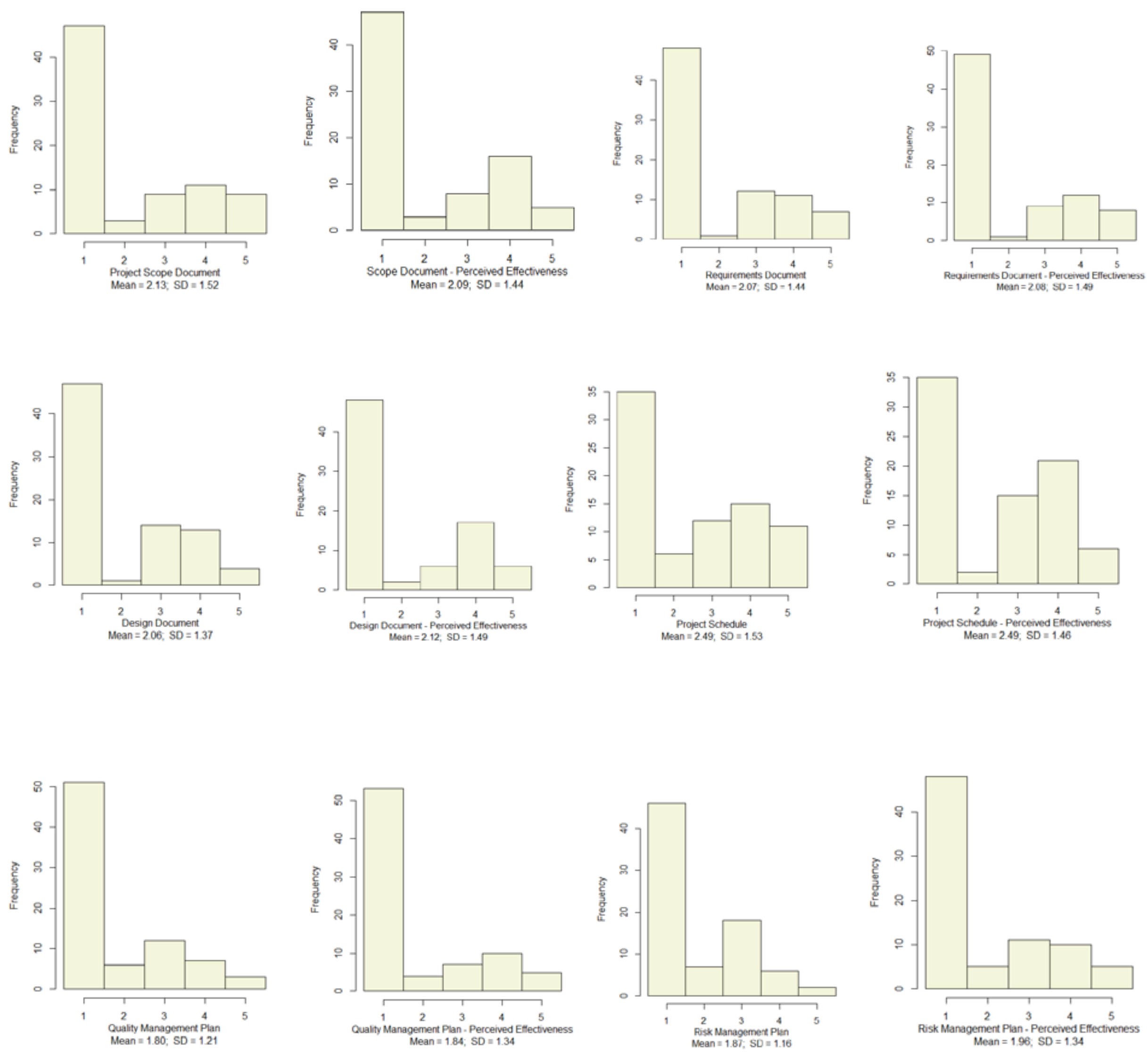


Figure 12 - Assessment of Normal Distribution and Skewness of Planning Tool Variables

Histograms of perceived schedular, technical, and overall risk showed normal distributions. Means of approximately 3.8 indicating a moderate level of risk across projects in general.

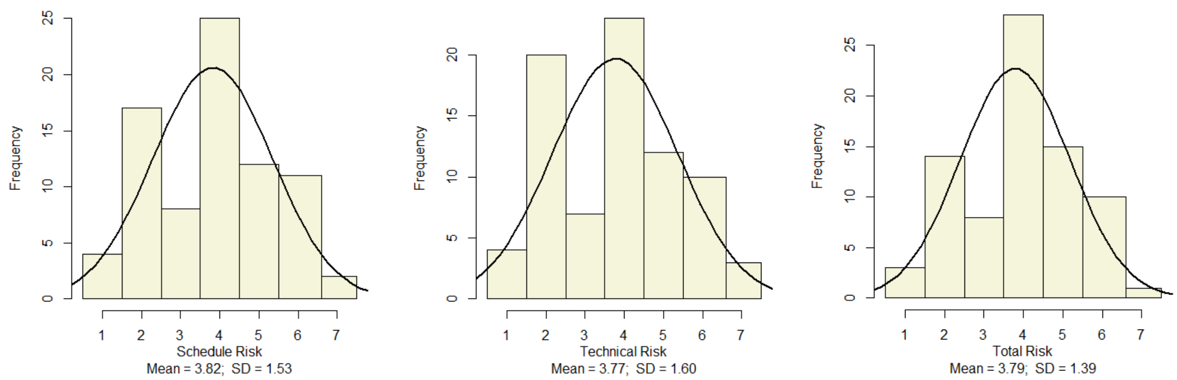


Figure 13 - Assessment of Normal Distribution and Skewness of Risk Variables

The distribution of the degree of general project orientation of organizations executing the projects studied is normal, with a mean of 3.22, indicating that organizations in general are more project than operations oriented. The second factor assessed below considers whether each individual project was managed as a project or not. The distribution is normal, so the value of the results can be compared with the outcome of each project, but the absolute value of this variable cannot be easily interpreted.

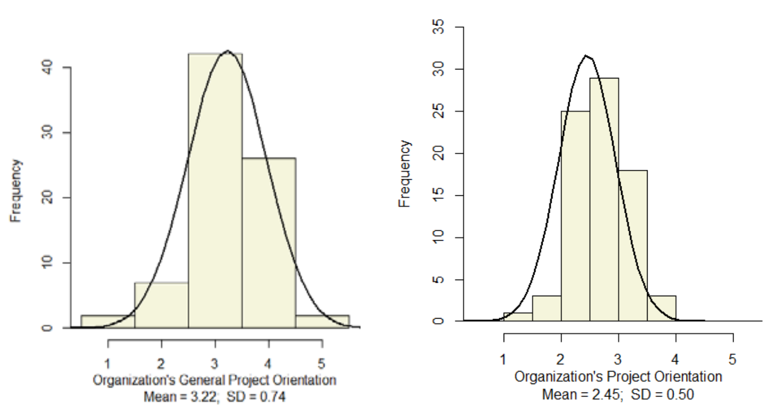


Figure 14 - Assessment of Normal Distribution and Skewness of Project Orientation Variables

The distribution of the number of PCs upgraded to Windows 7 in each project is not normal and strongly skewed to the right. Large outliers to the right are retained in this study; only projects that required more than one man-year of effort were not considered small projects and were excluded. Similarly, team size is not normal and skewed to the right, with the most frequent value of one, with teams of two and three accounting for the majority of the remaining projects. Variables associated with project complexity show a normal distribution, although skewed to the right.

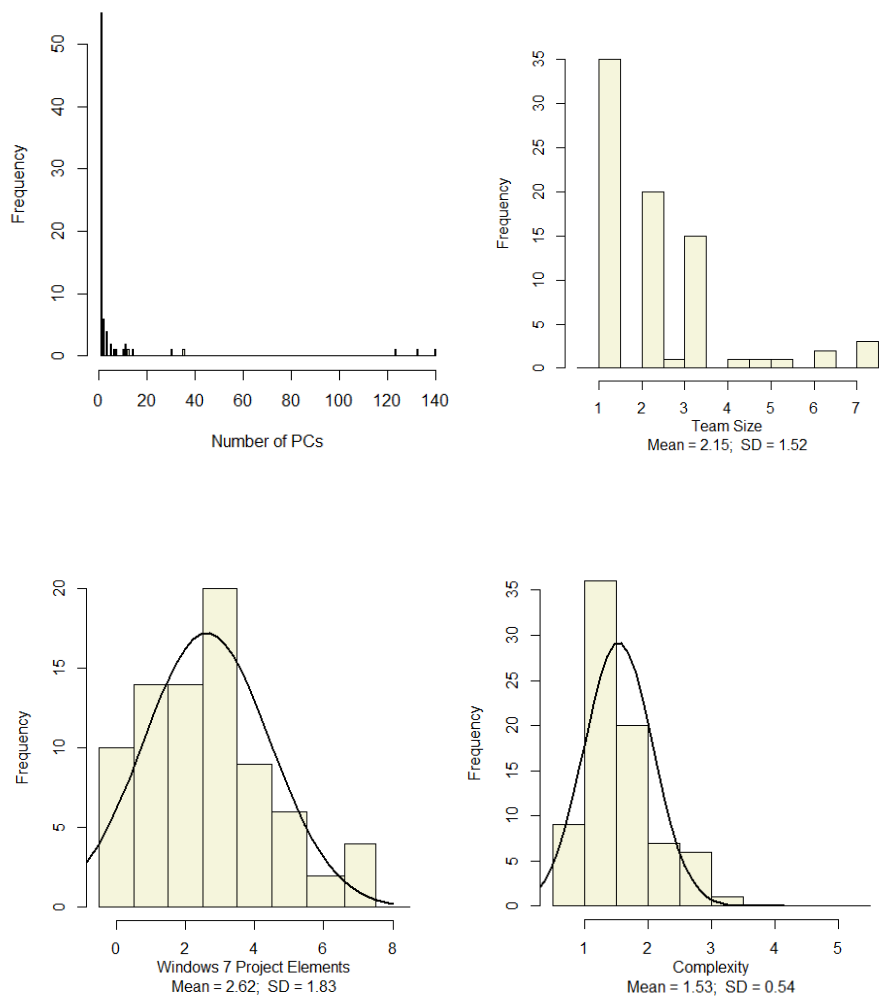


Figure 15 - Assessment of Normality and Skewness of Organizational and Project Variables

4.3 DATA ANALYSIS

This section discusses general considerations of the verification and validation of variables used in this study. This section also discusses general techniques for analyzing the data to support the hypotheses presented in this research. More detailed descriptions of statistical techniques are presented in Section 4.4 in the evaluation of each individual hypothesis.

4.3.1 Data Verification and Validation

Before the data analysis can be performed, specific properties must be satisfied for the various statistical methods to be appropriate for use. I describe here how each variable used in this study meets, or fails to meet, those properties. Additional verification and validation of individual statistical analyses may be provided with the individual hypothesis analysis results below. All variables were assessed for normality, and statistical techniques were selected for evaluation of data to account for instances where normality was not observed. Additionally, internal data validity was tested using Cronbach's alpha for variables derived from multiple inputs.

4.3.1.1 Internal Data Validity

Cronbach's alpha, a common measure of internal data validity for variables derived from a combination of multiple inputs, was computed for each variable construct discussed in section 3.2 above as was done in similar planning studies (Newkirk et al., 2003). A minimum value of 0.7 is recommended (Nunnally, 1978) to ensure internal consistency, but values above 0.6 are considered acceptable. Results for each construct are presented in Table 16.

Table 16 - Cronbach Alpha computation for Variable Constructs

Variable	Cronbach Alpha	# of Input Items	Confidence Interval	
			2.5%	97.5%
Total Level of Planning	0.904	8	.857	.934
Complexity	0.704	5	.578	.755
Total Risk	0.728	2	.560	.863
Success - Efficiency	0.246 **	3	-.023	.444
Success - Effectiveness	0.691	3	.553	.808
Success - Total	0.633	2	.391	.781

The original project management planning quality (PMPQ) instrument was validated by Zwikael and Globerson (2006a). In that study, the PMPQ model's reliability was calculated using a number of statistical tests, with results of 0.91 and 0.93, respectively for the entire model, and for its components. Results were also found in that study to be independent of the person answering the questions, be it a project manager or a senior manager. The Total Level of Planning variable construct in this research was based on the PMPQ but questions were modified as discussed in Section 3 above, and the number of planning tools assessed was reduced from sixteen to the six deemed most likely to be used in a Windows 7 upgrade project. The Cronbach Alpha for Level of Planning of .904 indicates a strong level of internal validity. The Cronbach Alpha for the variables measuring success are at the lower end of the acceptable range of internal validity with scores of .691 for effectiveness and .633 for the measure of overall success.

The value of .246 for the effectiveness component of success is not at an acceptable range of Cronbach Alpha, but the variable will continue to be reported in the statistical results. The traditional measures of project management success; completion on schedule, within cost, and delivering the required scope, has been difficult to measure and show accurate correlation with project and organizational factors. Additionally, Tavakol and Dennick (2011) indicate that internal consistency refers to the extent to which all the items in a test measure the same concept or construct. For a variable, such as effectiveness, which includes cost, schedule and quality, it does not make sense to report alpha for the test.

4.3.2 Data Analysis Statistics and Techniques

General statistical techniques for supporting the hypotheses proposed in this research are presented in this section. More specific techniques unique to evaluating individual hypotheses are discussed below each hypothesis.

4.3.2.1 Parametric Analysis of Ordinal Scales

Several assumptions must be met for parametric statistics such as bivariate Pearson correlation (Pearson's *r*) to be appropriate statistics to describe the relationship between two variables. Scores on both the X and Y variables must be quantitative and normally distributed. The charts in Section 4.2 show that values associated with critical success factors (CSFs), measures of project success, project orientation of the organization, and measures of risk are sufficiently normal to permit the use of parametric statistics. Measures of the level of planning, usage of individual planning tools, and the perceived value of planning tools used are not normal in distribution, and are significantly skewed to the right, indicating that a large percentage of the projects had a low level of planning and planning tool usage. Finally, measures of the size of projects including the number of PCs and the size of project team are also not normally distributed and skewed to the right, indicating that a large percentage of projects were small, with a declining percent as the numbers become larger.

Some researchers observe a strict requirement that variables must be at an interval/ratio level of measurement. Stevens (1946) provided a conservative set of rules related to the use of statistical analyses regarding the various levels of variable measurement; nominal, ordinal, interval and ratio. These rules suggested that because ordinal measurements (e.g., Likert scales) do not require equal intervals between values, that parametric statistics such as mean, Pearson's *r*, and Analysis of Variance (ANOVA) techniques are not valid. There is continuing debate about these criteria.

Zumbo and Zimmerman (1993) conducted simulation analyses and found that it is not necessary to replace parametric statistical tests with nonparametric tests when the scale of measurement is ordinal and not interval. Stevens (1946) himself, in his seminal paper, provided the below caveat to this restriction:

> "As a matter of fact, most of the scales used widely and effectively by psychologists are ordinal scales. In the strictest propriety the ordinary statistics involving means and standard deviations ought not to be used with these scales, for these statistics imply a knowledge of something more than the relative rank-order of data. On the other

hand, for this 'illegal' statisticizing there can be invoked a kind of pragmatic sanction: In numerous instances it leads to fruitful results."

It is common practice for Pearson's *r* to be used for 7-point Likert scale measures, which probably do not reflect exactly equal differences between values in the scale (Warner, 2008). Harris (2001) argued that it is more important that the data be normally distributed than this strict adherence to an interval/ratio level of measurement. Pearson correlation statistics are therefore used, however sparingly, in this study, and deviations from normality are noted as appropriate.

I used parametric one-way between-subjects ANOVA analyses in evaluating the differences in mean values of success for various nominal categories based on the above justification for use of parametric statistics, and because measures of success were sufficiently normal. In all correlation analyses throughout this study, however, I chose to use the more conservative non-parametric Spearman correlation statistic.

4.3.2.2 Correlation Analysis and Bivariate Linear Regression

Multiple linear regressions were conducted in some instances to test the significance of correlations between the variables as defined in the hypotheses. This analysis expands upon work performed by other researchers, and provides unique insights into the specified data correlations unique to small IT projects. Data was compared to previous studies in various areas, such as Dvir and Lechler (2004), who described the use of exploratory correlation analysis that reduced an initial list of twelve different contextual variables to six, which were found to significantly affect the planning process, and were the subject of additional analysis.

4.3.2.3 Partial Correlation Analysis

Partial correlation analysis was conducted to assess the correlation between two variables, while controlling for one additional variable. For example, the effect of planning on project success was assessed as discussed below using correlation and bivariate linear regression. However, because many factors influence the success of projects at the same time, it is desirable to control for one or more additional variables such as individual CSFs, the complexity of the project, the perceived level of risk, etc., in order to determine the true correlation between variables. The approach used in this study is similar to that used by Zwikael et al. (2014), who ran hierarchical regression analyses to test the main effect and moderating effect hypotheses in their studies to assess the effect of planning on project success as moderated by project risk.

4.3.2.4 Non-linear, inverted U-Shaped Function between Planning and Project Success

In evaluating the non-linear, inverted U-shaped function relating the level of planning with project success, segmented regression analysis techniques used by Newkirk et al. (2003) as defined by Hudson (1966) were employed. This technique consists of dividing the range of the independent variable into segments, and fitting either a linear or non-linear regression model to each segment, developing a continuous model for the independent variable. Newkirk et al. (2003) fitted a two-segment regression model to test for an inverted U-shaped function; a linear model for the lower half, followed by a quadratic model for the upper half. Where the slope of the linear model in the initial segment was significant and positive, and the coefficient of the quadratic term in the second segment was significant and negative, the hypothesis of a non-linear, U-shaped function was confirmed.

An alternative procedure for analyzing non-linear functions is to develop a bivariate scatter plot to visually assess the nature of the relationship between the two variables (Warner, 2008, p. 166). The non-linear curve could be broken into segments and each segment analyzed via regression analysis, or by applying a data transformation such as taking the log or square of the independent variable, then applying linear regression.

4.4 EVALUATION OF HYPOTHESES

This section presents the results of data analyses related to each of the hypotheses presented in the research design. Where statistical techniques employed are unique to the hypothesis, those techniques are discussed in further detail.

4.4.1 The Correlation between Project / Organizational Factors and IT Project Success

This group of hypotheses assesses the three elements of project success; efficiency, effectiveness, and total project success; with various project and organizational factors observed for each project.

Hypothesis 1.1 – There is a statistically significant correlation between IT Project Success (Success) and Performance on Individual Critical Success Factors (CSFs).

$$H_{1.1-0}\colon\ \rho_{Success,\ CSFs} = 0$$

$$H_{1.1-1}\colon\ \rho_{Success,\ CSFs} \neq 0$$

Spearman correlations were performed to assess whether levels of project success as measured in efficiency, effectiveness, and total project success could be predicted from the degree to which seven individual critical success factors were present in the project. The source and measurement of each variable analyzed across a sampling of 79 projects are described in section 3.2., above. The twenty-one Spearman correlation values are reported in Table 17 with associated statistical significance. The correlation between all of the CSFs and each of the three measures of project success was statistically significant using $p < .05$ (two-tailed), with three exceptions. The project team's proficiency in three CSFs, the level of management support, the ability to complete technical tasks, and the level of monitoring and feedback, were not statistically significant in their correlation with the Efficiency component of Project Success.

If Bonferroni-corrected alpha levels are used to control for the inflated risk of Type I error that occurs when multiple significance test are performed, the alpha level is .05/21 = .002. Using this more conservative criterion for statistical significance, fourteen of the twenty-one correlations remained statistically significant, and with regard to the correlation with Total Project Success, only Management Support and Monitoring and Feedback were not statistically significant. Researchers have debated the validity of Bonferroni adjustments, citing that these adjustments will increase the number of Type II errors, and often ignor promising findings as insignificant, that may prove to be interesting unexpected results (Perneger, 1998; Rothman, 1990). The Bonferroni analysis indicates a strong correlation between CSFs and Project Success, so assessment of the null hypothesis is based on the original alpha values used with the Spearman correlation. The null hypothesis is rejected for all pairwise comparisons with the exception of the three comparisons not highlighted in Table 17, and is accepted for all other comparisons.

Table 17 - Spearman Correlation between CSFs and Project Success

		Project Success		
		Efficiency	Effectiveness	Total
Project Mission	Spearman Correlation	.22	.52	.49
	Sig. (2-tailed)	.046	.000	.000
	N	79	79	79
Management Support	Spearman Correlation	.22	.34	.36
	Sig. (2-tailed)	.031	.002	.001
	N	79	79	79
Personnel	Spearman Correlation	.21	.52	.48
	Sig. (2-tailed)	.056	.000	.000
	N	79	79	79
Technical Tasks	Spearman Correlation	.21	.52	.49
	Sig. (2-tailed)	.058	.000	.000
	N	79	79	79
Monitoring and Feedback	Spearman Correlation	.15	.35	.30
	Sig. (2-tailed)	.197	.002	.007
	N	79	79	79
Communication	Spearman Correlation	.28	.50	.49
	Sig. (2-tailed)	.011	.000	.000
	N	79	79	79
Troubleshooting	Spearman Correlation	.40	.56	.59
	Sig. (2-tailed)	.000	.000	.000
	N	79	79	79

Hypothesis 1.2 – The ranking of the contribution of critical success factors to project success of Small IT Projects is significantly correlated with other researchers' findings.

$$H_{1.2-0}\colon\ \rho_{CSF\ Ranking_{Laird},\ CSF\ Ranking_{Other\ Studies}} = 0$$

$$H_{1.2-1}\colon\ \rho_{CSF\ Ranking_{Laird},\ CSF\ Ranking_{Other\ Studies}} \neq 0$$

The correlation values between Total Project Success and the Various CSFs in Table 17 are identified in rank order in Table 18. Spearman correlations of the CSF rankings between this study and previous research are presented in Table 19. The results reveal no significant correlation between this study and any of the future studies using α = .05 (two-tailed). Only the rankings reported between Delisle and Thomas (2002) and Pinto and Prescott (1988) were found to be significant in pairwise comparison among all of the studies. The Null hypothesis is therefore rejected.

Table 18 - Ranking of the Importance of CSFs between this Study and Earlier Research

	Laird (2016)	Hyvari (2006)	Finch (2003)	Delisle and Thomas (2002)	Pinto and Prescott (1988)	Pinto and Slevin (1987)
Project Mission	**2**	**6**	**7**	**1**	**1**	**1**
Top Management Support	**6**	**4**	**6**	**9**	**7**	**2**
Project Schedule/Plans	**-**	**5**	**5**	**5**	**9**	**3**
Client Consultation	**-**	**2**	**1**	**2**	**2**	**4**
Personnel	**5**	**9**	**10**	**10**	**10**	**5**
Technical Task	**3**	**7**	**9**	**4**	**3**	**6**
Client Acceptance	**-**	**3**	**4**	**6**	**4**	**7**
Monitoring and Feedback	**7**	**10**	**3**	**3**	**5**	**8**
Communication	**4**	**1**	**2**	**8**	**6**	**9**
Trouble-Shooting	**1**	**7**	**8**	**7**	**8**	**10**

Note: Numbers in the above table indicate relative rankings of different factors in individual studies.

Of most interest in this comparison of CSF rankings, the value of the ability to Trouble-Shoot problems was much higher in the current study than in all previous studies. The ranking of all other CSFs aligned with one or more of the historical studies, but no strong correlation existed with any of the previous studies across all CSFs.

Table 19 - Spearman Correlation between CSF Rankings of Various Studies

		Laird (2016)	Hyvari (2006)	Finch (2003)	Delisle and Thomas (2002)	Pinto and Prescott (1988)	Pinto and Slevin (1987)
Laird (2016)	Spearman Correlation	1.00	.25	-.36	.29	.14	-.18
	Sig. (2-tailed)		.585	.432	.535	.760	.702
	N		5	5	5	5	5
Hyvari (2006)	Spearman Correlation		1.00	.45	-.16	.14	.13
	Sig. (2-tailed)			.310	.728	.758	.788
	N			5	5	5	5
Finch (2003)	Spearman Correlation			1.00	.21	.29	-.21
	Sig. (2-tailed)				.645	.535	.645
	N				5	5	5
Delisle and Thomas (2002)	Spearman Correlation				1.00	.86	.07
	Sig. (2-tailed)					.014	.879
	N					5	5
Pinto and Prescott (1988)	Spearman Correlation					1.00	.32
	Sig. (2-tailed)						.482
	N						5
Pinto and Slevin (1987)	Spearman Correlation						1.00
	Sig. (2-tailed)						
	N						

Hypothesis 1.3 – There is a statistically significant correlation between IT Project Success (Success) and Various Project and Organizational Factors (Project Factors).

$$H_{1.3-0}\colon\ \rho_{Success,\ \ Project\ Factors} = 0$$

$$H_{1.3-1}\colon\ \rho_{Success,\ \ Project\ Factors} \neq 0$$

A Spearman Correlation test examined the correlations between the three measures of project success and various project and organizational factors. Table 20 displays the results of this test. The null hypothesis is rejected for all pairwise comparisons highlighted in Table 20, and is accepted for all other comparisons.

Table 20 - Correlation between Project Success and Various Project and Organizational Variables

		Project Success		
		Efficiency	Effectiveness	Total
Number of PCs	Spearman Correlation	-.08	.12	.07
	Sig. (2-tailed)	.468	.282	.517
	N	79	79	79
Project Organization	Spearman Correlation	.22	.10	.18
	Sig. (2-tailed)	.047	.402	.119
	N	79	79	79
Scheduler Risk	Spearman Correlation	-.04	.07	.07
	Sig. (2-tailed)	.749	.548	.554
	N	79	79	79
Technical Risk	Spearman Correlation	.03	-.13	-.09
	Sig. (2-tailed)	.821	.264	.446
	N	79	79	79
Total Risk	Spearman Correlation	.00	-.05	-.02
	Sig. (2-tailed)	.996	.694	.868
	N	79	79	79
Start	Spearman Correlation	-.29	.00	-.17
	Sig. (2-tailed)	.010	.981	.130
	N	79	79	79
Team Size	Spearman Correlation	.02	.06	.05
	Sig. (2-tailed)	.843	.580	.655
	N	79	79	79
Man Hours	Spearman Correlation	-.26	-.20	-.26
	Sig. (2-tailed)	.023	.859	.209
	N	79	79	79
Number of Windows 7 Project Elements	Spearman Correlation	-.24	-.20	-.25
	Sig. (2-tailed)	.030	.073	.022
	N	79	79	79
Managed as a Project?	Spearman Correlation	.11	.29	.24
	Sig. (2-tailed)	.316	.009	.034
	N	79	79	79
Complexity	Spearman Correlation	-.27	-.09	-.19
	Sig. (2-tailed)	.014	.418	.086
	N	79	79	79

Hypothesis 1.4 – The Level of IT Project Success (Success) is Significantly Improved if an IT task is Formally Managed as a Project (Managed as Project).

$$H_{1.4-0}\text{:}\ \mu_{Success:\ Managed\ as\ a\ Project} = \mu_{Success:\ Managed\ as\ Part\ of\ a\ Project} = \mu_{Success:\ Not\ Managed\ as\ a\ Project}$$

$$H_{1.4-1}\text{:}\ \ Means\ are\ not\ all\ equal$$

A one-way between-subjects ANOVA was done to compare the mean scores on a scale of overall project success (1 = No Success, 7 = Highly Successful) for small IT projects which were categorized by whether the task was managed as a project, managed as part of a project, or not managed as a project. Examination of a histogram of project success scores indicated that the scores were approximately normally distributed with no extreme outliers (see Figure 16).

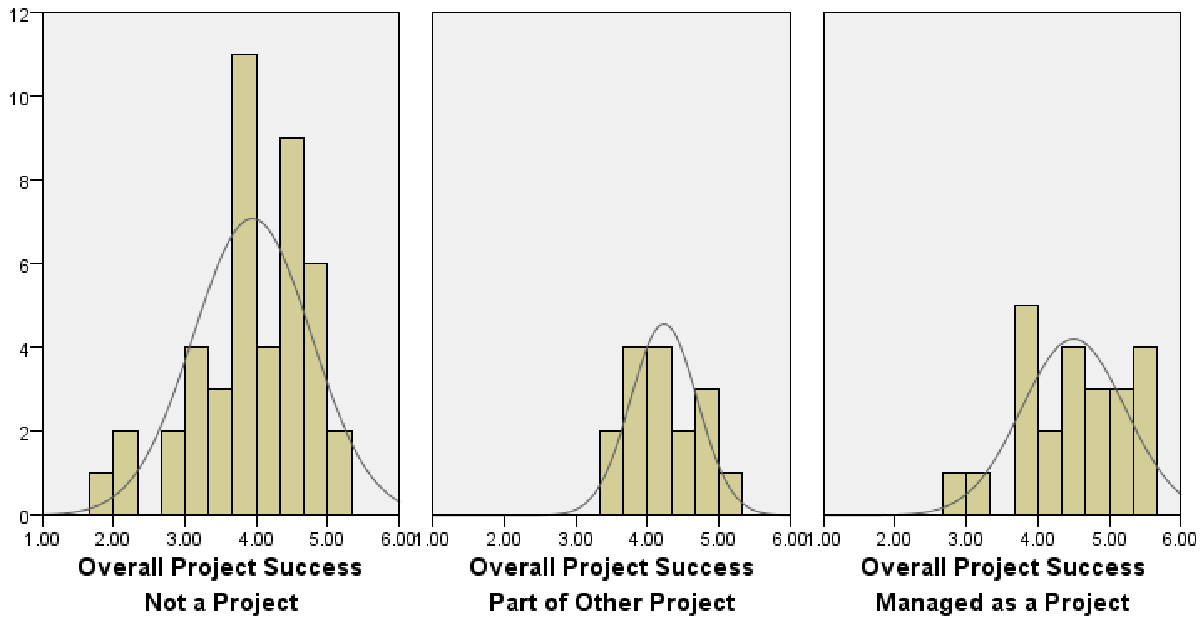


Figure 16 - Histogram of "Project Success" by "Managed as Project" Category

Prior to the analysis, a Levene test for homogeneity of variance was used to examine whether there were serious violations of the assumption of homogeneity of variance across groups, but no significant violation was found: $p=.063$. The overall F for the one-way ANOVA was statistically significant, $F(77) = 6.251$, $p=.015$. The null hypothesis is therefore rejected.

Table 21 - Mean level of Project Success grouped by whether a task was managed as a project, managed as part of a larger project, or not managed as a project

	N	Mean	Std. Dev	Minimum	Maximum
Not Managed as a Project	45	4.2049	.7896	1.5	5.33
Part of Another Project	16	4.4688	.4625	3.5	5.08
Managed as a Project	18	4.6750	.6352	3.5	5.5
Total	79	4.3654	.7211	1.5	5.5

This result corresponded to an effect size of ETA = .10; that is, about 10% of the variance in project success was predictable from the degree that the task was managed as a project. This is a small effect, so additional analysis and partial correlations are investigated later in this analysis. The means and standard deviations for the three groups are shown in Table 21.

One planned contrast (comparing the "Not Managed as a Project" group with the combination of the "Managed as a Project" and "Managed as Part of a Project" groups) was performed. This contrast was tested using Alpha = .05, two-tailed; the t-test that did not assume equal variances was used because the homogeneity of variance assumption was violated. For this contrast, $F(1,77) = 6.0117$, $p = .016$. The mean project success score for the "Not Managed as a Project" ($M = 4.20$) was significantly lower than the mean project success score for the groups that were managed as projects ($M = 4.58$).

In addition, all possible pairwise comparisons were made using the Tukey HSD test. Based on this test (using Alpha = .05), it was found that the "Managed as a Project" group scored significantly higher on project success ($M = 4.675$) than the "Not Managed as a Project" group ($M = 4.205$). Figure 17 shows a 75% CI around each group mean.

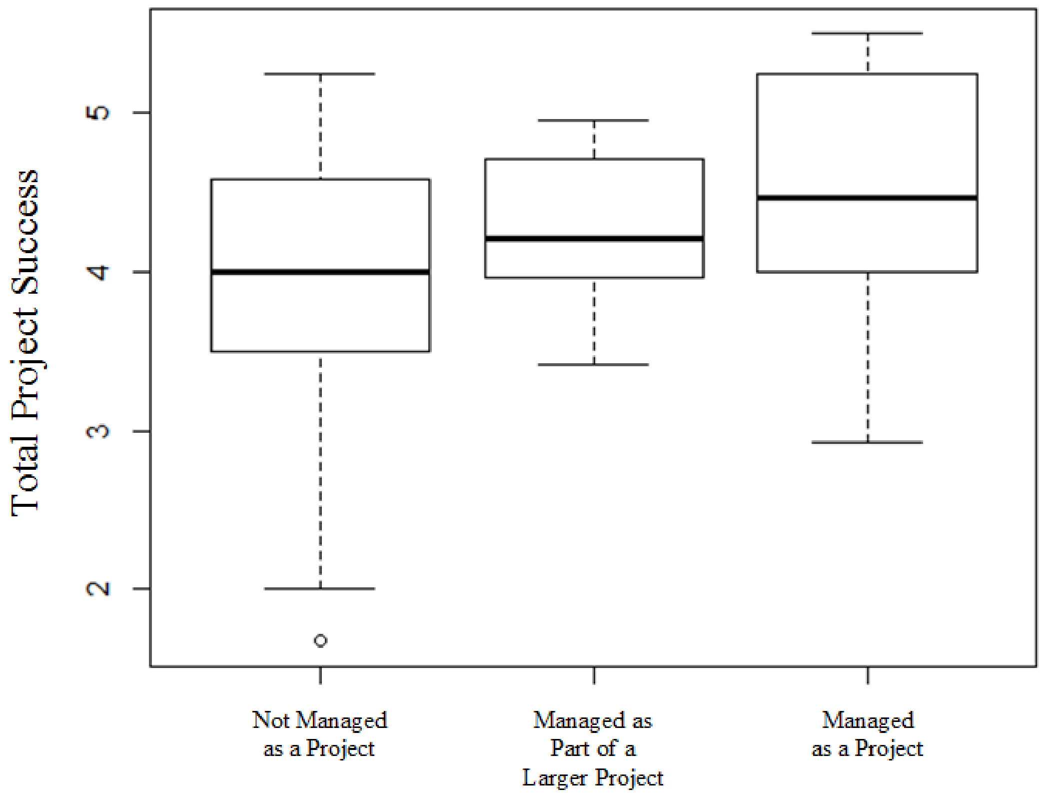


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Figure 17 - Box Plots of Project Success by Managed as Project Category

4.4.2 The Correlation Between Planning and Project Success

This group of hypotheses explores the relationship between the Level of Planning observed on a project and the success of that project.

Hypothesis 2.1 – There is a statistically significant correlation between IT Project Success (Success) and the Overall Level of Planning of a Project (Planning).

$H_{2.1-0}$: $\rho_{Success,\ Planning} = 0$

$H_{2.1-1}$: $\rho_{Success,\ Planning} \neq 0$

A Spearman correlation was performed to assess whether project success could be predicted from the level of planning applied to a small IT project. Examination of the histograms indicated that project success variables have a normal distribution, but the total level of planning scale was not close to normal and skewed to the right with most projects having little planning applied. A Spearman correlation first transforms the data to ranked values; a technique judged most appropriate given the non-interval nature of the level of planning data. The scatter plot of level of planning vs. project success generally indicated a linear relationship, but further analysis of the non-linear nature of this relationship is explored in later analysis. As shown in Table 22, the correlation between "level of planning" and "total project success", rho(79) = .23, p=.041, and between "level of planning" and the "effectiveness component of project success", rho(79) = .28, p=.011, were statistically significant, given $\alpha = .05$ (two tailed). The correlation between "level of planning" and "project efficiency" was not statistically significant (see Table 22).

Table 22 - Spearman correlation statistics between "Total Level of Planning" and "Project Success" and its components.

			Project Success		
			Efficiency	Effectiveness	Total
Spearman's rho	Total Level of Planning	Correlation Coefficient	.13	.28	.23
		Sig. (2-tailed)	.249	.011	.041
		N	79	79	79

The null hypothesis is therefore rejected for the correlation between the Level of Planning and both the Effectiveness Component of Project Success and Total Project Success, but is accepted for the correlation between the Level of Planning and the Efficiency Component of Project Success.

Additional Analysis using POAM Data

A Spearman correlation was performed to assess whether project success could be predicted from the level of planning applied to a small IT project, as measured by the subjective assessment of the project's level of planning gleaned from the POAM. Results of this assessment are provided in Table 23. All results are statistically insignificant.

Table 23 - Correlation between the Project Success and Level of Planning (Subjective POAM Assessment)

		Project Success		
		Efficiency	**Effectiveness**	**Total**
Subjective Assessment from POAM of the Level of Planning	Spearman Correlation	-.03	.00	.05
	Sig. (2-tailed)	.858	.996	.712
	N	52	52	52

Hypothesis 2.2 – Critical Success Factors and other Project Factors (Project Factors) significantly influence the correlation between IT Project Success (Success) and the Overall Level of Planning of a Project (Planning).

$$H_{2.2-0}\colon\ \rho_{Success,\ Planning} = \rho_{Success,\ Planning-\ controlling\ for\ Project\ Factors}$$

$$H_{2.2-1}\colon\ \rho_{Success,\ Planning} \neq \rho_{Success,\ Planning-\ controlling\ for\ Project\ Factors}$$

Partial correlations computed between the Level of Planning and Project Success detailed in Table 25, and compared to the zero order correlation from Table 24, indicate the following. The Null Hypothesis is rejected for the results highlighted in the Effectiveness and Total Success columns in Tables 25. The Null Hypothesis is accepted for all other tests.

The partial correlations controlling for the number of Windows 7 project elements in the task, and overall project complexity, were greater than the value of the zero-order correlation. This indicates that these variables are suppressor variables, and controlling for them reveals a stronger relationship between level of planning and project success.

Statistical power is the likelihood of obtaining a sample large enough to reject a null hypothesis of a correlation of zero, when the population correlation is really non-zero. The computed spearman correlation between Level of Planning and Total Project Effectiveness was found to be .28, which squared is .08. Assuming a grouping of 7 levels of the various control variables, and a total sample of 79 projects, there is an average of approximately 11 samples per group. Statistical tables indicate a power of less than 25% can be achieved based on the sample size available. As can be expected from this analysis, calculations of the partial correlation between level of planning and project success, while controlling for variables that may account for a large portion of the correlation, often fail to confirm a positive correlation. These analyses, however, provide an indication of the factors that may account for portions of the correlation, yet are not sufficient evidence to indicate that a correlation would not be found given a larger sample size.

Table 24 - Zero order correlation between Level of Planning and Project Success

			Project Success		
			Efficiency	Effectiveness	Total
Spearman's rho	Total Level of Planning	Correlation Coefficient	.13	.28	.23
		Sig. (2-tailed)	.249	.011	.041
		N	79	79	79

Table 25 - Partial correlation statistics between "Total Level of Planning" and "Project Success" and its components, controlling for various CSFs and organizational and project factors

			Project Success		
Control Variables			**Efficiency**	**Effectiveness**	**Total**
Project Organization	Total Level of Planning	Correlation Coefficient	.12	.28	.22
		Sig. (2-tailed)	.310	.013	.052
		df	79	79	79
Managed as a Project?	Total Level of Planning	Correlation Coefficient	.09	.19	.15
		Sig. (2-tailed)	.418	.097	.193
		df	79	79	79
Scheduler Risk	Total Level of Planning	Correlation Coefficient	.14	.28	.22
		Sig. (2-tailed)	.213	.014	.052
		df	79	79	79
Technical Risk	Total Level of Planning	Correlation Coefficient	.13	.33	.26
		Sig. (2-tailed)	.261	.004	.022
		df	79	79	79
Total Risk	Total Level of Planning	Correlation Coefficient	.14	.31	.24
		Sig. (2-tailed)	.238	.006	.033
		df	79	79	79
# Windows 7 Elements	Total Level of Planning	Correlation Coefficient	.14	.29	.24
		Sig. (2-tailed)	.228	.009	.033
		df	79	79	79
Complexity	Total Level of Planning	Correlation Coefficient	.21	.32	.29
		Sig. (2-tailed)	.061	.004	.009
		df	79	79	79
CSF – Clearly Defined Mission	Total Level of Planning	Correlation Coefficient	.04	.07	.01
		Sig. (2-tailed)	.759	.542	.919
		df	79	79	79
CSF – Management Support	Total Level of Planning	Correlation Coefficient	.09	.15	.09
		Sig. (2-tailed)	.420	.176	.413
		df	79	79	79
CSF – Ability of Personnel	Total Level of Planning	Correlation Coefficient	.08	.17	.11
		Sig. (2-tailed)	.512	.134	.325
		df	79	79	79
CSF – Technical Skills Available	Total Level of Planning	Correlation Coefficient	.05	.10	.04
		Sig. (2-tailed)	.669	.405	.737
		df	79	79	79
CSF – Monitoring and Feedback	Total Level of Planning	Correlation Coefficient	.08	.16	.12
		Sig. (2-tailed)	.499	.153	.292
		df	79	79	79
CSF - Communication	Total Level of Planning	Correlation Coefficient	.07	.21	.14
		Sig. (2-tailed)	.530	.071	.217
		df	79	79	79
CSF – Troubleshooting Ability	Total Level of Planning	Correlation Coefficient	.10	.27	.21
		Sig. (2-tailed)	.404	.016	.070
		df	79	79	79

Hypothesis 2.3 – There is a statistically significant correlation between IT Project Success (Success) and the Level of Usage of Individual Planning Tools (Planning Tools).

$$H_{2.3-0}:\ \rho_{Success,\ \ Planning\ Tools} = 0$$

$$H_{2.3-1}:\ \rho_{Success,\ \ Planning\ Tools} \neq 0$$

Spearman correlations were performed to assess whether a correlation exists between the use of each of the eight planning tools evaluated and project success. Distribution of each of the planning variables is non-normal and skewed to the left, indicating low usage of the planning tools across projects. Because of the ordinal nature of the planning variables in this study, and their non-normal distribution, the non-parametric Spearman correlation statistic is used. Scatter plots suggested weakly linear relationships between pairs of variables, so an alpha of 0.1 was used. The eight Spearman correlations are shown in Table 26. Usage of three of the planning tools had a statistically significant correlation with total project success. Use of a scope document (rho(77) = .24, p = .031), requirements document (rho(77) = .20, p = .076), and use of start and end dates (rho(77)= .23, p = .046). Four of the eight tools, Scope Document (rho(77) = .22, p = .046), Start and End Dates (rho(77) = .33, p < .003), Responsiblities Identified (rho(77) = .24, p = .030), and Quality Management Plan (rho(77) = .19, p = .093) had a positive correlation with project effectiveness as shown in Table 26, and one tool, requirements document (rho(77) = .19, p = .092), had a positive correlation with project efficiency. The Null Hypothesis is therefore rejected for all highlighted results in Table 26, and accepted for all other values.

If Bonferroni-corrected alpha levels are used to control for the inflated risk of Type I error that occurs when multiple significance tests are performed, the alpha level is 0.1/24 = .004. Using this more conservative criterion for statistical significance, only one correlation, use of start and end dates vs. project effectiveness was judged statistically significant.

Table 26 - Spearman correlation statistics between the level of usage of eight project planning tools and project success

		Project Success		
		Efficiency	Effectiveness	Total
Scope	Spearman Correlation	.18	.22	.24
	Sig. (2-tailed)	.111	.046	.031
	N	79	79	79
Requirements Document	Spearman Correlation	.19	.18	.20
	Sig. (2-tailed)	.092	.112	.076
	N	79	79	79
Design Document	Spearman Correlation	.17	.06	.12
	Sig. (2-tailed)	.140	.577	.287
	N	79	79	79
Project Schedule	Spearman Correlation	.09	.18	.16
	Sig. (2-tailed)	.431	.116	.167
	N	79	79	79
Start and End Dates Specified	Spearman Correlation	.02	.33	.23
	Sig. (2-tailed)	.864	.003	.046
	N	79	79	79
Responsibilities Identified	Spearman Correlation	.05	.24	.17
	Sig. (2-tailed)	.647	.030	.133
	N	79	79	79
Quality Management Plan	Spearman Correlation	.08	.19	.12
	Sig. (2-tailed)	.461	.093	.272
	N	79	79	79
Risk Management Plan	Spearman Correlation	.08	.14	.08
	Sig. (2-tailed)	.465	.233	.496
	N	79	79	79

Additional Analysis using POAM Data

A one-way between-subjects ANOVA was done to compare the mean scores on a scale of overall project success (1 = No Success, 7 = Highly Successful) for small IT projects which were categorized by whether resources were assigned in project plans within the POAM developed for the project. The results, shown in the boxplot in Figure 18, indicate a positive correlation between assigning resources and overall project success. The mean for projects in which resources were assigned to tasks was 4.37, and 4.27 when resources were not assigned to tasks in the POAM. The overall F for the one-way ANOVA was not statistically significant, $F(2,52) = 0.321$, $p=.727$.

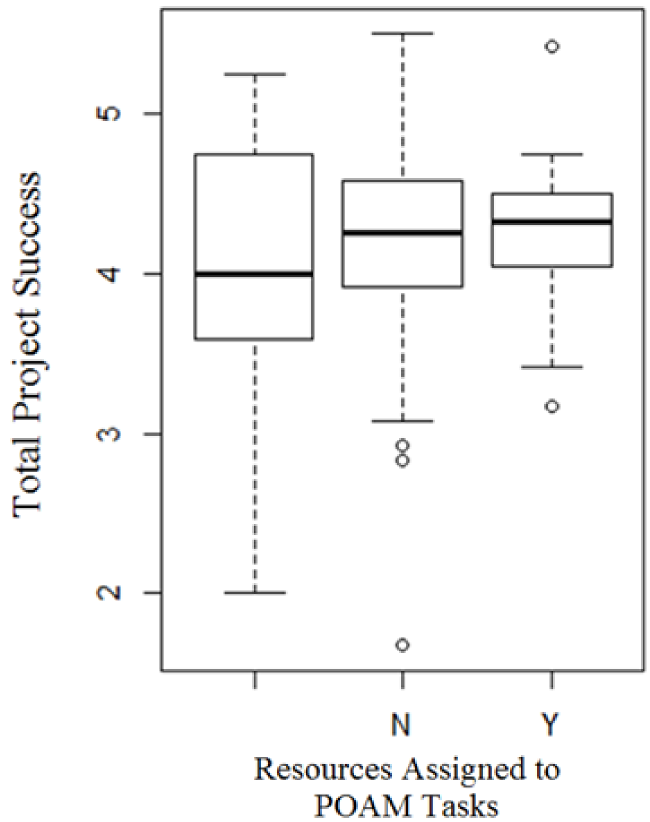


Figure 18 - Boxplot showing Mean Total Project Success for Projects with and without Resources assigned to tasks in POAMs

Hypothesis 2.4 – There is a statistically significant correlation between IT Project Success (Success) and the Level of Usage of Functional Requirements Documents (Requirements Documents).

$$H_{2.4-0}\colon\ \rho_{Success,\ \ Requirements\ Documents} = 0$$

$$H_{2.4-1}\colon\ \rho_{Success,\ \ Requirements\ Documents} \neq 0$$

As shown in Table 26, a statistically significant correlation exists between the use of a requirements document and the efficiency component of project success and total project success, but not for the effectiveness component of project success. The Null Hypothesis is therefore rejected for efficiency and total project success, but is accepted for the effectiveness component of project success.

Hypothesis 2.5 – There is a statistically significant correlation between IT Project Success (Success) and the Level of Usage of Design Specifications (Design Specifications).

$$H_{2.5-0}\colon\ \rho_{Success,\ Design\ Specifications} = 0$$

$$H_{2.5-1}\colon\ \rho_{Success,\ Design\ Specifications} \neq 0$$

As shown in Table 26, no statistically significant correlation exists between the use of a design document and project success. The Null Hypothesis is therefore accepted.

4.4.3 Non-Linear Inverse U-Shaped Correlation Between Planning and Project Success

This section seeks to identify the existence of non-linearity in the relationship between the level of planning and project success.

Hypothesis 3.1 – There is a statistically significant change in slope (beta) in the best fit curve relating the Level of Planning (LOP) with the various components of Project Success (Success).

$$H_{3.1-0}\colon\ beta = 0$$

$$H_{3.1-1}\colon\ beta \neq 0$$

A Davies Test was performed to test for the largest difference-in-slope between adjoining segments of a linear regression model for Level of Planning and the various components of Project Success. A statistically significant value indicates a non-linear relationship between variables. The Davies Test found no significant change in slope in 9 equal segments in the best fit curves relating Level of Planning to Efficiency, Effectiveness, or Total Success. The null hypothesis is confirmed.

4.4.3.1 There is a Point Where Additional Planning Detracts from Project Success

The below analysis investigates the assertion that there is a point where additional planning on a project detracts from the success of the project. Non-linear analyses were performed per procedures documented in (Rossiter, 2009).

In Figure 19, a polynomial best fit between Level of Planning and Total Project Success shows a slight non-linear relationship between the level of planning and project success. The shape of the curve might indicate that increasing levels of planning have marginally increasing value as measured by the level of project success. Figure 19 shows continuously increasing levels of success as the level of planning increases. There is no evidence in this graph to indicate that additional planning would detract from project success.

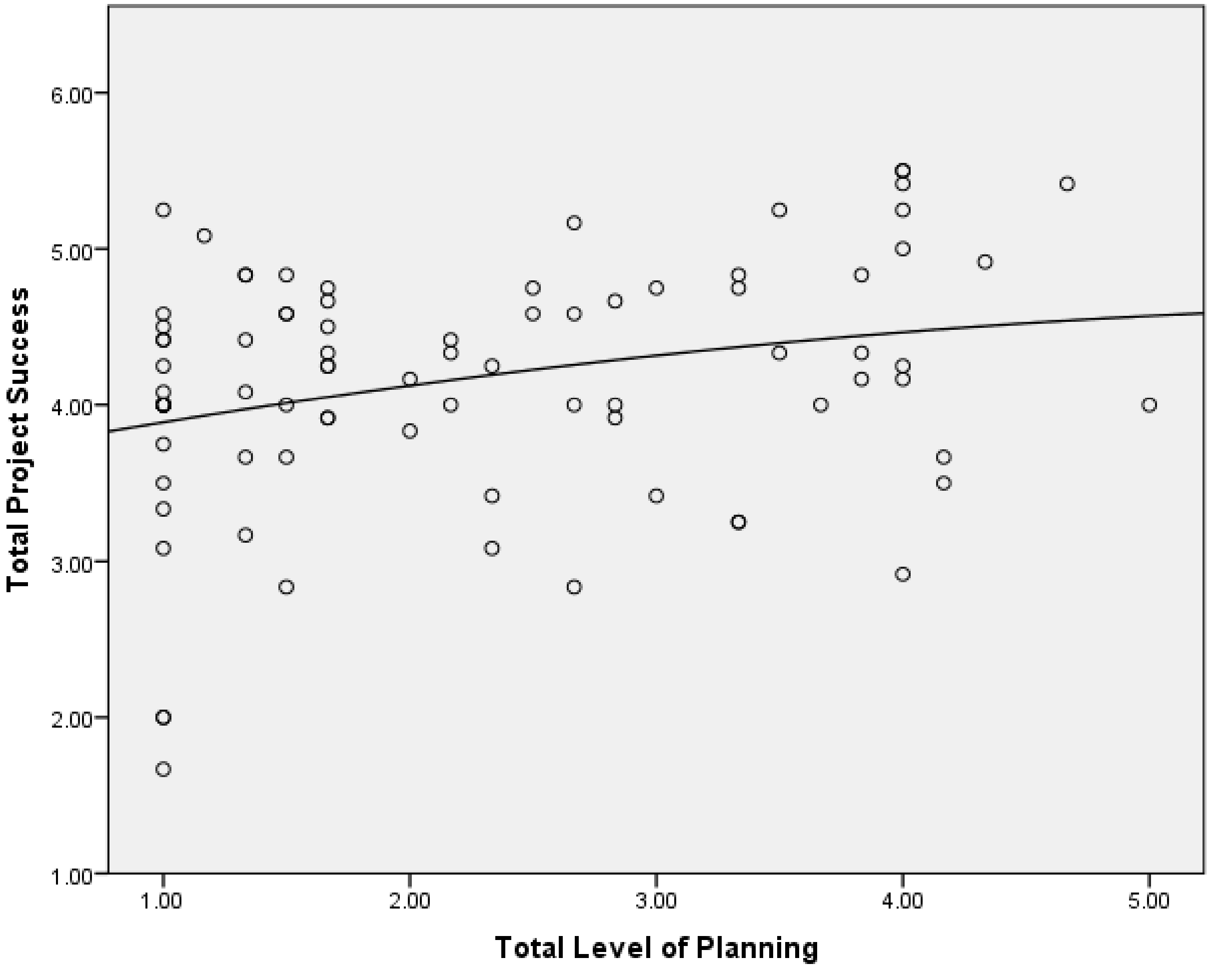


Figure 19 - Small non-linear relationship between the level of planning and project success

Figure 20 shows a more pronounced non-linear relationship between the level of planning and project success, when the data is presented in groupings, efforts that were “not managed as a project”, “managed as part of a larger project”, and “managed as a project.” I believe that this data shows a more pronounced non-linearity, and increasing and then decreasing level of project success as the level of planning increased, but this result is likely not statistically significant because of the scarcity of data in each group.

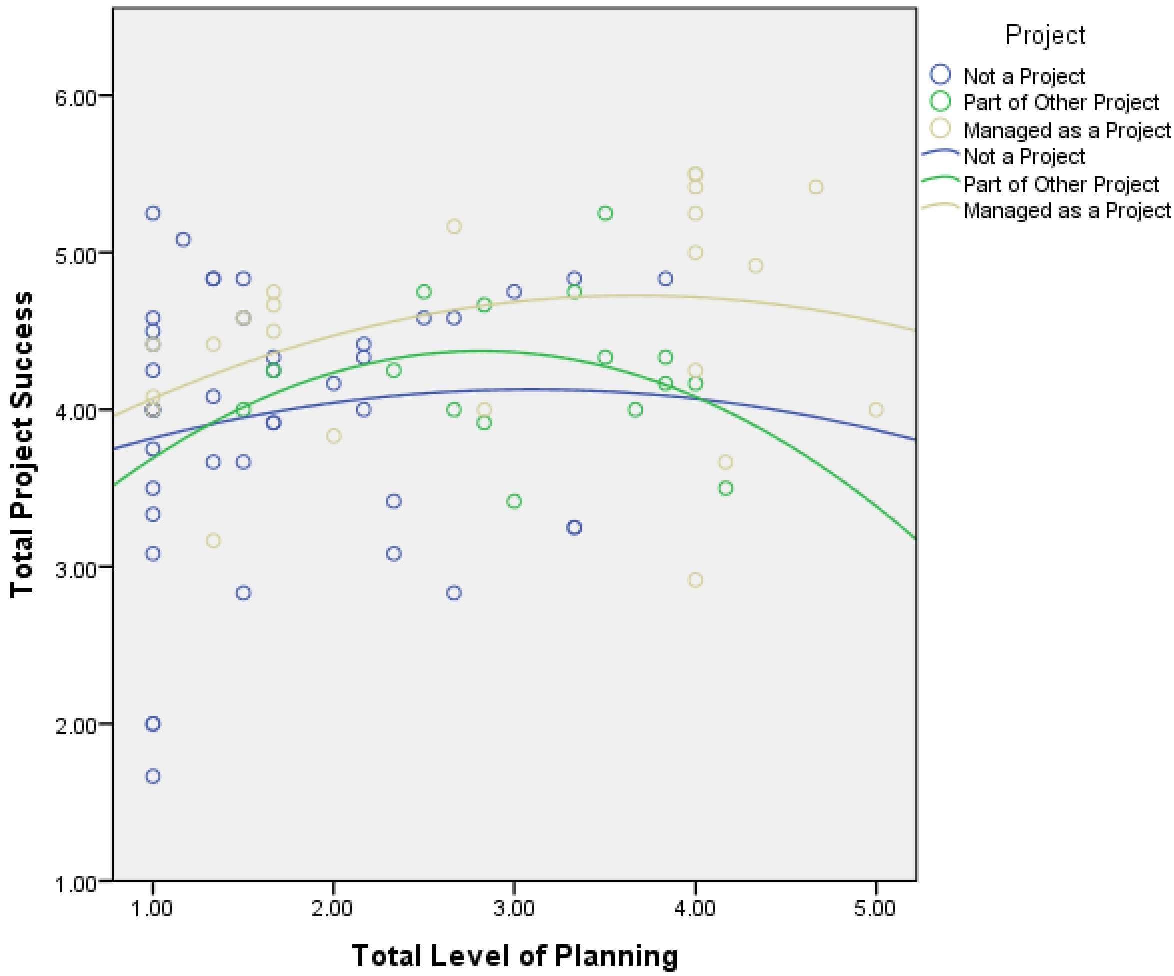


Figure 20 - Non-linear relationship between the level of planning and project success when controlled for whether the effort was managed as a project.

4.4.3.2 The Level of Success Increases, then Declines, with Increasing Use of Individual Tools

This section evaluates the assertion that as the level of each of the individual types of planning increases, the level of project success increases until it reaches a maximum; as the level of planning continues to increase, project success decreases.

As seen in the Figures 21 through 27, each of the planning tools except two show a similar and small non-linear correlation between usage of the planning tool being evaluated and project success. Two planning tools, requirements documents and quality management plans, show a slight exponential correlation; indicating that increases in the use of that planning tool is correlated with exponentially increasing levels of project success.

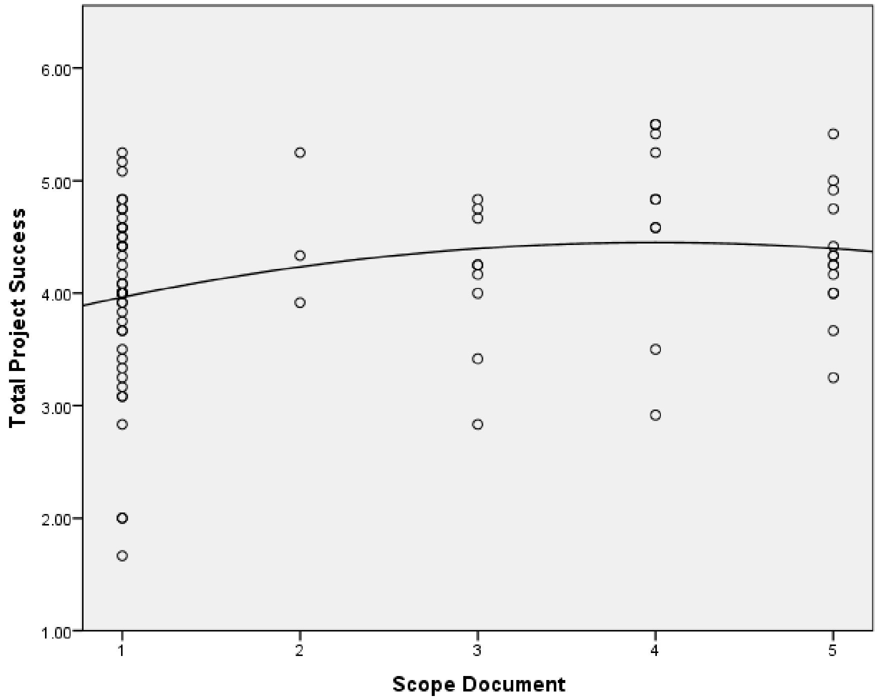


Figure 21 - Correlation between use of a scope document and project success.

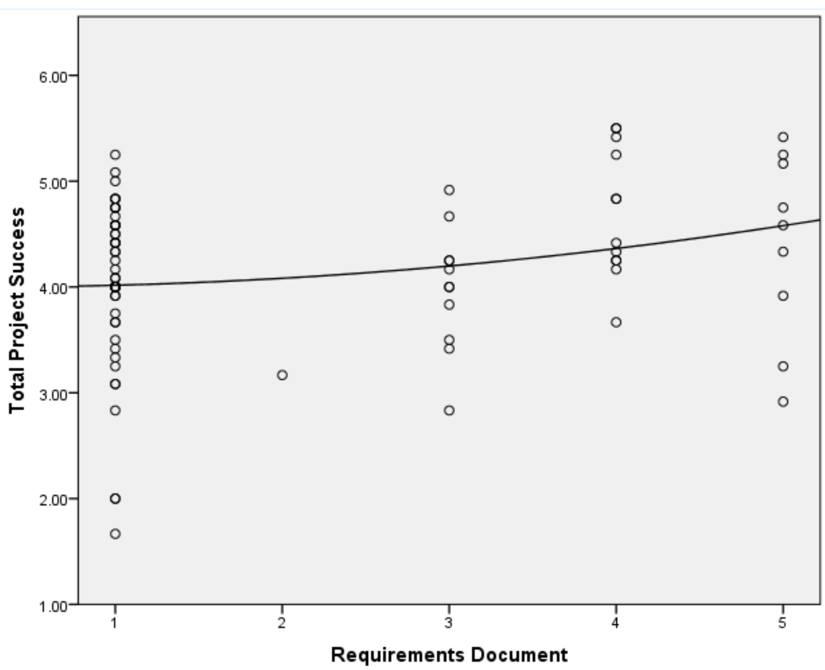


Figure 22 - Correlation between use of a requirements document and project success.

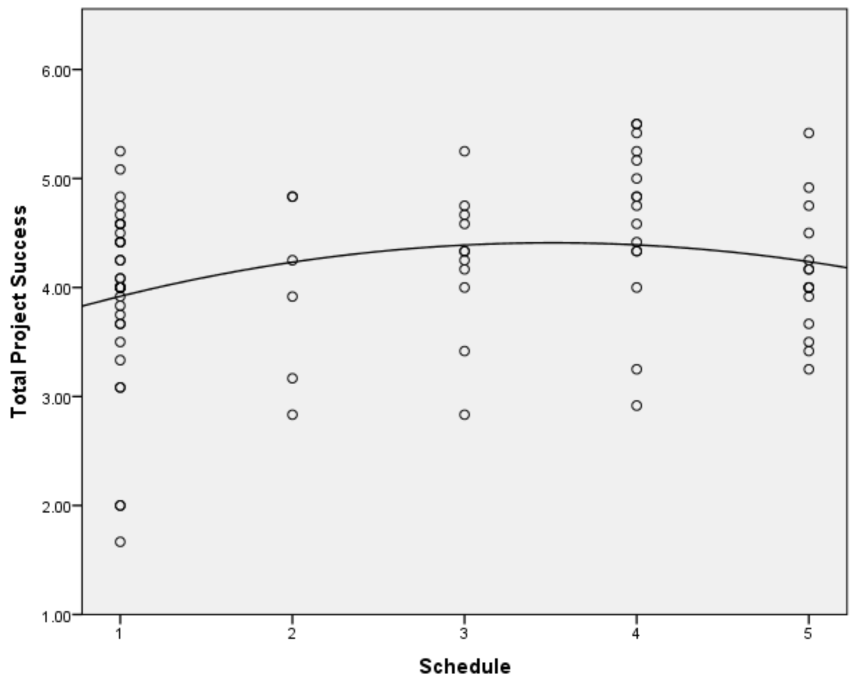


Figure 23 - Correlation between use of a project schedule and project success.

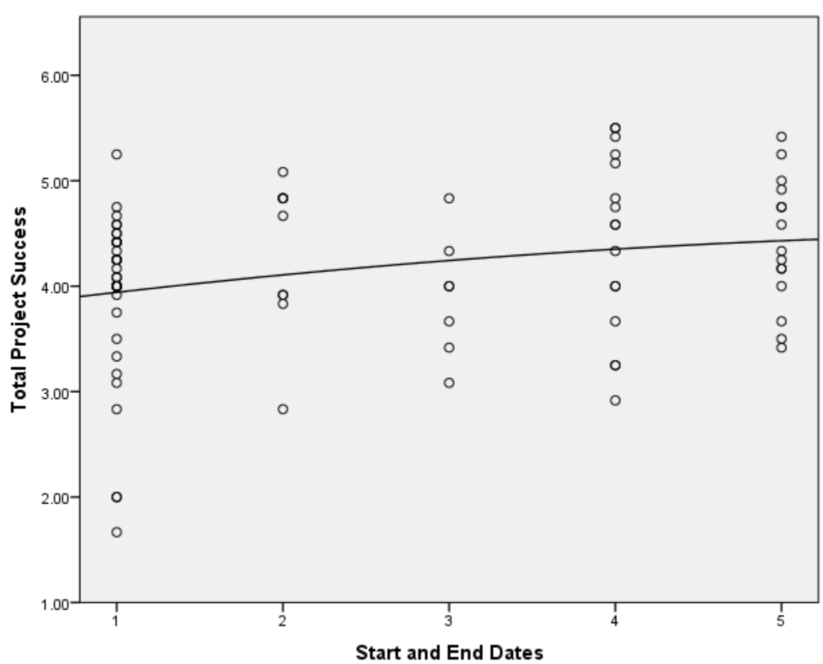


Figure 24 - Correlation between use of start and end dates in the project schedule and project success.

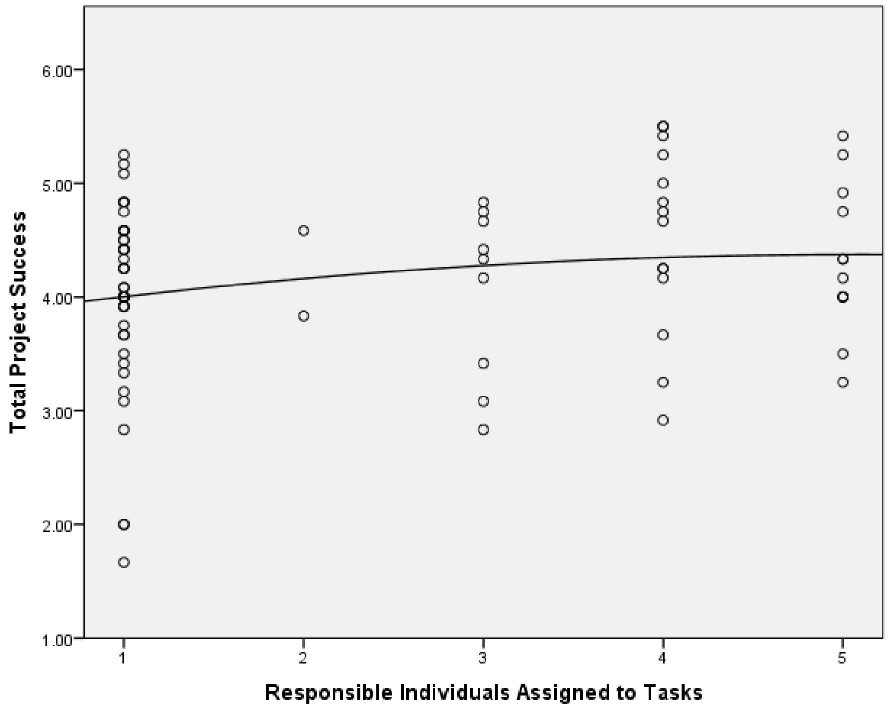


Figure 25 - Correlation between establishing responsible individuals for tasks in a project schedule and project success.

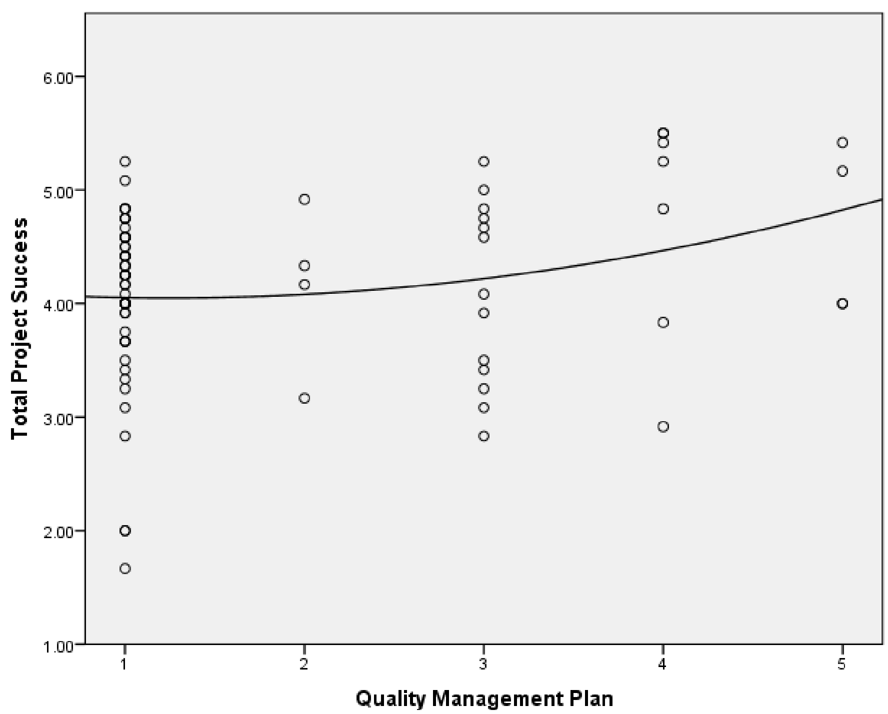


Figure 26 - Correlation between use of a quality management plan and project success.

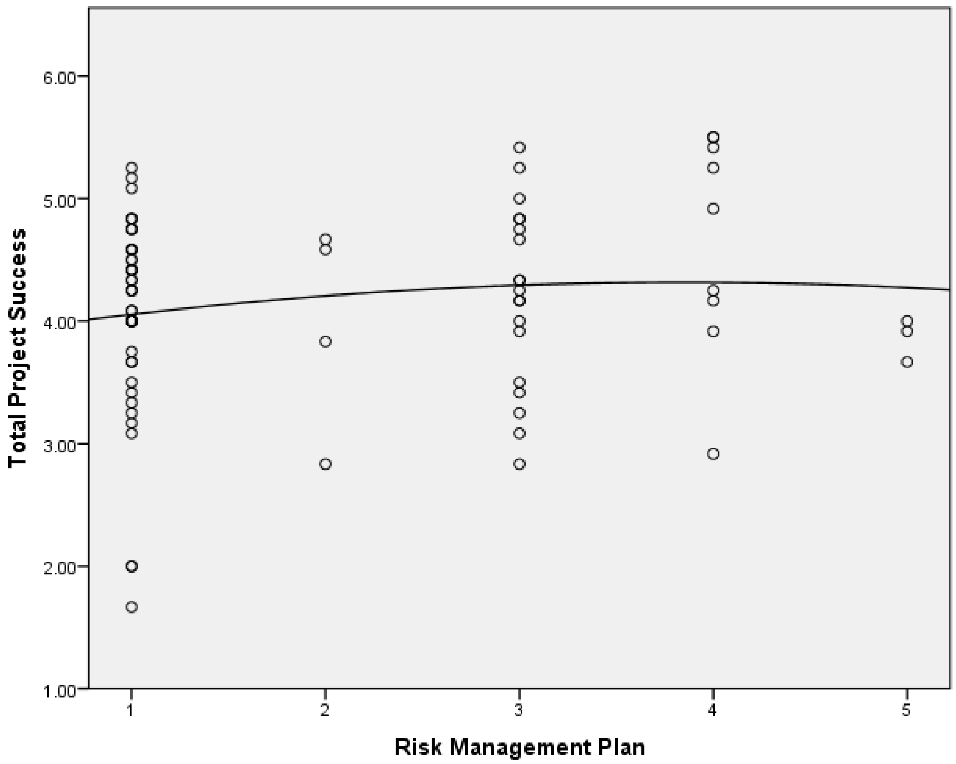


Figure 27 - Correlation between use of a risk management plan and project success.

4.4.3.3 Some Minimal level of Planning is Necessary for IT Project Success

This section investigates the assertion that some minimal level of planning is necessary for IT project success. A positive correlation has been observed between Total Project Success and the Level of Planning, and between Project Effectiveness and the Level of Planning, for small IT projects. However, analysis of scatter plots between the Level of Planning and the various components of project success, shown in the Figures 28 through 30, does not reveal that a minimum level of planning is necessary for IT project success. In all three plots it can be observed that even projects with no or minimal planning can achieve levels of success as high or higher than many projects that had higher levels of planning.

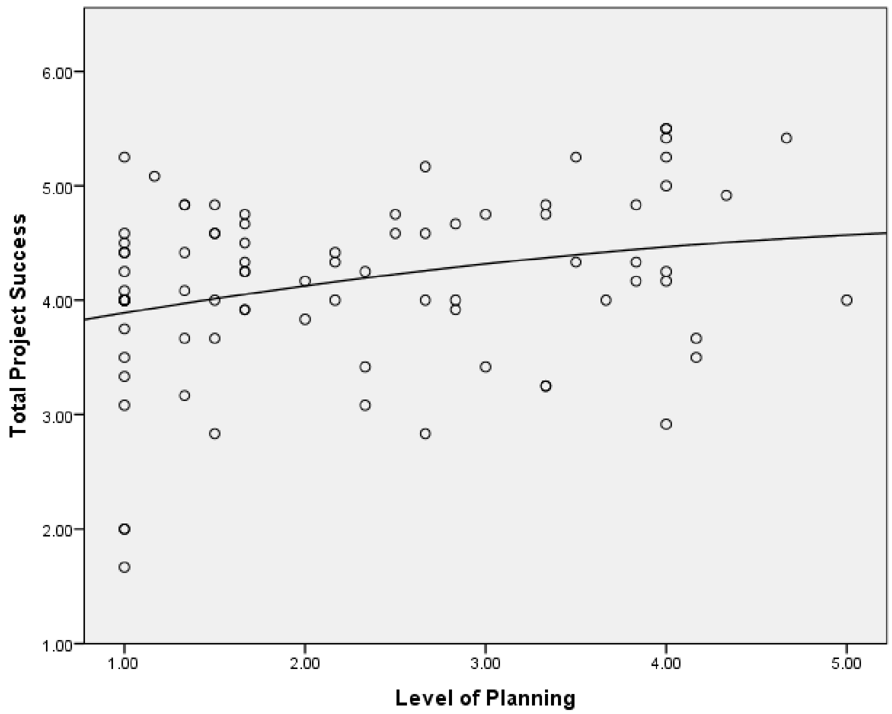


Figure 28 - Scatter plot of the level of Total Project Success vs. Level of Planning

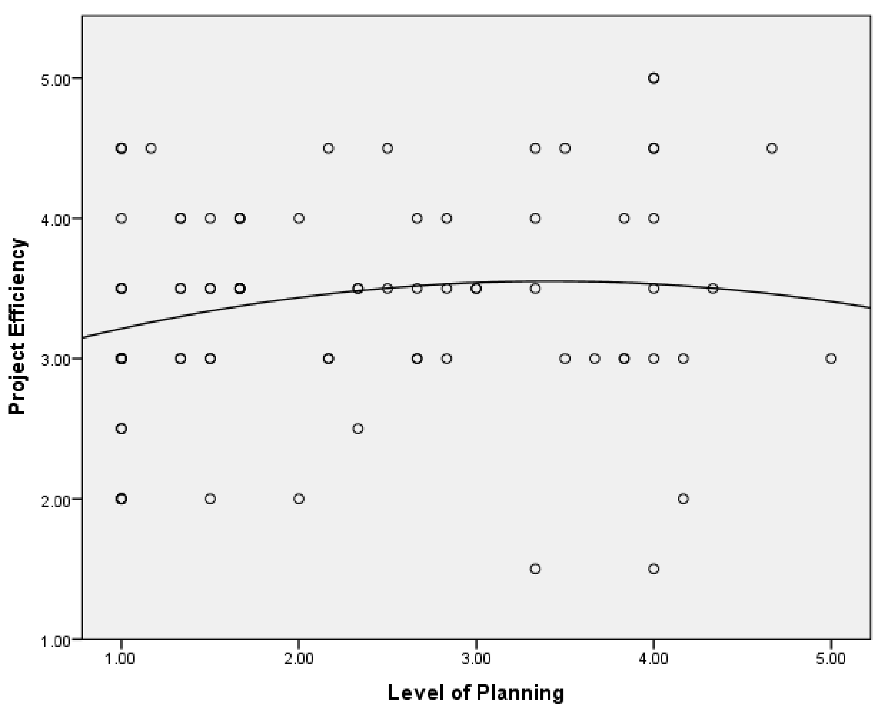


Figure 29 - Scatter plot of the level of Project Efficiency vs. Level of Planning

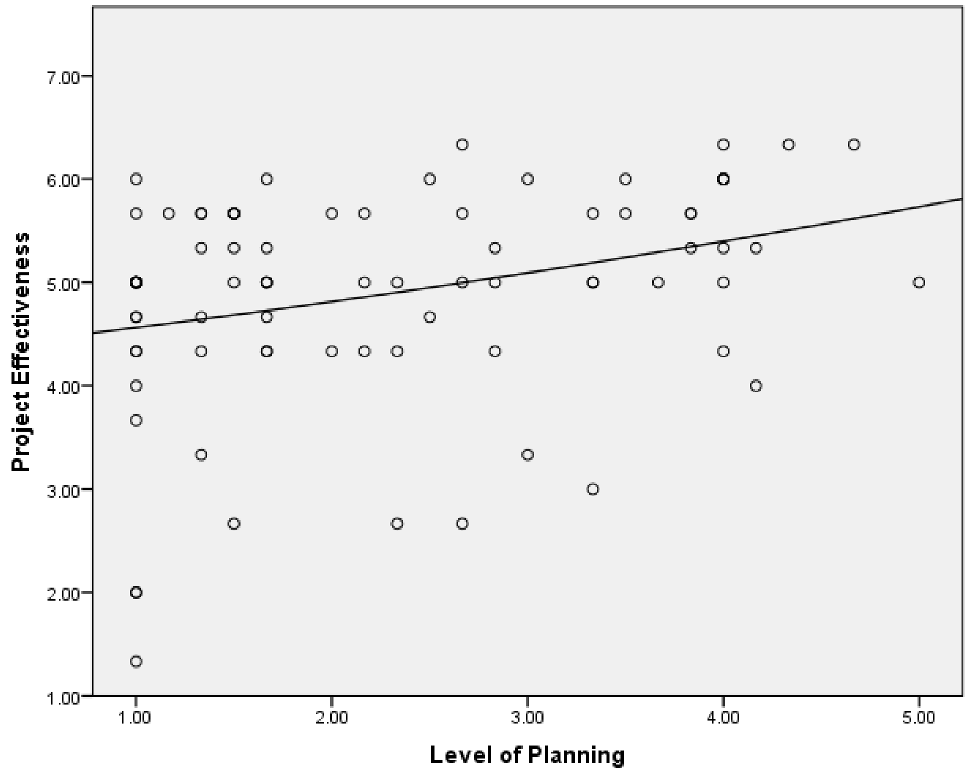


Figure 30 - Scatter plot of the level of Project Effectiveness vs. Level of Planning

4.4.3.4 Even Simple Plans Contribute Value to Project Success

This section investigates the assertion that even simple plans developed for non-complex IT projects deliver significant value to project success. Analysis of scatter plots between the level of planning and the various components of project success, shown in the Figures 28 through 30, does not reveal that low or moderate levels of planning correspond to significantly increased levels of project success over projects with no planning. In all three plots it can be observed that there was not a significant drop-off of the level of project success for projects that conducted little or no planning.

4.4.4 The Effect of Windows Upgrades on the Various Measures of Project Success

Projects to upgrade operating systems will contribute long-term value to the organization beyond the achievement of the primary objective, as measured by improved utility of the system to users and better ability to support the system in the future.

Hypothesis 4.1 – Upgrade of a system or network to Windows 7 will improve the Perceived System Quality.

$$H_{4.1-0}: \ \mu_{System\ Quality} \leq 4$$
$$H_{4.1-1}: \ \mu_{System\ Quality} > 4$$

The response to the question, "The Quality of this system was improved as a result of this project." was 4.96 with a standard deviation of 1.52 on a scale from 1 to 7, in which 1 was Strongly Disagree, and 7 was Strongly Agree. 4.96 most closely aligns with the response "Somewhat Agree." Similarly, the average response to the question "As a result of executing this project, the organization will be able to better support the users of this system in the future" was 5.07 with a standard deviation of 1.73; indicating general improved ability to support the system in the future. The Null Hypothesis is therefore rejected.

4.4.5 Assessing the Level and Type of Planning Done for Small IT projects.

Hypothesis 5.1 – Project Practitioners Prefer to Use Some Planning Tools More Than Others

$$H_{5.1-0}: \ \mu_{Schedule} = \mu_{Start\ and\ End} = \mu_{Tasks\ Assigned} = \mu_{Scope} = \mu_{Requirements} = \mu_{Design} = \mu_{Risk} = \mu_{Quality}$$
$$H_{5.1-1}: \ Means\ are\ not\ all\ equal$$

Table 27 shows the mean usage of each of the project planning tools evaluated in this study. Using t-tests to compare the means, grouping of statistically equivalent means are also presented. The data show a clear distinction between the usage of each of the tools, and that usage of project schedules and scope documents are the most frequently used project planning tools. Although project schedules are frequently used, specification of start and end dates for tasks, and assignment of individuals responsible for each task within those schedules are occasionally not included.

Table 27 - Mean usage of project planning tools and processes.

	Mean Usage	Std. Deviation	Groups with Statistically Equivalent Means			
Project Schedule	2.49	1.53	x			
Includes Start and End Dates	2.41	1.50	x	x		
Task Responsibilities Assigned	2.22	1.54	x	x		
Scope Document	2.14	1.52		x	x	
Requirements Document	2.07	1.44		x	x	x
Design Document	2.06	1.37		x	x	x
Risk Management	1.87	1.16			x	x
Quality Management	1.80	1.21				x

Hypothesis 5.2 – There is a statistically significant difference between the rank of the mean usage of a planning tool (Usage), the rank of the mean of its perceived value (Perceived Value), and the rank of the correlation between Success and the Use of that Tool (Actual Value).

$$H_{5.2-0}: \rho_{Usage,\ Perceived\,Value,\ Actual\,Value} = 0$$

$$H_{5.2-1}: \rho_{Usage,\ Perceived\,Value,\ Actual\,Value} \neq 0$$

There is a statistically significant correlation between rank of the mean usage of planning tools, and the rank of the mean of its perceived value ($\boldsymbol{\rho}$ (7) = .93, p = .001, α = .05 (two-tailed)). There is not a statistically significant correlation between the rank of usage and the rank of the correlation between success and the use of that tool ($\boldsymbol{\rho}$ (7) = .43, p = .289, α = .05 (two-tailed)). Nor is there a statistically significant correlation between the rank of perceived value and the rank of the correlation between success and the use of that tool ($\boldsymbol{\rho}$ (7) = .24, p = .570, α = .05 (two-tailed)). The null hypothesis is therefore rejected.

Actual usage of planning tools was well aligned with project team member's perception of their contribution to success. However, perceived value and actual value of planning tools was not aligned. Use of project schedules, including identification of start and end dates and assigning personnel to be responsible for individual tasks, had the highest usage, perceived value, and actual contribution to project success. Usage of a scope document and performing quality management, however, delivered more value than project managers perceived; each having a higher rank on actual correlation to project success than their ranks on actual usage or perceived value.

Table 28 - Comparison of Individual Planning Tools and Techniques for Small IT Projects. Comparisons are made on usage, perceived value, and correlation with actual project effectiveness.

	Average Usage (Rank)	Average Perceived Value (Rank)	* Correlation between Usage and Effectiveness (Rank)
Project Schedule	2.49 (1)	2.49 (1)	.18 (6) p= **.116
Schedule Includes Start and End Dates	2.41 (2)	2.34 (2)	.33 (1) p = .003
Task Responsibilities Assigned in Schedule	2.22 (3)	2.13 (3)	.24 (2) p = .030
Scope Document	2.14 (4)	2.09 (5)	.22 (3) p = .046
Requirements Document	2.07 (5)	2.08 (6)	.18 (5) p = **.112
Design Document	2.06 (6)	2.12 (4)	.06 (8) p = **.577
Risk Management	1.87 (7)	1.96 (7)	.14 (7) p = **.233
Quality Management	1.80 (8)	1.84 (8)	.19 (4) p = .093

* Spearman correlation between "Usage of Planning Tool" and "Project Effectiveness"
** Spearman correlations are not statistically significant at $\alpha = 0.1$

Hypothesis 5.3 – There is a statistically significant correlation between the Level of Planning performed on a Project (LOP) and various Project and Organizational Factors (Project Factors).

$$H_{5.3-0}:\ \rho_{LOP,\ \ Project\ Factors} = 0$$

$$H_{5.3-1}:\ \rho_{LOP,\ \ Project\ Factors} \neq 0$$

Statistically significant positive correlations exist between the level of planning of a Windows 7 upgrade project and various types of project and organizational factors, as shown in Table 29. No correlation was found to exist between the level of planning applied to a project and whether an organization typically deals with project versus emergent work. However, there is a strong positive correlation between the level of planning, and whether the effort was managed as a project or as part of a larger project. Additionally, a strong positive correlation exists between the level of planning and all types of project risk, and with increasing size and complexity of the project.

Table 29 - Correlation between Level of Planning and various project and organizational factors

Spearman's rho		Level of Planning
Project Organization	Correlation Coefficient	.08
	Sig. (2-tailed)	.482
	N	79
Managed as Project?	Correlation Coefficient	.41
	Sig. (2-tailed)	< .001
	N	79
Organizational Project Orientation	Correlation Coefficient	.37
	Sig. (2-tailed)	.001
	N	79
Scheduler Risk	Correlation Coefficient	.22
	Sig. (2-tailed)	.054
	N	79
Technical Risk	Correlation Coefficient	.24
	Sig. (2-tailed)	.037
	N	79
Total Risk	Correlation Coefficient	.25
	Sig. (2-tailed)	.028
	N	79
Number of PCs	Correlation Coefficient	.34
	Sig. (2-tailed)	.003
	N	79
Team Size	Correlation Coefficient	.26
	Sig. (2-tailed)	.023
	N	79
Man Hours	Correlation Coefficient	.23
	Sig. (2-tailed)	.040
	N	79
Number of Windows 7 Project Elements	Correlation Coefficient	.01
	Sig. (2-tailed)	.921
	N	79
Complexity	Correlation Coefficient	.25
	Sig. (2-tailed)	.029
	N	79

Hypothesis 5.4 – There is a statistically significant correlation between the Level of Planning performed on a Project (LOP) and the Project Orientation of the Organization Performing the Project (Project Orientation).

$$H_{5.4-0}\colon\ \rho_{LOP,\ \ Project\ Orientation} = 0$$
$$H_{5.4-1}\colon\ \rho_{LOP,\ \ Project\ Orientation} \neq 0$$

No statistically significant correlation was found between organizational project orientation and the level of planning applied to a given project. The null hypothesis is accepted.

4.4.6 Summary of Results

This section summarizes the results of each of the hypotheses in this study, and presented in Table 30. Equivalent statistical analyses were performed on just those projects for which the long survey forms were completed. No additional analysis of these results is presented other than in Table 30 because of the limitations on results from a sample size of just ten projects.

Table 30 - Summary of Results of Hypotheses

Hypothesis	Significant findings across all projects evaluated	Significant findings from long form projects
Hypothesis 1.1 – There is a statistically significant correlation between IT Project Success (Success) and Performance on Individual Critical Success Factors (CSFs).	All CSFs analyzed have a statistically significant positive correlation with all types of project success, with the exception of the "ability to complete technical tasks" and the "level of monitoring and feedback" and "assignment of quality personnel" with project efficiency.	Clarity of Mission, Management Support and Communications have statistically significant positive correlations with project effectiveness, and Management Support and Communications are correlated with total project success. No CSFs have a statistically significant correlation with project efficiency.
Hypothesis 1.2 – The ranking of the contribution of critical success factors to project success of Small IT Projects is not significantly correlated with other researchers' findings.	The ability to trouble-shoot was found to be significantly more important for small IT projects than for other types of projects. All other CSFs were generally aligned with previous research, but none had a statistically significant correlation with previous work.	There is insufficient data to evaluate this assertion.
Hypothesis 1.3 – There is a statistically significant correlation between IT Project Success (Success) and Various Project and Organizational Factors (Project Factors).	The degree of the organization's project orientation had a positive correlation with project efficiency, and complexity and several of its components (Man-hours and # Windows 7 Elements) had negative correlations. Managing a work effort as a formal project had a positive correlation with project effectiveness and overall project success.	Managing a work effort as a formal project had a positive correlation with both project effectiveness and overall project success, and the project orientation of the organization had a positive correlation with project efficiency. No other variables had a statistically significant correlation with any project success variables.

Table 30 (Continued)

Hypothesis	**Significant findings across all projects evaluated**	**Significant findings from long form projects**
Hypothesis 1.4 – The Level of IT Project Success (Success) is Significantly Improved if an IT Task is Formally Managed as a Project (Managed as Project).	A positive correlation was found between managing a task as a project or as part of a larger project, and both total project success and project effectiveness.	There were not enough observations to conduct a statistically significant ANOVA calculation to evaluate this hypothesis.
Hypothesis 2.1 – There is a statistically significant correlation between IT Project Success (Success) and the Overall Level of Planning of a Project (Planning).	A positive correlation was found between the level of planning, and both total project success and project effectiveness.	No statistically significant correlation was found.
Hypothesis 2.2 – Critical Success Factors and other Project Factors (Project Factors) significantly influence the correlation between IT Project Success (Success) and the Overall Level of Planning of a Project (Planning).	Partial correlations between planning and project success, controlling for the variables of Technical Risk, Total Risk, Complexity and # of Windows 7 Elements revealed increased correlation for both effectiveness and total project success. Partial correlations that controlled for CSF variables produced no improvement in correlation between Planning and Project Success.	No statistically significant correlation was found.
Hypothesis 2.3 – There is a statistically significant correlation between IT Project Success (Success) and the Level of Usage of Individual Planning Tools (Planning Tools).	A positive correlation was found between total project success and use of the following three planning tools: scope document, requirements document, and start and end dates on project plans. Four of the eight tools had a positive correlation with project effectiveness: scope document, start and end dates on project schedule, responsibilities identified on project schedule, and quality management plan. Only one tool, requirements document, had a positive correlation with efficiency.	A positive correlation was found only between use of a Quality Management Plan, and Total Project Success.
Hypothesis 2.4 – There is a statistically significant correlation between IT Project Success (Success) and the Level of Usage of Functional Requirements Documents (Requirements Documents).	A positive correlation is observed between the use of a requirements document and both project efficiency and overall project success. No statistically significant correlation between the use of a requirements document and project effectiveness is observed.	No statistically significant correlation was found.
Hypothesis 2.5 – There is a statistically significant correlation between IT Project Success (Success) and the Level of Usage of Design Specifications (Design Specifications).	No statistically significant correlation between the use of a design specification document and project success is observed.	No statistically significant correlation was found.

Table 30 (Continued)

Hypothesis	**Significant findings across all projects evaluated**	**Significant findings from long form projects**
Hypothesis 3.1 – There is a statistically significant change in slope (beta) in the best fit curve relating the Level of Planning (LOP) with the various components of Project Success (Success).	Hypothesis does not hold. Scatterplots show some indication of this relationship, but statistically significant evidence is not available.	There were statistically significant changes in the slopes of curves in all three measures of project success when plotted against the level of planning. Drawings of polynomial curves indicate a clear non-linear relationship between project success and level of planning, as expected.
Hypothesis 4.1 – Upgrade of a system or network to Windows 7 will improve the Perceived System Quality.	The Null hypothesis was rejected.	This assertion is supported, with both measures showing an average score of approximately 5, indicating that survey respondents "somewhat agree" that system quality has been improved, and "somewhat agree" that they will be able to better support the users of the system in the future, as a result of completing an upgrade to Windows 7.
Hypothesis 5.1 – Project Practitioners Prefer to Use Some Planning Tools More Than Others	Analysis of mean scores of usage indicate that project schedules and project scope documents are the most widely used planning tools for small IT projects.	There is insufficient data to evaluate this Assertion.

Table 30 (Continued)

Hypothesis	**Significant findings across all projects evaluated**	**Significant findings from long form projects**
Hypothesis 5.2 – There is a statically significant difference between the rank of the mean usage of a planning tool, the rank of the mean of its perceived value, and the rank of the correlation between Success and the Use of that Tool.	Actual usage of planning tools was well aligned with project managers' perception of their contribution to success. Use of project schedules, including identification of start and end dates and assigning personnel to be responsible for individual tasks, had the highest usage, perceived value, and actual contribution to project success. Usage of a scope document and performing quality management, however, delivered more value than project managers perceived; each having a higher rank on actual correlation to project success than their ranks on actual usage or perceived value.	A statistically significant correlation was found only between use of a Quality Management Plan and project effectiveness. There is insufficient data to evaluate this hypothesis.
Hypothesis 5.3 – There is a statistically significant correlation between the Level of Planning performed on a Project (LOP) and various Project and Organizational Factors (Project Factors).	A strong positive correlation exists between efforts managed as a project, or as part of a larger project, and the level of planning. Additionally, a strong positive correlation exists between the level of planning and all types of project risk, and with increasing size and complexity of the project.	There is insufficient data to evaluate this hypothesis.
Hypothesis 5.4 – There is a statistically significant correlation between the Level of Planning performed on a Project (LOP) and the Project Orientation of the Organization Performing the Project (Project Orientation).	No statistically significant correlation was found.	No statistically significant correlation was found.

Analysis of each of the hypotheses was performed both for the full 79 project samples, as well as for the 10 projects for which the more detailed long survey form was completed. Although a very small sample, I chose to take advantage of the more extensive survey to investigate where additional insights might be gained. These results are reflected in the rightmost column of Table 30. Table 31 provides the Cronbach Alpha computations for internal reliability for the 10 projects that used the long form survey. More extensive scales for many of the variables were utilized, and reflect improved internal validity of variables in Table 31.

Table 31 - Cronbach Alpha test of internal validity for Long Form Survey Items

Variable	Cronbach Alpha	# of Input Items	Confidence Interval	
			2.5%	97.5%
Total Level of Planning	0.807	8	.701	.889
Complexity	-0.009 **	5	-1.581	.690
Total Risk	0.827	2	.187	.889
Success - Efficiency	0.666	3	-.238	.828
Success - Effectiveness	0.934	3	.647	.982
Success - Total	0.785	2	-5.870	.826

4.5 DISCUSSION OF RESULTS

This section discusses the implications of the statistical findings associated with each of the hypotheses investigated in this study. Results are generalized across hypotheses, and compared with previous research.

4.5.1 The Correlation between Project / Organizational Factors and IT Project Success

In managing small IT projects, success was found to be dependent on several factors that also supported the success of most other types projects; most notably clearly defining the purpose and objectives early in the project, obtaining and utilizing project team members with strong technical skills, and effective communication with all stakeholders throughout the project. The research found that all eight of the CSFs evaluated had strong positive correlation with overall project success. The correlations were particularly strong with the effectiveness component of project success, whereas correlations with efficiency were less strong.

Most notably from the analysis of hypotheses 1.1 and 1.2, however, we found that the ability to trouble-shoot problems and respond to changing conditions was the most important critical success factor for the small IT projects studied in this research. When the CSFs were ranked on their degree of correlation with project success, the results indicated that the ability to trouble-shoot problems was the top rated CSF for small IT projects, whereas the highest ranking in previous studies of larger projects ranked that particular skill near the bottom of the top ten, at seventh. Post hoc discussions with project participants indicated that an inability to trouble-shoot problems during the course of the project could bring the project to a standstill until that issue was resolved, making IT troubleshooting a skill that is often essential to project success.

This finding suggests that increased training or other forms of enhancing IT troubleshooting skills among project team members could have a positive impact on the success of future IT projects. Additionally, selection of team members should take into consideration the need for individuals with good troubleshooting skills on IT projects.

Correlation analysis between project success and other organizational factors in support of Hypothesis 1.3 found a strong negative correlation between project success and elements indicating project size and complexity. Projects with many different project elements, requiring more man-hours, and having more overall complexity, experienced a lower level of success than smaller projects.

Most notably, however, in investigating the influences on project success, I found that managing a small IT task as a formal project may increase the probability of that project's success. ANOVA analysis of Hypothesis 1-4 found that the mean value of project success was significantly higher for Windows 7 upgrade efforts that were either managed as projects, or managed as part of larger projects, than equivalent efforts that were not managed as projects. Literature on the execution of small projects seeks to distinguish a typical work task this is informally managed, from work that should be formally managed as a project. Findings in this study indicate that IT tasks consisting of as little as 40 hours of work and performed by a single person could benefit by being managed as a project or as part of a larger project.

Several explanations of this finding include the following. Clear definition of a task at the beginning of a project effort through the preparation of a scope document clarifies the task, and ensures that the team is working toward a clear and common objective. Introducing the formality of planning inherent in project management allows the project manager and team members to focus energy and resources on the essential elements of the task, in the correct sequence, preventing lost time and effort that would result from performing unnecessary work, or rework needed because tasks were completed out of sequence. Lastly, by formally managing an IT effort as a project, more standardized management and communication practices are applied, increasing the likelihood that managers and stakeholders important to the project are aware of the ongoing effort and can take action to contribute to the success of the project when necessary.

Analysis found that managing a small IT task as a project has a correlation only with the effectiveness component of project success; indicating increased likelihood that more project objectives would be accomplished, the quality of the resultant system would be higher, and the project team would consider the project a success. There was no statistically significant correlation, however, with project efficiency, which in this study is largely a measure of the project being completed on schedule. This result is consistent with other research on the value of project management, notably (Thomas & Mullaly, 2008) which found that project management was correlated with intangible measures of project success, but less so with tangible measures such as return on investment (ROI) or completion of projects on schedule.

4.5.2 The Correlation Between Planning and Project Success

Analysis of Hypothesis 2.1 found a significant correlation between the overall level of planning applied to a project and the level of project effectiveness. When seeking to identify the CSFs and other organizational factors that influence this correlation, this study found that the correlation was magnified when controlled for the size and complexity of the project, but reduced when controlled for the project orientation of the project organization and various CSFs. Increasing size and complexity of a project increase the number of interrelated tasks and individuals performing those tasks. With the increasing complexity of tasks in a project, more effective planning is necessary to coordinate the interrelated efforts of team members, and prevent wasted effort, wait time, and rework.

Analysis of the level of planning as indicated by data in the POAM did not show a statistically significant correlation with project success. I believe that the effort applied to the development of POAMs did not accurately reflect the overall level of planning effort applied to the project in general. Future studies should inspect the actual project plans maintained by project teams throughout the course of the project, instead of just the initial plan, or a summary of the projects plan as provided in the POAMs for this study.

The overall level of planning as measured in this study is a function of the level of usage of eight individual project planning tools. This study found that use of several individual planning tools had a positive correlation with project effectiveness. Use of project schedules, especially when start and end dates were specified, and individual resources were assigned to tasks, were found to be the most widely used project planning tools for small IT projects, and were most effective in supporting project success. Similarly, analysis of POAM data revealed a correlation, although not statistically significant, between the assignment of resources to individual project schedule tasks and project success. Clear identification of individuals or resources to complete specific tasks removes ambiguity among project team members, and allows work to be planned and executed by assigned individuals more effectively.

Use of a project scope document was the next most widely used project planning tool in this study. Use of a requirements document was the only planning tool that had a positive correlation with project efficiency. It can be speculated that clear definition of product requirements early in the project will allow clear assignment and execution of tasks to complete the project on schedule. However, additional research would be required to understand the factors that contribute to this finding. Design specifications are generally not developed for small IT projects. No statistically significant findings were found in this area. All findings in this area are consistent with previous project management, with the exception that design specifications did not contribute to project success. It is likely that the projects studied here did not have sufficient complexity to warrant the use of formal design documents.

4.5.3 Non-Linear U-Shaped Correlation Between Planning and Project Success

Results in this portion of the study, which sought to identify if there was a non-linear relationship between the level of planning and project success, presented interesting patterns, but were largely inconclusive in presenting much insight. Scatter plots showing these relationships indicated that such a non-linear relationship might be present, but no statistically significant evidence was found of such a correlation. A non-linear correlation between planning and project success may not be detectable in small projects, and if present, might begin to emerge with the study of a larger sampling of projects.

4.5.4 The Effect of Windows Upgrades on the Various Measures of Project Success

Upgrade of PCs to the latest version of operating system is generally done for security reasons, and to ensure that the vendor support through security patches will continue to be available. In addition to these benefits, upgrade of security systems provide additional functionality and improved features and availability of bug fixes from the vendor; both of which will maintain or improve the quality of the system. Additionally, project teams taking action to upgrade a system will increase their familiarity with the system, identify needed enhancements, and put the team in a better position to support users going forward.

4.5.5 Assessing the Level and Type of Planning Done for Small IT projects.

Use of project schedules, especially when start and end dates were specified and individual resources were assigned to tasks, were found to be the most widely used project planning tools for small IT projects, and, as discussed above, were the most closely correlated with project success. Use of a project scope document was the next most widely used project planning tool in this study. Use of a scope document and a quality management plan both had a positive correlation with project success, but both also provided relatively more value to project success than perceived by project practitioners. This assessment is valuable because it highlights the fact that practitioners undervalue the use of scope documents and quality management plans in the execution of their projects. It was seen in this study that the level of planning applied to a project was correlated with the perceived level of all types of project risk, as well as with the size and complexity of the project. Practitioners understandably apply a higher level of planning to those projects that present apparent challenges to success. Project organizations that routinely work on projects will in general have the skills to perform better planning.

5.0 CONCLUSION

Extensive empirical research has been conducted to assess the value of project management and planning on large projects, and to evaluate the impact of critical success factors (CSFs) and other organizational factors on the success of large projects. Little research is available, however, on the techniques and factors used on small IT projects, and their influence on project success. This study begins to fill that gap. This chapter presents a summary of the research and findings of this dissertation, as well as its contributions and limitations, and suggestions for future work.

5.1 SUMMARY

In this dissertation, seventy-nine projects that were conducted to upgrade the operating systems on PCs on small IT systems from Windows XP to Windows 7 were studied. Data was collected from project artifacts, a project tracking mechanism, and an on-line survey completed by individuals involved in each project. Data was collected related to the success of each project, the planning techniques used, and the organizational conditions surrounding each project. Analysis was conducted to assess how small IT projects are executed, and to identify the factors that contribute to the success of small IT projects.

A project is defined as a temporary endeavor undertaken to create a unique product, service, or result (PMI, 2013). A small project, for the purposes of this study, is any task that meets the definition of a project, whether or not it is formally managed as a project, and requires less than one man-year of effort to accomplish. Besner and Hobbs (2012) defined different project types, and made a clear distinction between telecommunications and information technology (IT) projects, versus software development projects. This study evaluates telecommunications and IT projects, which may be further classified as IT infrastructure maintenance projects. Results presented in this research apply specifically this this limited category of project types, but provide insight into the execution of all types of small projects.

This research found that many of the factors that correlate to success on large projects also influence the success of small IT projects. However, it also identifies several distinct differences between large and small projects that may inform project practitioners on techniques to apply during the execution of small IT projects that may improve their probability of success. Significant findings from this research are discussed below.

5.1.1 Project Critical Success Factors

Conditions and practices identified as Critical Success Factors (CSF) in previous project management research, which include clear definition of the project's mission, appropriate levels of management support, and effective planning; similarly influence the success of small IT projects. Uniquely, the ability of project teams to troubleshoot problems and adjust to changing situations quickly was found to be the most important CSF in its influence on project success.

This finding suggests that increased training or other forms of enhancing IT troubleshooting skills among project team members could have a positive impact on the success of future IT projects. Additionally, selection of team members should take into consideration the need for individuals with good troubleshooting skills on IT projects.

CSF's generally found to be important to larger projects, such a Senior Management Support, may not be as important for the execution of smaller infrastructure maintenance projects, because there are fewer complex interactions with outside organizations with that level of support would be more needed or beneficial to the project.

5.1.2 Project Planning

This study found a significant correlation between the overall level of planning applied to a project and the level of project effectiveness. The overall level of planning as measured in this study is a function of the level of usage of eight individual project planning tools. This study found that use of several individual planning tools had a positive correlation with project effectiveness. Use of project schedules, especially when start and end dates were specified, and individual resources were assigned to tasks, were found to be the most widely used project planning tools for small IT projects, and were most effective in supporting project success.

This study sought to assess whether an optimal level of planning existed, after which the value of planning would begin to decline. Visual representation of planning versus project success data indicated such a relationship, but no statistically significant findings were discovered to support this assertion. Further research is proposed below in this area.

5.1.3 Project Management

This research found that managing a small IT task as a formal project may increase the probability of that project's success. Findings in this study indicate that IT tasks consisting of as little as 40 hours of work and performed by a single person could benefit by being managed as a project or as part of a larger project. Introducing the formality of planning inherent in project management allows the project manager and team members to focus energy and resources on the essential elements of the task, in the correct sequence, preventing lost time and effort that would result from performing unnecessary work, or rework needed because tasks were completed out of sequence. Lastly, by formally managing an IT effort as a project, more standardized management and communication practices are applied, increasing the likelihood that managers and stakeholders important to the project are aware of the ongoing effort and can take action to contribute to the success of the project when necessary.

5.1.4 Project Complexity

There was found to be a negative correlation between the complexity of a project and the level of success of that project. This research also found that controlling for complexity revealed a clearer correlation between the level of planning and project success; specifically in the traditional iron triangle measures of project success; delivering the project on time, within budget, and achieving the required project scope.

5.1.5 Project Risk

This research did not reveal a statistically significant correlation between the level of project risk and the success of projects. Findings did reveal that varying levels of project risk did significantly impact the influence of the level of planning on project success. It also found that project teams that perceived higher levels of risk conducted more extensive levels of planning on small IT projects to mitigate that additional risk.

5.1.6 Perceived vs. Actual Value of Project Planning Tools

Use of a scope document and a quality management plan both had a positive correlation with project success, but both also provided relatively more value to project success than perceived by project practitioners. This assessment is valuable because it highlights the fact that practitioners undervalue the use of scope documents and quality management plans in the execution of their projects.

5.2 CONTRIBUTIONS

This section describes the unique contributions that this study makes to the research literature on project management. It also describes new insights for project practitioners in the execution of small IT projects.

5.2.1 Contributions to Project Management Research Literature

Little empirical research has been done related to the management of small IT projects. This research begins to fill that gap by evaluating which critical success factors, planning techniques, and other project and organizational factors influence the success of small IT projects, and where they may differ from other, more thoroughly studied types of projects. This study found that the use of a scope document and a quality management plan both had a positive correlation with project success, but both also provided relatively more value to small IT project success than perceived by project practitioners.

The above finding highlights the value of the Level of Planning survey instrument introduced in this study, which provides a more intuitive measure of the degree that individual planning tools are used on individual projects than previous survey instruments, and is the first to identify the perceived value of a planning tool, allowing a comparison between its actual and perceived value. Analysis of data from this instrument provides a clearer picture of how small IT projects are executed, and found that practitioners sometimes underestimate the value that specific planning tools contribute to their project's success, and that they could potentially benefit from increasing the usage of those tools.

5.2.2 Contributions to the Project Management Practitioner

This study found that the CSF of the ability to Trouble-shoot problems in a project was considerably more important to the success of small IT projects than other types of projects. Second, it revealed that managing a small IT task as a project, or as part of a larger project, is correlated with project success. Practitioners in general should utilize more formal project management techniques, even on small projects. And lastly, results from use of the new Level of Planning survey instrument described above revealed that practitioners undervalue the use of scope documents and quality management plans in the execution of their projects.

Project managers of small infrastructure maintenance projects like those studied in this research, should consider the following techniques to improve level of success in their projects. Consider managing small IT projects using formal project management techniques as defined within your organization. This study found that formal project management is correlated with project success even for very small projects. Because of the importance found in this study of being able to trouble-shoot and resolve problems quickly, project managers should be create an environment in which project team members are comfortable in asking team members or management for assistance to overcoming problems, and establish trust that such requests for help will be viewed as good for the project instead of a sign of weakness. Project managers and project team members should also respond quickly in overcoming identified problems, so that projects don't become "bogged down" or delayed on a particular problem area, but can overcome obstacles and proceed on schedule. Finally, project team should universally employ some type of project scope document at the start of the project to clearly define the objectives of the project, to ensure that team members are working consistently toward a clearly defined and understood goal, and decisions can be made during the course of the project to advance the project toward its formally stated objectives.

5.3 LIMITATIONS

The following limitations of this study are noted. Considerations for overcoming those limitations are addressed in the future research discussion below.

Plans of Action and Milestones (POAMs) that were developed by the project manager or other system owner for each project may not accurately reflect the degree or quality of planning that was applied to the project. Respondents may have had more advanced plans than what are reflected in the POAMs that were evaluated in this study. This limitation of the study is mitigated by the collection of planning data via the system owner survey, using an adaptation of the Project Management Planning Quality (PMPQ) scale developed by Zwikael and Globerson (2004) and used and validated by numerous subsequent studies. Collection of data from multiple sources, however, provides more reliable data than that provided by the survey alone, so the POAM data was included in the analysis.

System owners were asked to retroactively assess the level of risk that existed at the start of the project. Project managers may have been influenced by the outcome of the project, or the actions taken through the course of the project in evaluating the level of risk at the end of the project. In future studies, this data would be more reliable if obtained from project managers at the start of the project in a longitudinal research design.

In an effort to ensure higher survey response from the project leaders in the population to be studied, the self-directed survey questionnaire was shortened from its original design, with fewer questions supporting each variable construct. This change negatively impacted the validity of the data, so use of a longer survey in future research, or reducing the number of variables assessed by the survey, would allow a more thorough assessment of each variable.

In a recent similar study (Zwikael et al., 2014), distinctly different questionnaires were administered separately to project managers and their immediate supervisors. Project managers were asked to provide project characteristics and data, as well as contact information for their immediate managers. Those managers were then contacted to obtain higher level project success data. This separation of data reporting was used to avoid "same source bias". Such a technique was not utilized in this study, and might result in more valid data in future studies.

A survey of convenience was utilized in this study as opposed to a random sampling of projects within the overall population of Windows 7 projects. Pursuing survey results of all projects in the population, or selecting projects from the population using random or stratified sampling and obtaining survey data from all of those selected projects, would potentially improve inferences that might be made about small IT projects in general (Cozby, 2004).

5.4 FUTURE WORK

This study revealed several interesting project factors that are correlated with the success of small IT projects, which are not seen, or not seen to the same degree, on larger projects. Additional research is proposed below to further investigate these findings. Additionally, several of the hypotheses proposed in this study did not reveal statistically significant results; partly because of the type and amount of data collected to assess those hypotheses. I propose expanded studies to continue to investigate some of those research areas that I think may still be fruitful. Next, this study draws conclusions about interesting correlations between project factors, but does not support a statement of causality. Experiments are proposed below to investigate factors that may lead to project success. Finally, the survey instrument introduced in this study that measures both the level of usage of planning tools, as well as their perceived value to project success, revealed several interesting findings related to scope documents and quality management plans. This survey instrument could have useful applications in studying broader areas of project management, as well as other domains of research.

5.4.1 Expanded Investigation of New Findings

This study found a strong correlation between Troubleshooting on small IT projects and project success. Additional research could define and investigate the individual elements that make up troubleshooting to provide a clearer understanding of this broad concept, and more specifically how and why it contributes to project success.

This study also found that use of a quality management plan has a positive correlation with project success, and also had a stronger correlation with project success than project participants perceived. Conducting a study focusing on use of quality management plans across a broader range of projects could provide more insight into this unique finding.

5.4.2 Expanded Survey

Several of the hypotheses proposed in this study did not reveal statistically significant results; partly because of the type and amount of data collected to assess those hypotheses. Concerns about the willingness of project owners to complete extensive surveys, and the cost to the organization of committing the time to complete those surveys, led to limited use of the long form survey shown in Appendix C. This long form allows the use of statistically stronger scales for measuring various parameters, including CSFs, project success, and level of planning. Expanding this research to a larger set of projects, and requiring the use of the long form, will provide stronger evidence of correlations than in the current study.

Areas that could be investigated more thoroughly would include the non-linear nature of the relationship between project planning and project success. Investigation of small projects in areas of IT other than system maintenance, and in other domains would allow more generalized statements about the nature of small projects and the factors that are correlated with their success.

5.4.3 Evidence of Causality

This study draws conclusions about interesting correlations between project factors, but does not support a statement of causality. In order to show, for instance, a causal relationship between use of individual planning tools such as a quality management plan, and project success, experiments could be established in which a control group executes their project without researcher intervention, and an experimental group is given expert instruction in the use of specific project planning tools before the start of the experiment, and encouraged to use them. In this experiment, measures of project success could be shown to be caused by use of specific tools.

5.4.4 Expanded Use of the Level of Planning Survey Instrument

The Level of Planning survey instrument introduced in this study measures both the level of usage of project planning tools, as well as their perceived value to project success as assessed by the project manager. This instrument revealed that the use of both scope documents and quality management plans have a stronger correlation with project success than perceived by the project managers, and should be used more extensively to improve the outcomes of projects. This survey instrument could have useful applications in studying broader areas of project management, as well as other domains of research.

APPENDIX A - DATA DERIVED FROM PLANS OF ACTION AND MILESTONES (POAMS)

All systems that were to be retired or upgraded to Windows 7 were requested to provide a plan of action and milestones (POAM) specifying the plan for achieving that strategy. Approximately 200 systems were identified with a strategy to retire or update to Windows 7, and all had posted POAMs by December 6, 2013. The Windows 7 team tracked the progress of upgrade of each system based on the plan provided in the POAM, and recorded when each system was completed. Systems that had been upgraded prior to December 6, 2013 did not have a POAM prepared.

This Appendix describes the data that was available in the Data extracted from individual POAMs for each project, and provides the written guidelines for translating each field into structured data from the non-standard formats followed for each individual project.

1. Number of Tasks in the Project Plan – Each POAM provides a list of tasks for completion of upgrade of the affected system to Windows 7. Count the number of individual tasks.

2. # of lines of clarifying text. In addition to the listing of tasks to complete the Windows 7 upgrade, there is clarifying text that describes various aspects of the system or project tasks. Count the number of lines of text in the POAM other than those that represent the project tasks.

3. Existence and number of clarifying documents or drawings. Associated with many of the POAMs are supplementary documents that describe the system or project in questions. Count the number of additional files provided by the project team with the POAM.

4. Completion dates are identified for individual tasks in the project schedule. Identify “Y” or “N” whether all or a majority of the individual tasks in the POAM project schedule have an associated planned or actual completion date.

5. Resources are identified for individual tasks in the project schedule. Identify “Y” or “N” whether all or a majority of the individual tasks in the POAM project schedule have an associated resource

identified. A resource will generally be an individual or group assigned to complete the task in questions.

6. Researcher's subjective judgment of the level of effort applied in developing the POAM project plan. Judging from the above data, establish a value from 0 to 4 based on the below criteria, and based on the researchers understanding of the amount of effort that would be expended by a reasonable person who was familiar with the project in developing the POAM:

    - 1 – No or minimal thought or effort was applied in developing the POAM. This will generally be in the form of a simple statement promising completion, or an extremely rudimentary list of 1 or 2 tasks.
    - 2 – Less than 10 minutes was applied in developing the POAM.
    - 3 – Between 10 minutes and 1 hour was applied in developing the POAM.
    - 4 – Between 1 and 4 hours were applied in developing the POAM.
    - 5 – More than 4 hours were applied in developing the POAM.

7. Researcher's subjective judgment of the complexity of the project based on evaluation of the planning and descriptive data provided in the POAM. Judging from the above date, establish a value from 1 to 5 based on the below criteria:

    1 – This project involved the upgrade of 1 PC to Windows 7, with no more than 2 complicating factors. Complicating factors include but are not limited to:

    - Need to upgrade the PC
    - Need to upgrade or procurement replacement software that will run properly in Windows 7
    - Need to process security paperwork
    - Need to coordinate with other individuals or organizations to complete testing

    2 – This project involved the upgrade of 2 or more PCs to Windows 7, with no more than 2 complicating factors as discussed in item 1 above for any one PC.

    3 – This project involved the upgrade of 1 PC to Windows 7, with more than 2 complicating factors as discussed in item 1 above.

    4 – This project involved the upgrade of 2 or more PCs to Windows 7, with more than 2 complicating factors as discussed in item 1 above for any one PC.

5 – This project involved the upgrade of 10 or more PCs to Windows 7, with more than 2 complicating factors as discussed in item 1 above for any one PC, or between 2 and 9 PCs but with extensive effort required by project team members.

APPENDIX B - DATA OBTAINED FROM THE PROJECT TRACKING DATABASE

A project tracking database was maintained by the Windows 7 team to record information about the nature and progress of each project. This database was updated by individual project participants or by the Windows 7 team monitoring the progress of individual efforts. The following data was obtained from the Project Tracking Database for each project in support of this study:

1. Estimated project completion date from POAM
2. Actual project completion date
3. # Personal computers within the system or network
4. Sensitivity of data associated with the system that was the subject of the project (Yes or No)

APPENDIX C - SYSTEM OWNER SURVEY INSTRUMENT – LONG FORM

The system owner survey instruments were deployed initially on April 18, 2014. The forwarding email and actual survey long form are provided below.

Name of Group or System Owner,

Congratulations on completing the Windows 7 upgrade of the system listed below! Execution of the Windows 7 upgrade project was very important in ensuring the security and operational stability of our systems in the future, and we greatly appreciate the effort that it required of you and others throughout the NR Program.

System Owner	System Name

To help us execute similar projects more effectively in the future, we are asking all system owners, their managers, or anyone else who was very closely involved in the project, to fill out a survey on their Windows 7 upgrade efforts so we can learn from your experiences and share best practices to be used in similar projects in the future. As you go through the survey, recognize that you were not expected to have used all of the tools asked about in the survey, and we appreciate your responses about which were used, even on an informal basis, and were helpful in completing your project.

Survey Instructions:

Please click on this link to access the on-line survey, and click on "new" as shown in the below diagram to be presented with a blank survey form. At the top of the survey form, select your department and choose your system from the dropdown list, answer all questions on the survey related to the upgrade of that system to Windows 7, and click on the "SUBMIT" button when you have completed the survey.

Figure 31 - Email to long form survey respondents

Please complete a separate survey for each system for which you were responsible. We expect the survey to take about 15 minutes, and request that you complete it by Wednesday, April 30. Be aware that you must answer all questions on the survey before you can submit the results. Please contact Dave Laird or Brad Wilding if you encounter any problems with, or questions about, the survey.

Thank you for your hard work in supporting the Windows 7 effort and for your input to the survey!

Figure 31 (Continued)

Windows 7 - System Owner Survey

The purpose of this survey is to help identify the factors that contribute to the success of projects like the Windows 7 upgrade so the most successful techniques and practices can be applied to similar challenges in the future. This survey will also help IT develop ways to work with and better support owners of computer systems throughout the organization.

Please provide answers to the questions below as they relate to each Windows 7 system upgrade you have recently completed or are currently working on. If you were responsible for multiple Windows 7 upgrade efforts, please complete a separate survey for each system. Thank you in advance for your input.

Project Information

Department: *

System or Network: *

1. My primary role on the project team was:

- Project Team Member
- Project Technical Lead
- Subject Matter Expert
- Project Manager
- Cognizant Manager
- Project Sponsor or Champion

2. My organization generally performs the following mix of unplanned emergent work vs. planned project work.

- Nearly 100% Emergent Work
- Mostly Emergent Work
- Equal Mix of Emergent and Planned Work
- Mostly Planned project Work
- Nearly 100% Planned Project Work

3. My project contained significant scheduler risk at the start of the project.

- Strongly Disagree
- Disagree
- Somewhat Disagree
- Neither Agree nor Disagree
- Somewhat Agree
- Agree
- Strongly Agree

4. My project contained significant technical risk at the start of the project.

- Strongly Disagree
- Disagree
- Somewhat Disagree
- Neither Agree nor Disagree
- Somewhat Agree
- Agree
- Strongly Agree

5. Approximately when did work begin on this project?

- Before 2013
- Jan - June 2013
- July - Dec 2013
- In 2014

6. How many individuals made up your project team? *

7. Approximately how many man-hours of work did this project require? (40 = one man-week; 2000 = one man-year)

- Under 40
- 40-200
- 201-1000
- 1001-2000
- Over 2000

Figure 32 - System Owner Survey - Long Form

8. Specify which project elements existed in your project: (Select all that apply)

- ☐ Obtain security approval or accreditation to proceed with changes
- ☐ Network infrastructure upgrades
- ☐ Procure and install new hardware to be Windows 7 compatible
- ☐ Procure and install software upgrades to be Windows 7 compatible
- ☐ Upgrade custom software to be Windows 7 compatible
- ☐ Significant other non-Windows 7 improvements to the system
- ☐ Backup or restore system data

9. Was this effort formally managed as a project?

- ○ Managed as its Own Project
- ○ Managed as Part of a Larger Project
- ○ Not Managed as a Project

Critical Success Factors

Project Mission

1. The basic goals of the project were made clear to the project team.

- ○ Strongly Disagree
- ○ Disagree
- ○ Somewhat Disagree
- ○ Neither Agree nor Disagree
- ○ Somewhat Agree
- ○ Agree
- ○ Strongly Agree

2. The results of the project will benefit the organization as a whole.

- ○ Strongly Disagree
- ○ Disagree
- ○ Somewhat Disagree
- ○ Neither Agree nor Disagree
- ○ Somewhat Agree
- ○ Agree
- ○ Strongly Agree

Top Management Support

3. Upper management was responsive to our requests for additional resources, when the need arose.

- ○ Strongly Disagree
- ○ Disagree
- ○ Somewhat Disagree
- ○ Neither Agree nor Disagree
- ○ Somewhat Agree
- ○ Agree
- ○ Strongly Agree
- ○ N/A

4. Upper management shared responsibility with the project team for ensuring the project's success.

- ○ Strongly Disagree
- ○ Disagree
- ○ Somewhat Disagree
- ○ Neither Agree nor Disagree
- ○ Somewhat Agree
- ○ Agree
- ○ Strongly Agree

Figure 32 (Continued)

5. Upper management supported me in times of crisis.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree N/A
Personnel	
6. Project team personnel understood their role on the project team.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
7. There was sufficient manpower to complete the project on schedule.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
8. Team members received sufficient training to effectively support the project.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
Technical Tasks	
9. Specific project tasks were well managed.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
10. Technical personnel on the project had the knowledge and training to be successful.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
11. The technology that was being used to support the project worked well.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree

Figure 32 (Continued)

Monitoring and Feedback	
12. All important aspects of the project were monitored, including measures to provide a complete picture of the project's progress (adherence to budget and schedule, manpower and equipment utilization, team morale, etc.).	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
13. Regular meetings to monitor project progress and improve the feedback to the project team were conducted.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
14. Actual progress was regularly compared with the project schedule.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
Communication	
15. Communication was effective among management, team members, and other personnel involved.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
16. All groups affected by the project knew how to make problems known to the project team.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
17. When the budget or schedule was revised, the changes and the reasons for the changes were communicated to all members of the project team.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
Troubleshooting	
18. The project leader was willing to enlist the aid of personnel not involved in the project in the event of problems.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree

Figure 32 (Continued)

19. In case of project difficulties, project team members knew exactly where to go for assistance.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
20. Immediate action was taken when problems came to the project team's attention.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
Vendor and Contractor Performance	
21. Performance by outside vendors and contractors was essential to the success of this project.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
22. Outside vendors and contractors provided high quality products and services.	N/A Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
23. The work of vendors and contractors was completed in a timely fashion.	N/A Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
External Support	
24. Support from the IT department was readily available.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
25. My team took advantage of the available support offered by the IT Department.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree

Figure 32 (Continued)

Level of Planning

For each of the project planning tools identified below, please indicate in the first column whether the tool was used and its formality. In the second column indicate how effective that tool was in supporting the success of the project.

	Formality	Effectiveness
1. **Project Management Plan** High level document that defines how the project is to be executed, monitored and controlled, and closed.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
2. **Project Scope Document** Describes the project and product scope, major deliverables, assumptions and constraints.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
3. **Requirements Document** Describes the requirements of the product to be developed.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
4. **Design Specification** Provides the design specifications of the product to be developed.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
5. **Work Breakdown Structure (WBS)** Hierarchical chart of all activities needed to be performed during execution of the project.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
6. **Project Schedule / Activities List** List of all activities that should be performed during execution of the project. The list includes small and manageable components and their detailed description.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
7. **Project Schedule / PERT or Gantt Chart** A graphical representation of the dependencies among the project schedule activities.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
8. **Project Schedule / Activity Duration Estimates** A quantitative estimation of the duration needed to complete the execution of each activity in the project.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective

Figure 32 (Continued)

9. **Project Schedule / Activity Start and End Dates** Definitions of start and end planning dates for each activity in the project. Usually presented in a Gantt chart.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
10. **Project Staff Assignments** Formal designation of the individuals assigned to the project team.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
11. **Project Schedule / Role and Responsibility Assignments** Identifies the responsible team member for each project activity.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
12. **Project Schedule / Activity Resource Requirements** Identifies the types and quantities of resources required for each activity in the project schedule.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
13. **Activity Cost Estimates** Assessment of the probable costs to complete each activity in the project plan.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
14. **Time-phased Budget** Estimate of the total project cost over time.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
15. **Quality Management Plan** Describes the implementations of quality policy in the project, including processes, procedures, responsibility and resources.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
16. **Communications Management Plan** Describes how project communications internal to the team and with external stakeholders will be conducted.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
17. **Risk Management Plan / Risk Register** Identifies and describes the risks that may damage project success. Includes the probability and impact of each risk, prioritized listing of risks, and contingency plans and triggers for risks.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
18. **Procurement Management Plan** Describes how the project team will purchase goods and services, and manage the procurement process and suppliers.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective

Figure 32 (Continued)

Project Success

1. The project was completed:	Significantly Behind Schedule Behind Schedule Slightly Behind Schedule As Scheduled Slightly Ahead of Schedule Ahead of Schedule Significantly Ahead of Schedule
2. Usage of personnel resources on the project was:	Significantly More than Budgeted More than Budgeted Slightly More than Budgeted As Budgeted Slightly Less than Budgeted Less than Budgeted Significantly Less than Budgeted
3. The cost (M&S) of the project was:	Significantly More than Budgeted More than Budgeted Slightly More than Budgeted As Budgeted Slightly Less than Budgeted Less than Budgeted Significantly Less than Budgeted
4. Identify the number of project objectives completed.	None Less than Half About Half Most All
5. The quality of this system was improved as a result of this project.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
6. As a result of executing this project, the organization will be able to better support the users of this system in the future.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
7. I personally consider the project a success.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree

Figure 32 (Continued)

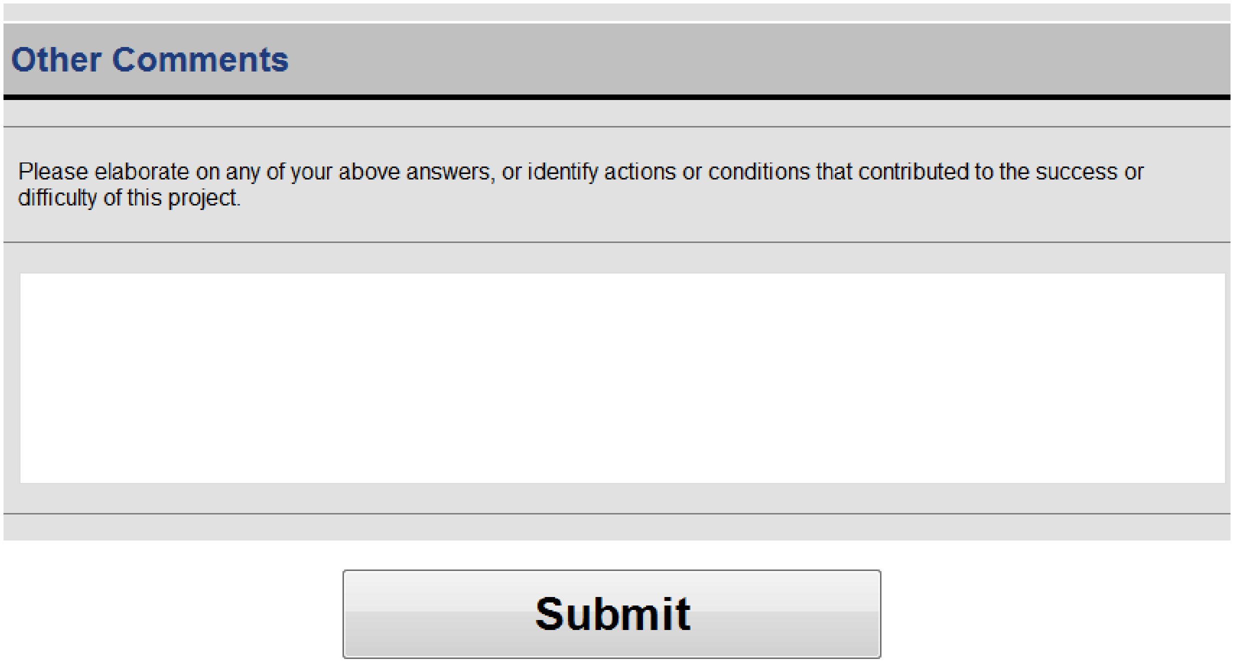


Figure 32 (Continued)

APPENDIX D - SYSTEM OWNER SURVEY INSTRUMENT – SHORT FORM

The system owner survey instruments were deployed initially on April 18, 2014. The forwarding email and actual survey short form are provided below.

Name of Group or System Owner,

Congratulations on completing the Windows 7 upgrade of the system listed below! Execution of the Windows 7 upgrade project was very important in ensuring the security and operational stability of our systems in the future, and we greatly appreciate the effort that it required of you and others throughout the NR Program.

System Owner	System Name

To help us execute similar projects more effectively in the future, we are asking all system owners, their managers, or anyone else who was very closely involved in the project, to fill out a survey on their Windows 7 upgrade efforts so we can learn from your experiences and share best practices to be used in similar projects in the future. As you go through the survey, recognize that you were not expected to have used all of the tools asked about in the survey, and we appreciate your responses about which were used, even on an informal basis, and were helpful in completing your project.

Survey Instructions:

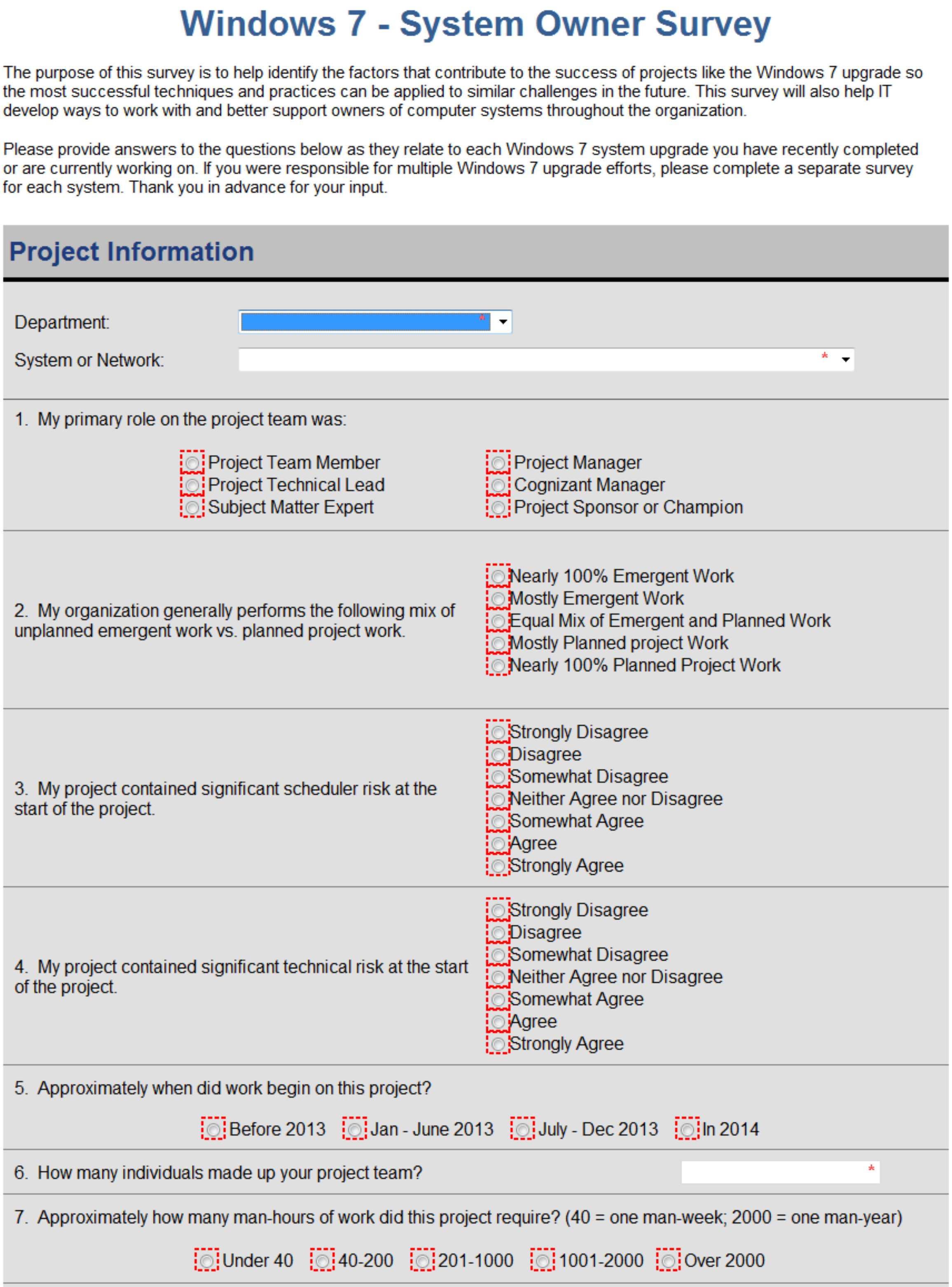
Please click on this link to access the on-line survey, and click on "new" as shown in the below diagram to be presented with a blank survey form. At the top of the survey form, select your department and choose your system from the dropdown list, answer all questions on the survey related to the upgrade of that system to Windows 7, and click on the "SUBMIT" button when you have completed the survey.

Figure 33 - Email to short form survey respondents

Please complete a separate survey for each system for which you were responsible. We expect the survey to take about 15 minutes, and request that you complete it by Wednesday, April 30. Be aware that you must answer all questions on the survey before you can submit the results. Please contact Dave Laird or Brad Wilding if you encounter any problems with, or questions about, the survey.

Thank you for your hard work in supporting the Windows 7 effort and for your input to the survey!

Figure 33 (Continued)



Windows 7 - System Owner Survey

The purpose of this survey is to help identify the factors that contribute to the success of projects like the Windows 7 upgrade so the most successful techniques and practices can be applied to similar challenges in the future. This survey will also help IT develop ways to work with and better support owners of computer systems throughout the organization.

Please provide answers to the questions below as they relate to each Windows 7 system upgrade you have recently completed or are currently working on. If you were responsible for multiple Windows 7 upgrade efforts, please complete a separate survey for each system. Thank you in advance for your input.

Project Information

Department: *

System or Network: *

1. My primary role on the project team was:

- Project Team Member
- Project Technical Lead
- Subject Matter Expert
- Project Manager
- Cognizant Manager
- Project Sponsor or Champion

2. My organization generally performs the following mix of unplanned emergent work vs. planned project work.

- Nearly 100% Emergent Work
- Mostly Emergent Work
- Equal Mix of Emergent and Planned Work
- Mostly Planned project Work
- Nearly 100% Planned Project Work

3. My project contained significant scheduler risk at the start of the project.

- Strongly Disagree
- Disagree
- Somewhat Disagree
- Neither Agree nor Disagree
- Somewhat Agree
- Agree
- Strongly Agree

4. My project contained significant technical risk at the start of the project.

- Strongly Disagree
- Disagree
- Somewhat Disagree
- Neither Agree nor Disagree
- Somewhat Agree
- Agree
- Strongly Agree

5. Approximately when did work begin on this project?

- Before 2013
- Jan - June 2013
- July - Dec 2013
- In 2014

6. How many individuals made up your project team? *

7. Approximately how many man-hours of work did this project require? (40 = one man-week; 2000 = one man-year)

- Under 40
- 40-200
- 201-1000
- 1001-2000
- Over 2000

Figure 34 - System Owner Survey - Short Form

8. Specify which project elements existed in your project: (Select all that apply)

- ☐ Obtain security approval or accreditation to proceed with changes
- ☐ Network infrastructure upgrades
- ☐ Procure and install new hardware to be Windows 7 compatible
- ☐ Procure and install software upgrades to be Windows 7 compatible
- ☐ Upgrade custom software to be Windows 7 compatible
- ☐ Significant other non-Windows 7 improvements to the system
- ☐ Backup or restore system data

9. Was this effort formally managed as a project?

- ○ Managed as its Own Project
- ○ Managed as Part of a Larger Project
- ○ Not Managed as a Project

Critical Success Factors

Project Mission

1. The basic goals of the project were made clear to the project team.

- ○ Strongly Disagree
- ○ Disagree
- ○ Somewhat Disagree
- ○ Neither Agree nor Disagree
- ○ Somewhat Agree
- ○ Agree
- ○ Strongly Agree

Top Management Support

2. Upper management shared responsibility with the project team for ensuring the project's success.

- ○ Strongly Disagree
- ○ Disagree
- ○ Somewhat Disagree
- ○ Neither Agree nor Disagree
- ○ Somewhat Agree
- ○ Agree
- ○ Strongly Agree

Personnel

3. There was sufficient manpower to complete the project on schedule.

- ○ Strongly Disagree
- ○ Disagree
- ○ Somewhat Disagree
- ○ Neither Agree nor Disagree
- ○ Somewhat Agree
- ○ Agree
- ○ Strongly Agree

Technical Tasks

4. Technical personnel on the project had the knowledge and training to be successful.

- ○ Strongly Disagree
- ○ Disagree
- ○ Somewhat Disagree
- ○ Neither Agree nor Disagree
- ○ Somewhat Agree
- ○ Agree
- ○ Strongly Agree

Figure 34 (Continued)

Monitoring and Feedback

5. Regular meetings to monitor project progress and improve the feedback to the project team were conducted.	○ Strongly Disagree ○ Disagree ○ Somewhat Disagree ○ Neither Agree nor Disagree ○ Somewhat Agree ○ Agree ○ Strongly Agree

Communication

6. Communication was effective among management, team members and other personnel involved.	○ Strongly Disagree ○ Disagree ○ Somewhat Disagree ○ Neither Agree nor Disagree ○ Somewhat Agree ○ Agree ○ Strongly Agree

Troubleshooting

7. In case of project difficulties, project team members knew exactly where to go for assistance.	○ Strongly Disagree ○ Disagree ○ Somewhat Disagree ○ Neither Agree nor Disagree ○ Somewhat Agree ○ Agree ○ Strongly Agree

Vendor and Contractor Performance

8. Outside vendors and contractors provided high quality products and services.	○ N/A ○ Strongly Disagree ○ Disagree ○ Somewhat Disagree ○ Neither Agree nor Disagree ○ Somewhat Agree ○ Agree ○ Strongly Agree

External Support

9. Support from the IT department was readily available.	○ Strongly Disagree ○ Disagree ○ Somewhat Disagree ○ Neither Agree nor Disagree ○ Somewhat Agree ○ Agree ○ Strongly Agree

Figure 34 (Continued)

Level of Planning

For each of the project planning tools identified below, please indicate in the first column whether the tool was used and its formality. In the second column indicate how effective that tool was in supporting the success of the project.

	Formality	Effectiveness
1. **Project Scope Document** Describes the project and product scope, major deliverables, assumptions and constraints.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
2. **Requirements Document** Describes the requirements of the product to be developed.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
3. **Design Specification** Provides the design specifications of the product to be developed.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
4. **Project Schedule / Activities List** List of all activities that should be performed during execution of the project. The list includes small and manageable components and their detailed description.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
5. **Project Schedule / Activity Start and End Dates** Definitions of start and end planning dates for each activity in the project. Usually presented in a Gantt chart.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
6. **Project Schedule / Role and Responsibility Assignments** Identifies the responsible team member for each project activity.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
7. **Quality Management Plan** Describes the implementations of quality policy in the project, including processes, procedures, responsibility and resources.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective
8. **Risk Management Plan / Risk Register** Identifies and describes the risks that may damage project success. Includes the probability and impact of each risk, prioritized listing of risks, and contingency plans and triggers for risks.	Not Used Briefly Considered Discussed with Others Informally Documented Formally Documented	Not Used Ineffective Marginally Effective Effective Very Effective

Figure 34 (Continued)

Project Success

1. The project was completed:	Significantly Behind Schedule Behind Schedule Slightly Behind Schedule As Scheduled Slightly Ahead of Schedule Ahead of Schedule Significantly Ahead of Schedule
2. Identify the number of project objectives completed:	None Less than Half About Half Most All
3. The quality of this system was improved as a result of this project.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree
4. I personally consider the project a success.	Strongly Disagree Disagree Somewhat Disagree Neither Agree nor Disagree Somewhat Agree Agree Strongly Agree

Other Comments

Please elaborate on any of your above answers, or identify actions or conditions that contributed to the success or difficulty of this project.

Submit

Figure 34 (Continued)

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