2008

A Meta Analysis of Critical Success Factors for Computer Technology Projects

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A META ANALYSIS OF CRITICAL SUCCESS FACTORS FOR COMPUTER TECHNOLOGY PROJECTS

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An Abstract Presented to the Faculty of the Graduate School of Lindenwood University in Partial Fulfillment of the Requirements for the Degree of Master of Business Administration

2008

ABSTRACT

Project managers are continually in pursuit of a magic formula that will deliver a successful project. Companies are interested in formulas for project success because billions of dollars are wasted each year, in U.S.A. Information Technology projects alone, through poorly managed or failed projects. Failing projects are not only bad for the individual project team members, but a failed project's impacts emanate outward to cause companies to decline or die. In addition, the targeted customers who receive inferior products, late products, or no products at all (due to project failures) are significantly impacted as well. Because failed computer technology projects are not isolated to the U.S.A., ultimately the entire world economy would be benefited by the identification of reliable critical success factors.

This study investigates, through a meta analysis of current research and literature, the existence of Critical Success Factors (CSFs) that influence the ability to deliver successful projects. Twenty-nine literature sources, from three different categories of literature (Researchers, Organizations, and Experts) were used as input to the analysis. The results obtained from the analysis yielded seventeen CSFs which contribute to the success of a project.

1) Project management
2) Clear goals and objectives
3) Project team competence
4) Requirements management

5) User & stakeholder involvement
6) Senior management support
7) Organization change management
8) Architecture and design
9) 360 degree communication
10) Quality management
11) Iterative & incremental development
12) Product development life cycle
13) Interdepartmental cooperation
14) Expectation management
15) Individual and team attitudes
16) Risk management
17) Vender management

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A Culminating Project Presented to the Faculty of the Graduate School of Lindenwood University in Partial Fulfillment of the Requirements for the Degree of Master of Business Administration

2008

COMMITTEE IN CHARGE OF CANDIDACY

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Dedication

To my loving family through whom God blesses me every day and gives me inspiration, strength, and help to meet all of life's challenges

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Preface

For those who are regularly involved in the development or acquisition of computer technology, it is not surprising to hear about projects that have either failed (cancelled or restarted) or are in serious trouble (over budget and slipped schedule). The larger the project, and the more complex the computer technology involved, the more likely the project will fail. A question has continually been asked, "What can a person do to help influence the successful conclusion of a project?"

Project managers and software engineers have been looking for factors that can improve the probability of delivering successful projects for decades. Ideas about Critical Success Factors (CSFs), from experts, researchers, and organizations, documented in public literature, have been helpful in improving the probability of success. However, each individual author's list of CSFs is incomplete when compared with the other individual author's lists of CSFs and lacks a validation against numerous other sources.

This study's aim is to provide a complete list of CSFs that is synthesized from many literature sources (meta-analysis study) to assure validity of the results. The common list of CSFs, synthesized from this study, is not meant to be a magic formula for success but rather guiding principals which, if applied carefully, will make a successful outcome more likely.

Chapter I

INTRODUCTION

Project Success and Failure

Everyone likes to win. No one enjoys losing. In the world of business, projects are constantly competing to succeed but they often fail. We see the results of "successful" projects from the past as well as today: Noah's Ark, the Egyptian Pyramids, the Golden Gate Bridge, the Empire State Building, the Saint Louis Arch, the IBM Personal Computer, and the Microsoft Windows Operating System. However, not all projects are successful. Examples of older project failures include: the Tower of Babel, the Leaning Tower of Pisa, and Her Majesty's Ship (HMS) Titanic. Recent failures include: attempts at replacing the FAA Air Traffic Control System, a cancer radiation treatment system that released an accidental lethal dose of radiation to a cancer patient, the Denver Airport baggage handling system, and many more. (Charette "Why Software Fails", Charette "Sowing the Seeds …") Why do some projects succeed and why do some projects fail? Projects fail for many reasons. Some of the reasons for failure are the same and some are different. Most projects fail to deliver on one or more of the desired outcomes even if they are considered "successful". A project may succeed in delivering a product on time with an acceptable quality, but it may have come in over budget. The time and cost requirement might be met, but the quality was not acceptable. This may even be true of some of the already

mentioned "successful" projects.

Project managers are continually in pursuit of a magic formula that will deliver a successful project. They may have previously determined that having certain conditions established for a project can lead to success (e.g., senior management support, use of industry best practices, and experienced resources). Individual project managers tend to build a mental checklist of characteristics that they try to reproduce for each new project. This mental checklist is based on lessons learned from previous successful or unsuccessful projects. Some expert project managers have codified and published their personal ideas for other colleagues to adopt or modify for their own personal use. Project management (e.g., Project Management Institute - PMI, Office of Government Commerce – OGC) and engineering organizations (e.g., Institute of Electrical and Electronics Engineers - IEEE, Software Engineering Institute - SEI, Association of Computing Machinery - ACM) have offered even more structure by making formulas available (or best practices) that should be considered in governing successful projects.

How is a project determined to be successful? There are characteristics of projects by which people measure a project's success. These measurements are called "key success criteria". There are other characteristics of projects that influence whether a project achieves success (as measured by the project success criteria). These characteristics that influence whether a project achieves success are called "critical success factors" (CSFs).

Key Success Criteria

Most project managers would agree that projects are considered successful if they are delivered on time, within budget, and meet the user's specified requirements. Harold Kerzner, author of a well-read project management text book, Project Management: A Systems Approach to Planning, Scheduling, and Controlling, says:

> "Today, the definition of project success has been modified to include completion:
> - Within the allocated time period
> - Within the budgeted cost
> - At the proper performance or specification level
> - With acceptance by the customer/user
> - When you can use the customer's name as a reference
> - With minimum or mutually agreed upon scope changes
> - Without disturbing the main work flow of the organization
> - Without changing the corporate culture" (5-6)

A survey conducted of 150 Australian project managers revealed this understanding about what is perceived as project success:

> "The traditional project management success criteria of time, cost and quality still has a strong hold within the project management community in Australia. However, the most important success criterion was considered to be the product success criterion of meeting the owner's needs." (Collins 211)

In a study, "What Characterizes Successful IT Projects", by Jan Terje Karlsen and three other researchers, a strong focus on the delivery of a solution to a problem that meets or exceeds the needs of the user was found.

> "Research results show that the five most important success criteria are: (1) the IT system works as expected and solves the problems, (2) satisfied users, (3) the IT system has high reliability, (4) the solution contributes to improved efficiency and competitive power, and (5) the IT system realizes strategic, tactical and operational objectives." (525-541)

It is with this understanding of what constitutes a successful project (satisfied user, meeting the user's specified requirements, on time, and within budget) that the key factors contributing to a project's success are explored in light of research, organizational best practices, and expert opinion.

Most project management authorities will consider a project successful if the project delivers its products within a prescribed time frame (time), within a cost range (cost), and with the end product meeting specified requirements with a minimal acceptable level of quality (scope). Changing any one of these three parameters usually necessitates a change in the two other parameters. Once agreed upon at an early stage of the project, these three parameters are usually tracked through to completion. They may be adjusted at different points along the way. There are usually acceptable tolerances allowed at different points within the project life. For example, very early in the project, before the detailed product requirements are fully understood, a wider allowance for error in estimating time and cost are allowed (e.g., plus or minus fifty percent may be allowed). As the project matures along the timeline, these tolerances are tightened.

Critical Success Factors

Many variables must be taken into consideration when planning and controlling a project. Some of these variables (also known as factors) include: capital (money), technology, management support, skill level of team members, experience of team members, methodologies employed, motivation of team members, project manager and other leader experience, type of project (embedded system development, information technology, hardware, software, commercial-

off-the-shelf - COTS, custom development, etc.) to name a few. The project manager and team leadership need to sort through all of these variables and give their primary attention to the few variables (or critical success factors) that have the strongest sway in the overall success of the project. If they pick the wrong ones or overlook some critical factors, it could mean the demise of their project.

Purpose of the Study

This study intends to investigate, through a meta analysis of existing research, the existence of critical success factors which have a strong influence on the success of a project. By determining if such a list of common success factors exists and, if so, sharing these success factors with the world of project management, projects may be able to obtain a greater incidence of successful project outcomes.

Many project management practitioners have attempted to identify the critical success factors that will yield a successful project. What is it that lays a foundation for a successful project? What factors, if met, will cause a project to succeed? There are many studies that have attempted to identify these characteristics. Some of the studies are a result of a single author's personal experience with projects that he/she has led or in which he/she has participated. Other researchers have made a study of multiple projects of which they have not been directly involved. Reading through these studies should yield a common set of success factors if there truly is a recognizable formula for project success.

The work that precedes this study to identify key success factors includes: international standards body books of knowledge (e.g., Project Management

Institute's Project Management Book Of Knowledge, United Kingdom's Office of Government Commerce PRINCE2, Six Sigma), individual authors (e.g., Barry Boehm, Grady Booch, James Rumbaugh, Ivar Jacobson, Harold Kerzner), companies (e.g., IBM Rational Unified Process), and other ad hoc organizations (e.g., Agile Development). The unfortunate truth is that there are many variances between what these sources of knowledge identify as project essentials or success factors. This variance between sources of success factors leaves the typical or novice project manager with a dilemma as to what factors are most important for their focus in order to have a successful project. Selecting one of the source's suggested factors will yield better results, than not considering success factors at all. However, selecting one may not yield as good of results as another or some selective combination of all sources. In addition, there may be a priority of importance that should be placed on some factors over others. In other words, all success factors may not be equal in importance for delivering a successful project. A project manager will want to know where they should focus their attention to get the most successful return.

The result of this study may produce a fairly lengthy list of success factors as a result of considering numerous studies. The intent is to identify those success factors that are consistently revealed to impact project success. The priorities of these success factors will be established based on the number of their occurrences in the included research and literature. This prioritization can assist a project manager in focusing their primary attention on the strongest contributors to success first and then move down the ladder of priority until all key factors are

appropriately addressed.

This study will focus primarily on literature related to computer technology projects. However, many of these factors may be extendable into other forms of project management. This will be left as an exercise for another researcher to study.

Problem Statement

A variety of researchers, organizations, and project management leaders advocate a different set of computer technology project success factors.

Research Question

Are there common critical success factors for computer technology projects? If so, what are the prominent variables (success factors) that contribute to project success?

Hypothesis

There are common critical success factors common to all computer technology projects.

Importance of the Problem and Need for Research

Companies are interested in formulas for project success because billions of dollars are wasted each year on poorly managed or failed projects. A 2000 Standish report indicates a loss of $78 billion per year in the U.S.A. alone due to failed computer software projects. (Benediktsson 4) Failing computer technology

projects are not only bad for the individual project team and its members, but failed project's impacts emanate outward to cause significant problems for companies and in some cases have caused companies to go out of business. The targeted customers who receive inferior products, late products, or no products at all (due to project failures) are significantly impacted as well. Ultimately, the entire world economy would be benefited by the identification of reliable key success factors.

Clearly, projects of massive proportions have been successful for hundreds and even thousands of years in history. As time marched forward into modern times, many of the techniques for successfully managing projects have remained unchanged. There are some project aspects that have changed dramatically as a result of modern technology. One aspect is the complexity of the products that are being delivered. The amount of resources and information to be managed, in order to deliver a computer technology product successfully, can easily overwhelm older manual techniques. A second aspect that differs from earlier projects is the rapidity with which products must be delivered in order to not miss their window of opportunity. As the complexity increases, and the time-to-market shortens, there is less opportunity to recover a failing project and turn it around into a success. It is much more important to get it right the first time. Setting the project up with the appropriate mix of critical success factors from the beginning can make the difference between success or failure.

The author has invested a majority of his professional life managing computer technology projects. These projects included the development of

leading-edge technologies from concept to operation. Other projects were efforts which involved turning around failed or failing projects. From this experience, correlations have been informally observed between the presence or absence of certain critical success factors. Some of these correlations were learned in a negative way and others in a positive way. Seeing the impact of not addressing a particular critical success factor (e.g., senior management support) yielded less than desired results. At other times, whether purposefully or by happenstance, the presence of critical success factors (e.g., strong team experience and skill) yielded project success.

Limitations of the Study

This is a meta analysis of others' research. It is a combining of many authors' work that is not fully understood in context or in value. Much of the research leveraged for this study is quality work.

Unreliable and non-applicable resources have been screened from this meta analysis. This screening is tainted by the author's own framework acquired over many years of project management and study. This too could wrongly influence the outcome of this study.

Merely knowing the critical success factors does not make the project successful. Applying the key success factors, in an appropriate fashion, is what leads a project to success. Key success factors can be implemented in an improper fashion with less than successful results. Each project is unique in many facets too. There are small, medium, and large projects. There are leading edge technology projects (e.g., flight control systems for a manned mission to Mars)

and there are "run-of-the-mill" technology projects (e.g., migrating to a new off-the-shelf accounting system) that are not pushing the envelope. These and other factors will have influence in the overall strategy for directing a project. This study does not underestimate these factors, but assumes the key success factors will be applied in a compatible approach with other discriminating project characteristics.

The project manager has the ability to manipulate many factors of a project. However, even if all of the critical success factors outlined in this study are properly addressed, there are some characteristics that are very difficult or impossible to factor into the equation. Some characteristics that can strongly influence the success of a project, but are mostly out of the control of the project team, are the economy, natural disasters, and being at the wrong place at the wrong time. Some call it Murphy's Law "if anything can go wrong, it will". Therefore, the application of the critical success factors, identified from this research, does not guarantee that the proper application will yield a successful project. However, you can assume that your chances are better for having applied them.

Definition of Terms

Meta-Analysis:

A process of merging and consolidating numerous research results to obtain an overall result of a subject under study.

Successful Project:

A successful project executes and completes within an acceptable variance

of the estimated time and cost, given a specified product scope and quality.

Key Success Criteria:

Key success criteria are the metrics that are used to determine if a project is considered successful. Project success is often measured by whether the project delivered a product meeting the specified requirements within a specified time and cost.

Critical Success Factors:

Critical success factors are variables that strongly influence the success or failure of a project. These variables are also known as "essentials". Examples of critical success factors include: executive support, user involvement, experienced project manager, clear business objectives, minimized scope, firm basic requirements, formal methodology, and reliable estimates. (Johnson)

Summary and Conclusions

Projects have been, and will continue to be, a significant part of our world's economy. Some projects will succeed and some will fail. It is the hope of this author that a greater percentage of projects will succeed as a result of leveraging this study which has benefited from the research of many others (organizations, companies, and individual authors) regarding critical success factors.

These key success factors are not intended to be a magic formula, a silver bullet, or any other sort of recipe for automatic success. A project can fail even if all known success factors are employed properly. The project manager and project team may have done all things well but there were circumstances out of their

control which caused the project to fail.

> "Again I saw that under the sun the race is not to the swift, nor the battle to the strong, nor bread to the wise, nor riches to the intelligent, nor favor to those with knowledge, but time and chance happen to them all." (Holy Bible, Eccl. 9:11)

Project management is a tough job and requires regular compromise and adjustments in order to satisfy the time, schedule, requirements, and quality definition of a successful project. A project manager has to juggle many factors, not just critical success factors. However, faithfully and prudently applying these success factors will improve the probability of delivering a successful project.

Chapter II

LITERATURE REVIEW

Project success is influenced by Critical Success Factors (CSFs). There are factors that are consistently agreed upon to be important to project success by researchers, project management organizations, and experts alike. This chapter reviews the CSF information that is revealed in these categories of literature and is divided into three sections:

1. Research Findings
2. Organization Findings
3. Expert Findings

Research Findings

Research of success factors has been carried out in several ways. Sometimes a researcher performs a survey of a select group of projects to identify the leading causes of success or failure for that body of survey participants – essentially performing project forensics. Other researchers have selected project management subject matter experts within an organization and interviewed them to discover what they consider to be key success factors. And, other researchers performed a random sample of projects with a questionnaire. There are other variations of methods for obtaining research input that are sifted down into a list of CSFs.

Markus Biehl looked at the success factors associated with the development of Global Information System projects. Based on a 2002-2003 study the following factors were identified:

1. Top management support
2. Capable and well understood business processes
3. Use of cross-functional teams
4. Maintaining cross functional cooperation and communication
5. Clear project goals
6. Organization change management (management of expectations)
7. Training of managers and the system's future users data accuracy
8. User attitude
9. Staff capability (55)

The study involved sixteen information system implementation projects from eight multinational firms. Eight of the projects were considered successful and the other eight projects were considered unsuccessful. A pretested and subsequently revised questionnaire was used to interview the project managers. All sixteen of the projects were either completed or aborted at the time the interviews were conducted.

Nah and Delgado performed a study of Enterprise Resource Planning (ERP) implementation and upgrade projects to determine what are important CSFs. ERP systems are usually commercial, off-the-shelf solutions that are integrated and customized to fit the needs of an organization. This study involved two organizations (a power company and a university). Both organizations had implemented and upgraded at least one ERP system. Nah emphasizes that this study includes a look at CSFs that are important for upgrade projects. Many other CSF studies had not included upgrade projects in their mix of projects for their study. The other unique aspect of this study was to distinguish which CSFs were

particularly important in different stages of the project. Structured interviews and questionnaires were used to capture input from members of the project teams. Below are the critical success factors that surfaced from this study.

1. Business plan and vision
2. Change management
3. Communication
4. ERP team composition
5. Skills and compensation
6. Management support and championship
7. Project management
8. System analysis, selection, and technical implementation (99)

Another study related to ERP system projects was conducted by Joseph Bradley. Eight projects were examined as part of this study.

> "The study finds that the experience of the project manager, quantity and quality of training and the effectiveness of a project champion lead to successful implementations. Both successful and unsuccessful firms use practices such as establishment of a project headed by a project manager, training, use of consultants, and control by a steering committee. No evidence was found to support integration of business processing and IT planning, reporting level of project manager, involvement of general management or role of management in reducing user resistance." (Bradley)

This study identified the following CSF's lead to successful ERP implementations.

1. Experience of the project manager
2. Quantity and quality of training
3. Effectiveness of a project champion

In a third research of ERP projects, Saud H. Al-Sehali performed a study on a random sample of 150 Enterprise Resource Planning (ERP) projects (30 Arab Gulf State companies and 120 United States of America companies). Sixty-seven (67) of the one hundred fifty (150) surveys were returned. "The respondents reported that the major critical success factor for the ERP implementation was the

top management support and involvement." (Al-Sehali) As indicated above, ERP implementations may have peculiarities due to the nature of their solutions. The study also revealed no statistical difference between the results obtained from Arab Gulf States and those obtained from the United States. The size of the company did not influence the results of the CSF importance.

A fourth ERP related research to be included in this study, turned out these findings.

> "The purpose of this study was to employ a Delphi panel to explore the characteristics of project success, gain an understanding of the most important ERP implementation CSFs and to analyze whether these same CSFs are applicable to mid-sized organizations. The two round Delphi study found the importance of senior management and project champion participation in the project. Additionally, the study indicated that the same CSFs existing in large-sized organizations are also applicable to mid-sized organizations." (Carson)

Somers and Nelson performed a study of eighty-six organizations that had either completed or were in the process of completing ERP implementations. They arrived at a list of 22 CSFs.

1. Top management support
2. Project team competence
3. Interdepartmental cooperation
4. Clear goals and objectives
5. Project management
6. Interdepartmental communication
7. Management of expectations
8. Project champion
9. Vendor support
10. Careful package selection
11. Data analysis and conversion
12. Dedicated resources
13. Use of steering committee
14. User training on software
15. Education on new business processes
16. Business Process Reengineering
17. Minimal customization

18. Architecture choices
19. Change management
20. Partnership with vendor
21. Use of vendors' tools
22. Use of consultants (Somers 2-5)

Plant took the Somers and Nelson CSFs and performed a study on two ERP projects. A pre and post survey was performed of project members to determine how important the 21 CSFs are to the success of ERP projects. The study confirmed that Somers and Nelson CSFs were important to the success of both projects. (Plant)

Ackkermans leveraged Somers' list of CSF to further study the interrelationships of CSFs on a major ERP implementation in the aviation industry. The study focused on the top ten CSFs of Somers and Nelson's twenty-two.

> "In this particular case, poor project performance led to a serious project crisis but this situation was turned around into a success. The list of CSFs employed was found to be helpful and appropriate in explaining both the initial failure and the eventual success of the implementation. CSFs in this case appeared to be highly correlated, ie changes in any one of them would influence most of the others as well." (Ackkermans 35)

Taking a different approach in identifying what causes projects to fail and then identifying what will help prevent failure, was the approach of another researcher.

> "This research investigated the causes for software project failures, the strategies that have been effective in reducing or eliminating these failures, and the critical success factors that are most commonly used by successful software companies in improving their software-development process, time, and quality. The study addresses the following research questions: (1) What major factors cause software projects to fail? (2) What strategies might be or have been effective in reducing or eliminating software project failures? (3) What are the critical success factors that lead

> to successful development of software projects in software development organizations?" (Boghossian)

Jarik Jahan Boghossian took this approach by interviewing eleven experts from ten different companies. From this study, fifteen critical success factors were identified.

1. Defined Product Development Life Cycle (PDLC)
2. Executive management support through PDLC
3. User involvement at the early stages of development
4. Strong project management
5. Small and miniature project milestones
6. Clear statement of requirements
7. Realistic expectations on the product and development schedule
8. Proper resource and strategic-level planning
9. Competent, trained, and focused work force
10. Ownership at all levels
11. Clear vision and objectives
12. Software development and engineering practices
13. Well-defined processes
14. Software estimation
15. Independent verification and validation (Boghossian)

This study involved a semi-structured interviewing process of the eleven experts over a period of eighteen months. The participating companies were carefully selected on various criteria including: revenue, innovation, and leadership in their own market segments.

Alan performed an empirical study with graduate students to determine the influence of emotions, personal processes, and team processes on the success of projects. They obtained these results.

> "The findings suggest that intelligence as GPA can have a significant influence on positive team processes. This finding supports Hacker (2000). For practitioners, this may suggest that it is important to have the best people working together to maximize team performance. Another finding is that negative emotions impact team process unfavorably. Work must be done to identify reasons and remedies for negative emotions during a project's life. Clearly team processes had a very positive affect on

> project success. Training and other measures should be recommended to improve specific team processes in industry. Trust also showed a positive affect on project success. The social bonding and team camaraderie that can be developed in an organization should be pursued. Finally, passive positive emotions may negatively impact project success. Work should be undertaken to maintain an aggressive, enthusiastic work setting. Comfort and contentment may breed mediocrity." (Alan 30)

Agile software development is a modern methodology for delivering successful software projects. Dac-Buu Cao performed a study of 109 Agile projects from 25 countries around the world. Cao looked at both success and failure factors for Agile projects. A result of the study was the identification of "...Three critical success factors for Agile software development projects: (a) Delivery Strategy, (b) Agile Software Engineering Techniques, and (c) Team Capability." (Cao)

In a survey conducted by the NASCIO (National Association of State Chief Information Officers) in 2005, the following success factors were identified. "...Clarifying the governance structure during the initiation phase of the project is essential. ... Organizational change management must be viewed as an integral component of project management." (1)

Hartman and Ashrafi surveyed 36 people associated with 12 projects to arrive at some conclusions about project success. They outline common causes for project failure from their survey of literature.

1. Misunderstood requirements
2. Optimistic schedules and budgets
3. Inadequate risk assessment and management
4. Inconsistent standards and lack of training in project management
5. Management of resources
6. Unclear charter for a project
7. Lack of communication (Hartman 6)

From their survey results, the following critical success factors were identified.

1. Stakeholders
2. Minimum scope changes
3. Change management
4. Technology and expertise
5. Project plan
6. Business purpose
7. Top management support
8. Project mission
9. Communication
10. Owner's consultation
11. Owner's approval (Hartman 8)

Ho and Lin say in their study, "Consideration of the various critical success factors in the life cycle of the integrated-enterprise systems implementation reduces the risk of failures. Loh and Koh (2003) highlighted some of these CSFs for small- and medium-sized enterprises (typically fewer than 250 employees). A more comprehensive list follows:

1. Methodology: design and implementation
2. Implementation strategy
3. Skills of implementation professionals
4. Organization structure
5. Change management
6. Cost management
7. Project management
8. Architecture and design
9. Collaborative process design: customers, suppliers, employees
10. Multilanguage and multi-currency
11. Hardware landscape optimization
12. Heterogeneous systems" (3733)

Kim identified 18 critical strategies for successful IS implementation through a literature survey.

1. User participation in the project
2. Top management support
3. Clearly state objectives
4. Alignment of project and corporate goals
5. Detailed project plan

6. Project leader's feedback to team
7. Project leader's experience
8. Project leader's project monitoring/control
9. Proper project scope
10. Reengineering business process
11. Adequate training for the team
12. Peer review on project progress
13. Utilizing a prototype
14. Team member experience
15. Team member commitment
16. Team member self-control
17. Utilizing an effective methodology
18. Use of an appropriate technology (Kim 3)

Kim's study shows that culture (cultivated behaviors in different countries) can impact the relative importance of each factor on the success of a project. The purpose of the study was to determine the strategies that IS developers use both in Japan and the U.S. to obtain successful implementations. The study revealed five components affecting success.

> "(1) Characteristics of the Team Members, (2) Characteristics of the Project Leader, (3) Management/User Input, (4) Proper Technology, and (5) Communication. The results indicated that there was a significant difference in the perceptions of Japanese and U.S. developers with respect to the importance of the five components. Japanese developers perceived the Project Leader as the most crucial component for determining the success of an IS project. Team Member Characteristics was viewed as the least important by Japanese developers. On the other hand, the developers from the U.S. viewed Communications as the most critical component. Project Leader Characteristics was perceived to be the least important by U.S. developers. The results were discussed in terms of cultural differences." (Kim 1)

Kim used a questionnaire which was reviewed and validated by 21 faculty members and pilot tested by IS developers from two local companies. Overall 100 IS developers were included in the questionnaire survey – 50 from Japan and 50 from the U.S. A variety of companies representing numerous industries were

involved. 49 U.S. and 46 Japan developers completed and submitted responses to the questionnaire.

Legris presents a more detailed list of success factors broken down by phase. This roadmap of key factors is based on literature and field experiments. There is a strong emphasis on stakeholder's contribution and critical management behaviors to deliver successful implementations.

Preliminary Analysis

1. A credible analysis of the current situation and of users' perceptions is achieved (through surveys, group discussions, interviews, etc.).
2. The analysis of the situation is largely shared by end-users.
3. The end-users believe that the proposed solution is consistent with the organization's priorities and strategy.
4. The tangible and intangible benefits and drawbacks of the new system have been clearly stated for each group of affected people, and have been communicated to those people.
5. The problem that the proposed system addresses is seen by end-users as crucial for the organization's survival or wealth.
6. The extra resources required are available in the organization, and management will make them available.
7. The organization has the resources to achieve the project, and it takes steps to retain them for its duration.
8. There is no threat with regard to labor relations.
9. All members of senior management openly support the project and actively cooperate.

System Requirements

1. The selected solution is well adapted to the situation.
2. The cost of the solution is suited to the organization.
3. The end-users are aware of the challenges the organization faces and the constraints it has to deal with.
4. The organization has the human, technical, and financial resources to manage the implementation process, and then to effectively maintain it.
5. Senior management clearly supports the choices.
6. The selected solutions are widely supported by the people responsible for their implementation.
7. The selected solutions are widely supported by end-users.
8. An event is organized to celebrate the ending of this phase.

Preparation

1. An action plan has been communicated to team members and to end-users, and is updated regularly.
2. People affected by the change have been actively involved in the definition of the new processes.
3. People affected by the change have been actively involved in testing the new processes.
4. People are openly informed about the system's limitations and drawbacks.
5. People affected by the change have received relevant and practical training on the new processes. They know concretely what is expected from them on the work site.
6. A senior line manager is explicitly identified to be in charge of the project.
7. Senior management clearly and regularly restates its commitment to the project, and to the level of priority it deserves.
8. Management promptly makes decisions about problems that could hinder the project's progress.
9. An event is organized to celebrate the end of this phase.

Implementation of the new System

1. A special event is organized to publicize the kick-off of implementation.
2. Field guidance is provided to users to help them cope with the new system and rapidly reach proficiency.
3. Technical and functional supports are rapidly available online, through a hotline, or on-site.
4. Measurement of progress is achieved and people are informed of the results.
5. The manager responsible for the implementation is clearly identified and known to everyone.
6. A dedicated, temporary structure is set up to lead and manage the implementation effort.
7. The implementation is designed as a succession of short, intensive cycles, with time to recover between each one.
8. People affected by the change are kept informed of any problems and the delays.
9. Users can quickly see the results and benefits of the new processes.
10. End-users are informed of the side effects of the transition period. These can include a temporary drop in productivity and a higher level of stress, fatigue, and confusion.
11. Senior management clearly demonstrates its interest in the implementation of the project.

12. Management tracks problems and resolves them promptly. Afterward, the situation is monitored.
13. An event is organized to celebrate the completion of this phase, or of any intermediate phase.

Consolidation

1. An assessment of the results and benefits of the new system is achieved and a report is communicated.
2. The assessment takes into account end-users' opinions.
3. Problems are clearly identified, analyzed, and properly solved.
4. An event is organized to celebrate the completion of the project.

Medoza, Perez, and Griman define 20 CSFs for managing systems integration. These 20 CSFs were developed by the authors and not derived from the study. The purpose of the study was to develop a framework of CSFs to help manage integration projects and identify metrics to measure CSFs for projects. The study consisted of applying the CSFs to two case studies of companies undertaking application development projects.

1. Significant administrative support for the project
2. Complete technological infrastructure
3. Effective project leadership
4. Valuable project management
5. Relevant user involvement
6. Effective internal and external training plan
7. Effective organizational change management
8. Low impact of Information Systems on the organization
9. Careful strategy of implementation
10. High-expertise project team
11. Helpful technical support
12. Appropriate configuration of the communication software
13. Standard data model documentation, unification, and updating
14. Appropriate outsourcing management
15. Known organizational structure
16. Change determined and justified at a productivity level
17. Valuable support by senior management
18. Adequate management of project scope
19. Appropriate strategy of security
20. Effective out-going and in-coming communication

Umble looks at CSFs for ERP systems in his study and identifies the 9 critical success factors that the authors consider prominent ERP implementation CSFs from what others have proposed. The work is a case study of, what is considered, a successful ERP implementation, in light of the 9 CSFs put forth by the authors.

1. Clear understanding of strategic goals
2. Commitment by top management
3. Excellent project management
4. Organizational change management
5. A great implementation team
6. Data accuracy
7. Extensive education and training
8. Focused performance measures
9. Multi-site issues (Umble 244-247)

Wilson identifies factors that influence CRM (Customer Relationship Management) system success. Using an analytic induction method, the authors derived 14 CSFs from 5 in-depth case studies. A description of the analytic induction method is provided first, followed by a listing of the 14 CSFs.

> "In brief, the method involves formulating a hypothesis; comparing the hypothesis against the first case; if it does not fit, reformulating the hypothesis so as to be consistent with the data in the first case; comparing the revised hypothesis against the second case; and so on." (Wilson 202)

<u>Determine the Intent</u>

1. Gain champion/sponsor
2. Ensure market orientation
3. Define approval procedures which allow for uncertainty
4. Gain board awareness of strategic potential of IT

<u>Assess the Context</u>

5. Identify need for business system convergence internally & coordination externally
6. Organize round customer
7. Address culture change in project scope

<u>Describe CONTENT</u>

8. Involve users interactively in system design
9. Design for flexibility

10. Manage IT infrastructure
11. Leverage models of best practice

Construct intervention PROCESS

12. Rapid strategy/action loop to experiment and gain credibility
13. Prototype new processes, not just IT

MANAGE intervention process

14. Manage for delivery of benefits, not specification (Wilson 208)

Organization Findings

There are many national and international organizations that promote software project best practices. These best practices are formulated by groups of project management experts to help projects be successful. Almost all of these project practices and guidelines were developed out of a reaction to the numerous failures of projects over the years. The interpretations applied to project best practices, in this study, are that they are considered important success factors for projects otherwise they would not be valuable enough to include in the standard practice.

These organizations and their best practices include: Motorola's Six Sigma, Project Management Institute's (PMI) Project Management Book Of Knowledge (PMBOK), UK's OGC (Office of Government Commerce) PRINCE2 (Projects IN Controlled Environments), IEEE (Institute of Electrical and Electronics Engineers) 12207, and IBM Rational RUP. Most of these best practices were initially started more than twenty years ago and have been continually refined over the years. These project management practices often represent a compromise of thought involving hundreds or thousands of expert opinions. In all cases the practices have been refined by trial under fire on real projects which lend to their credibility.

Six Sigma (originating at Motorola in the late eighties and early nineties) is a methodology dedicated to improving products and activities that are selected for enhancement in an organization. A product or activity could be anything, including the development of a software application. Some companies have shifted their entire IT staff over to a Six Sigma approach to project management.

Six Sigma projects follow a common model. The model can be described in the DMAIC acronym. The letters of the acronym stand for the following:

D Define the goals of the improvement activity
M Measure the existing system
A Analyze the system to identify ways to eliminate the gap between the current performance of the system or process and the desired goal
I Improve the system
C Control the new system (Pyzdek 4)

PRINCE2 is a recognized standard for project management originating in the UK but also put in practice in the United States and around the world. The acronym for PRINCE2 stands for PRojects IN Controlled Environments (the 2 represents a later version).

PRINCE2 has grown to a point of acceptance around the world where certification programs for project managers are offered and sometimes mandated by businesses. Some projects will require certification training in the PRINCE2 best practices.

Listed below are some of the key aspects of PRINCE2 project management.

Components:
1. Business Case
2. Organisation
3. Plans
4. Controls

5. Management of Risk
6. Quality in a Project Environment
7. Configuration Management
8. Change Control

Processes:
1. Planning
2. Directing a Project
3. Starting up a Project
4. Initiating a Project
5. Controlling a Project
6. Managing Product Delivery
7. Managing Stage Boundaries
8. Closing a Project (Office of Government Commerce 12)

Techniques:
1. Product Based Planning
2. Quality Review
3. Change Control (Office of Government Commerce 291)

Project Management Team Roles:
1. Project Board
2. Executive
3. Senior User
4. Senior Supplier
5. Project Manager
6. Team Manager
7. Project Assurance
8. Project Support
9. Configuration Librarian
10. Project Support Office (PSO) (Office of Government Commerce 395-407)

The Project Management Institute (PMI) is an international organization of project managers. The PMI has produced and regularly updates a document called the Project Management Book Of Knowledge (PMBOK). This book encapsulates the factors that are considered important for projects. Below is a list of these factors.

Management of the following project characteristics:
1. Integration (charter, scope statement, management plan, direct and manage execution, monitor and control work, change control)

2. Scope (planning, definition, verification, control)
3. Time (activity definition, sequencing, resource assignment, resource estimating, duration estimating, schedule development, and control)
4. Cost (estimating, budgeting, control)
5. Quality (planning, assurance, control)
6. Human Resources (acquire, develop, and manage project team)
7. Communications (information distribution, performance reporting, manage stakeholders)
8. Risk (identification, analysis, response, monitoring)
9. Procurement (purchases and acquisitions) (Project Management Institute 8)

The PMBOK has become the basis of knowledge for a certification program. One of the certifications that can be obtained from PMI is the PMP (Project Management Professional). Many companies require PMP certification in order to perform the role of a project manager.

In the late 1990's a merging of ideas between three leaders in the software development movement (Grady Booch, Ivar Jacobson, and James Rumbaugh) resulted in what is now called the Rational Unified Process (RUP). The essentials of RUP are outlined to be the following:

1. Vision—Develop a Vision
2. Plan—Manage to the Plan
3. Risks—Mitigate Risks and Track Related Issues
4. Business Case—Examine the Business Case
5. Architecture—Design a Component Architecture
6. Prototype—Incrementally Build and Test the Product
7. Evaluation—Regularly Assess Results
8. Change Requests—Manage and Control Changes
9. User Support—Deploy a Usable Product
10. Process—Adopt a Process that Fits Your Project (Rational Unified Process)

RUP also specifies six best practices –

1. Develop software iteratively
2. Manage requirements
3. Use component-based architectures
4. Visually model software

5. Verify software quality
6. Control changes to software (Rational Unified Process)

The military has required software development projects to conform to standards going as far back as the 1970's. Mil Std 2167 (Mil Std – an abbreviation for Military Standard) was replaced by interim Mil Std 498 which ultimately has been replaced by IEEE standard 12207.

1. Primary life cycle processes :
   a. Acquisition process
   b. Supply process
   c. Development process
   d. Operation process
   e. Maintenance process
2. Supporting life cycle processes:
   a. Audit process
   b. Configuration Management
   c. Joint review process
   d. Documentation process
   e. Quality assurance process
   f. Problem solving process
   g. Verification process
   h. Validation process
3. Organizational processes:
   a. Management process
   b. Infrastructure process
   c. Improvement process
   d. Training process (IEEE)

The Standish Group, West Yarmouth, Mass., is a research firm that focuses on mission-critical project management applications. "In 1994, only 16% of application development projects met the criteria for success— completed on time, on budget, and with all features/functions originally specified. In 2000, 28% of projects were in the successful column." (Johnson) Johnson shares the "Recipe for Success: CHAOS Ten" CSFs listed below. "What ensures a project's success? The original CHAOS study, conducted in 1994, identified 10 success factors.

Standish has updated the CHAOS Ten for 2000. Although no project requires all 10 factors to be successful, the more factors present in the project strategy, the higher the confidence level." (Johnson)

1. Executive support
2. User involvement
3. Experienced project manager
4. Clear business objectives
5. Minimized scope
6. Standard software infrastructure
7. Firm basic requirements
8. Formal methodology
9. Reliable estimates
10. Other criteria (Johnson)

The Standish Group publishes the list below in 2005:

1. User involvement
2. Executive management support
3. Clear business objectives
4. Experienced project manager
5. Minimal scope and requirements
6. Iterative and agile process
7. Skilled personnel
8. Formal methodology
9. Financial management
10. Standard tools and infrastructure (Collett 40)

Expert Findings

There is a vast body of literature espoused by project management experts, some well recognized and others not so well recognized, identifying what they consider to be key success factors. In a meta-analysis this information can be used to augment the more scientific approach of research and the committee (Delphi like) approach of organizations.

Barry Boehm is a world renowned expert on software development. Here is what he says about the causes for project failure and the factors that bring success.

Boehm´s top ten risk items and remedies:

1. Personnel Shortfalls
   Staffing with top talent; job matching; team-building....
2. Unrealistic Schedules and Budgets
   Design to cost; incremental development; software reuse...
3. Developing the wrong software functions
   Organizational analysis; mission analysis; user surveys;...
4. Developing the wrong user interface
   Prototyping; scenarios; task analysis
5. Gold-plating
   Requirements scrubbing; prototyping; cost-benefit analysis...
6. Continuing stream of requirements changes
   High change threshold; incremental development…
7. Shortfalls in externally-performed tasks
   Reference-checking; pre-award audits; award-fee contracts; prototyping; team-building...
8. Shortfalls in externally-furnished components
   Benchmarking; inspections; compatibility analysis…
9. Real-time performance shortfalls
   Simulation; benchmarking; modeling; prototyping...
10. Straining computer science capabilities
    Technical analysis; cost-benefit analysis; prototyping... (Benediktsson 7-8)

Charette identifies the primary reasons why projects fail in his article "Why Software Fails". In this article the author shares examples of failed projects costing 100's of millions or even billions of dollars each. Charette is convinced that the failure rate for projects with over $10 million budgets is 15-20% or more. Below is the author's list of the most common factors for project failure. From this list, CSFs can be derived.

1. Unrealistic or unarticulated project goals
2. Inaccurate estimates of needed resources
3. Badly defined system requirements
4. Poor reporting of the project's status

5. Unmanaged risks
6. Poor communication among customers, developers, and users
7. Use of immature technology
8. Inability to handle the project's complexity
9. Sloppy development practices
10. Poor project management
11. Stakeholder politics
12. Commercial pressures (Charette "Why Software Fails")

In another article, "Sowing the Seeds of Failure: Understanding Why Software Projects Collapse", Charette points out that projects often fail because of what people don't know about managing projects.

> "On large projects, uncertainty is a way of life. Requirements change, budgets change, resource and schedule estimates are incorrect, yet through it all, project plans are treated as if they were train timetables. Projects that collapse fail to recognize that a plan is nothing more than a hypothesis, a (hopefully) educated guess about what is expected to occur over the future, if the assumptions at each point in time do not change. Every failed project we have assessed has treated their planning targets as events that were certain to occur, instead of as expressed desires." (Charette "Sowing the Seeds")

Wayne Turk, in an article "Project Management Top 20", identifies key principles or guidelines for project management from his expert experience. "Among them are good planning, organizational communication, consideration of end users, meeting desired cost, schedule and quality, good management and leadership, setting of priorities and giving people the right tools." Here is the list of Turk's top 20 plus 1.

1. Requirements are the underpinnings
2. Planning is the project's roadmap and is ongoing
3. Communication – up, down, and side-ways – is a must
4. User/customer involvement can prevent misunderstandings
5. The three primary dimensions – cost, schedule, and quality – must be top concerns
6. Leadership and management go together
7. Responsibility with the appropriate authority is necessary for the PM and task leads

8. Set priorities; then re-examine them periodically
9. Gather the right metrics for the right reasons
10. Good people make or break the project
11. Give people the right tools so that they can do their jobs
12. Selling the project can garner support from above
13. Manage risk – but take risks when you have to
14. Use good people skills, and people will respond with good work
15. Adequate, thorough, and timely testing with good test plans make for good products
16. Transmitting the appropriate urgency is the right kind of motivation
17. Monitor, but don't micromanage
18. Using "Outsiders" correctly is a team multiplier
19. Focus on the important areas, but don't ignore the rest
20. Expectations should be high for your self and your people, and realistic for the stakeholders
21. Don't lose your sense of humor (Turk 35-41)

The project team and involvement of director level managers were important project success factors identified by Lucy Rowbothom in her article "Not a Minute to Lose". Rowbothom discusses that the success of an innovative product launch depends on all team members. She describes that project making is risky and full of barriers where the essential element to be gathered should start with a high-performance team and mechanisms for open innovation. Moreover, the involvement of director-level managers that covers the key disciplines, such as marketing, manufacturing and engineering, is needed to invest at least eight hours to supervise the process. (Rowbothom 26)

Robert Scott says, "Setting deadlines and measuring the project's profitability is essential. A standardized project management approach is necessary to get things done. The executive's commitment towards the project can make a difference regarding its success and failure." (Scott 30)

In "The Way to Get IT right" Shaun Taylor outlines what he considers to be critical. "It is essential to create significant milestones and checkpoints

throughout the life of the initiative at different junctures so that progress can be gauged and go/no-go decisions can be made if necessary. The project management team or project manager should have the authority to require all persons likely to be involved with the project to carry out specified activities when it is clear that these are in the interest of the project." (Taylor 15)

1. Create a genuine and constructive partnership between the business unit and the I.T. unit
2. Devise a clear specification for the aims, targets, and rationale of the initiative and make sure that everyone involved in the project understands the specification and subscribes to it
3. Organize and implement a pilot project
4. Address the toughest design issues first
5. Organize modular delivery
6. Prioritize the need for mutual communication
7. Pay particular attention to the user interface of any component of the system that will involve the Internet
8. Specify significant milestones and check points
9. Retain tight control of the project (Taylor 15)

Pattit and Wilemon identify best practices that can be used by software development projects to improve project success.

1. Clearly define tasks and role assignments
2. Use small, effective teams
3. Proactive company policies toward conflict management
4. Confronting and give-and-take conflict management style
5. Utilize a development process
6. Track and manage changes to project
7. Use component-based design
8. Frequent integration of software components (i.e. builds)
9. Peer reviews
10. Feedback from customers
11. Use multi-functional teams
12. Use multiple best practices (Pattit 384-386)

Page provides a list of CSF for the acceptance of clinical information systems. Although there may be peculiar needs for the successful delivery of a

clinical information system, these CSFs track closely with others identified for computer technology projects.

1. Share vision
2. Executive leadership
3. Decision involvement
4. Expectation setting
5. Communication process
6. Project management
7. Management of system access
8. Compatibility of workflow processes
9. Critical mass of data automated
10. Resource allocation
11. System administration (Page 256)

John Reel in his article "Critical Success Factors in Software Development" identifies five CSFs that are important to project success.

1. Start on the right foot
    a. Set realistic objectives and expectations for everyone
    b. Build the right team
    c. Give the team what they think they need
2. Maintain momentum
    a. Keep attrition low
    b. Monitor quality early on and establish an expectation of excellence
    c. Manage the product more than the people
3. Track progress
4. Make smart decisions
5. Institutionalize post-mortem analyses (Reel 19-23)

Spector and West share a new concept of lean program management in their article "The Art of Lean Program Management" which identifies 5 prerequisites and 6 key steps for successful lean/six sigma programs.

5 Prerequisites:

1. Improvement programs must align with the company's strategy and objectives
2. Top management must be committed and actively involved
3. Projects must be focused on a growth strategy
4. Take an enterprise approach to program management

5. Establish a cross-functional, process focused infrastructure (Spector 52-54)

6 Steps:

1. Prioritize projects based on their impact and use of strategic resources
2. Use "critical chain project management" to plan and execute projects
3. Minimize the number of concurrent projects
4. Make data quality an imperative
5. Don't waste time and resources gathering unnecessary data, performing unnecessary analysis, and creating unnecessary metrics
6. Pursue perfection, but tolerate failure (Spector 54-57)

A category of software development methodology called "Agile" development has become more and more popular in the past couple of decades. The Rational Unified Process (RUP) is considered an Agile development methodology. RUP was introduced earlier in this chapter. Two other popular Agile methods are Extreme Programming and SCRUM. Listed below are some of the tenets of Extreme Programming and SCRUM.

Extreme Programming:

1. Planning Game
2. Small/Short Releases
3. Metaphor
4. Simple Design
5. Testing
6. Refactoring
7. Pair Programming
8. Collective Ownership
9. Continuous Integration
10. 40-Hour Week
11. On-Site Customer
12. Coding Standards
13. Open Workspace
14. Just Rules (Abrahamsson 23-25)

SCRUM:

1. Product Backlog
2. Effort Estimation
3. Sprint
4. Sprint Planning Meeting
5. Sprint Backlog

6. Daily Scrum Meeting
7. Sprint Review Meeting (Abrahamsson 31-34)

Summary and Conclusions

From this review it is obvious that there are common project success factors that cross all three segments of literature included in this study – researchers, organizations, and experts. This is not surprising because in our modern day, project managers exchange ideas with ever increasing speed and coverage. There is an implicit international Delphi study that is ongoing. Experts put forth their ideas in industry and academia. Experts see each other's ideas in the public sector. From this feedback they refine their ideas and put forth improved and refined ideas.

The review also reveals differences in the project success factors. This can be explained by a number of causes. Each project has its own unique characteristics. There are no two projects that are exactly alike. There are ERP system developments, Web Site developments, Global Information Systems, Embedded systems, projects involving vendor products and development, and other possibilities too numerous to mention. Each project manager has a different personality with different skills and experience. Each project team has a different size, skill mix, and numerous other characteristics. Each company culture is different which has an influence on the factors that are emphasized for project success.

The quality of data gathered by all of the different research projects varies greatly. This includes the rigor in which the data was gathered to the way it was

analyzed and presented. In this meta-analysis the noise in the data caused by quality control concerns will hopefully be rendered harmless to the overall outcome. Success factors with the highest value should recur enough that their inclusion in the top success factors is assured. Success factors that are spurious should not recur frequently enough to rise to a level of inclusion in the top success factors.

The addition of other literature may introduce variations to the overall results. However, a significant amount of expertise has been captured in this body of literature and it is unlikely that the addition of more sources would greatly alter the overall results.

Chapter III

SELECTIVE REVIEW AND EVALUATION OF RESEARCH

Introduction

Computer technology projects have been important for many decades. They continue to increase in importance as the entire globe becomes more and more computerized. Every facet of our daily life, in the western world, involves products developed by computer technology projects. Even in the Third World, computer technology is breaking into the daily lives of their inhabitants. This makes finding the independent variables (critical success factors) that contribute to the success of computer technology projects (dependent variable) all that more important.

Projects have long been plagued by cost and schedule over-runs, poor quality, and disillusioned users. Project managers have identified success factors which they consider to be critical for a project to succeed. Each expert has often identified their own mix of success factors. One expert's list of success factors doesn't fully match the items found on another's list. The importance placed on each success factor may also vary from one success factor list to the next.

This study has attempted to pull together a vast knowledge base on the subject of Critical Success Factors (CSFs) associated with computer technology projects. The data has been analyzed to determine if there is truly a common list of success factors that are critical to all computer technology projects. Having this

important knowledge will hopefully assist project managers in consistently delivering successful project outcomes.

The author is not deluded into thinking that a magic formula of critical success factors will eliminate all failed computer technology projects. There are too many variables to deal with that are not within the control of the project manager. Yet, the consistent application of these critical success factors should improve the probability of a successful project outcome.

Subjects Demographics and Research Methods

In this meta-analysis, the material of many authors has been analyzed. The characteristics of this population of authors can be broken into at least three different taxonomies.

1. Type of author
2. Type of project
3. Type of research

The first taxonomy is segmented by type of author – dissertation and thesis researcher, academic researcher, industry researcher, organization in the computer technology and project management sectors, and industry leaders in the computer technology and project management sectors. There are peculiarities associated with each of these authors that can have influence on the outcome of the research. Dissertation writers, thesis writers, and other academic researchers can be isolated from the real world of project management. Unless the authors have previously worked as project managers or participants on numerous projects in the industrial world, they will have a heavy reliance on the input of the person with whom they obtain the input data. If they have only a book and classroom

knowledge of project critical success factors, they may be disadvantaged by a limited framework to make the correct interpretations of gathered data. This can also be seen from a different perspective in a more positive light. A researcher who has not been tainted or biased by his/her own real world project experiences could be better at objectively analyzing the data. A way to address this problem is to carefully screen the background of the researchers by examining biographies and vitas of the authors.

Some academic researchers may conduct isolated experiments using graduate and undergraduate students for the duration of a semester course. The problem is that these sorts of experiments can not always be extrapolated into real world projects. There are different motivation factors associated with the classroom based projects than with real projects in industry.

Industry researchers are persons working in industry who do research either on their own time or associated with their jobs. Most of the studies that they do are based on data gathered from real projects. As mentioned earlier, the real world experienced researcher's objectivity can be clouded or biased by his/her own personal experiences which may not be true of industry at large. Their own company or personal methods, and application of CSFs, could yield results that are not matching to the norm of the world around them. There may also be hopes of fame and fortune which steer the outcome of the study (e.g., presentation of findings at a popular symposium, company financial rewords for publishing).

Organizations in computer technology and project management sectors are usually represented by a committee. Committees provide a valuable service in that

they allow a reasonable number of people to represent an overall organization. It would be too unmanageable to have a large organization work as one team to come up with a best practice or procedure. The committee could be ad hoc or formal, but either way, a group of people to represent the overall body of members of the organization (i.e., company, association, institute, etc.). Committees attempt to blend the opinions and information from many individuals into one shared opinion and belief. Committee work involves a lot of compromise and each member of the committee does not usually have an equal input into the outcome. Often, the outcome of the committee is made available to the organization for review and approval before the committee's work is put forth as a standard or guideline. This review process provides a check on external validity. If the findings were too far off from reality, members of the organization may voice their concerns.

A final consideration of author types is individual industry leaders/experts who share their thoughts, often with only antidotal backup. Some of these authors have a long pedigree of experience and are well recognized in industry. Others do not have a well established background and share their opinions with very little real world experience. With the information age in which we live, it is very easy to get published into the public sector. This may pose a problem for inexperienced students of project management who can be deceived by literature put forth by authors with a limited discriminating framework.

The second taxonomy is to segment the works by types of projects – size, complexity, product being produced, and other project characteristics. It turns out

that most of the authored material on CSFs deals with large and complex projects. This is not surprising because smaller projects do not tend to have the significant failure rate that larger and more complex projects have and hence writing about them may be less edifying. A very small amount of the literature included in this study dealt with small projects. These studies were only provided in the literature for diversity of examples and were not included as contribution to the analysis results.

It is interesting to note that a current movement in project management is to approach large projects by breaking them down into smaller projects or increments; (the author realizes this approach to project management has existed for decades, centuries, and even millennium). Doing so seems to break down, or in some cases remove, many of the characteristics that can cause a project to fail. This topic could make a separate study in and of itself.

Size and complexity typically go hand-in-hand. The larger the project, the more complexity is involved. Most of the studies dealing with CSFs are addressing an application to complex projects. Much of the literature related to CSFs includes the topic of ERP (Enterprise Resource Planning) systems – some of the most complex and largest system implementations in the world.

The final segment is based on the type of research that was conducted. In this segment there are empirical studies (conducted through surveys and interviews of various project management experts in industry), meta analysis (similar to this study), formal Delphi method through groups of experts agreeing on a common standard or process, and expert opinion from years of study and

experience. All of these methods are represented in this meta analysis study.

Surveys and interviews are a very effective method for drawing out solid data to determine the validity of a hypothesis. The value of a survey or interview is limited by the quality of the survey instrument and the quality of the person who performs an interview. The survey can be written in such a way as to allow the respondent to provide an open response or restrain them to a very controlled response. An interviewer can also guide the interviewee in an inhibited fashion or an open manner. A meta analysis, given an ample supply of quality input, should yield a reasonably accurate picture of the results of the topic under study. The Delphi method is an efficient way to grasp, in a synergistic way, the understanding of a topic by a group of individuals. The quality delivered by the Delphi method is dependent on the knowledge of the critical mass of people participating. A committee, in essence, can be considered an informal Delphi method.

Expert opinion can be tainted by the constraints of the individual's training and experience. Some examples of constraints include:

1. No real world experience
2. Experience at only one company
3. Experience on only small projects
4. Trained in only one project management methodology
5. Experience in one industry type
6. Limited number of projects
7. Limited to one role in the project team

These constraints can be screened by carefully checking the credentials of the author(s) of the literature under study.

Research methods employed by the authors of the literature used in this

study can have an impact on the validity of this meta analysis. The impact is limited to the extent that there is a statistical significance to the number of studies containing bad methods. The author was careful to take into consideration experimental control, sampling techniques, threats to external validity, statistical methods used, conclusions supported by data, and limitations acknowledged by researchers when selecting literature to be included in this meta analysis.

Deficiencies can be found to some extent in all of the included research. The advantage of the meta analysis method of research in overcoming these ills is explained further in the sections to follow.

Sampling Procedures

There is a vast amount of research available on project success factors – far more than could be reasonably analyzed and reported on for this study. A two stage approach was used for this study. The first stage involved identifying the target population of the research on the subject of critical success factors. The target population criteria was accomplished through establishing search engine parameters that filtered studies to include only work that incorporated computer technology terminology and used the term "success factor". Several search engines were used to recover appropriate information – e.g., EBSCO, ERIC, Pro Quest, Google, AltaVista, and more.

For this study, the target population is all literature available that addresses the topic of computer technology project critical success factors. Note: this is a subset of the total population of project experts with knowledge on computer technology project success factors (a small percentage of this population actually

publishes works on this topic). In some way, the sampling method used on this meta-analysis could be classified as a convenience sample in the sense that the author chose to use all literature which was available through select search engines. The total population of knowledge would include references obtainable through other search engines as well as those documents that are not available through online references – university libraries, company libraries, public libraries, and other untapped sources.

This population was further discriminated through a purposive sampling. A purposive sampling is "based on a population and the specific purpose of the research, investigators use personal judgment to select a sample" (Fraenkel 100). Based on the author's knowledge of the project management and computer technology fields, the candidates were singled out to create the final sampling to be used in the study. This purposive sampling did not discriminate on whether the research supported or was counter to the hypothesis of this study.

Research Setting

This research was conducted as a meta-analysis. (A "thesis driven" expository study is another way of describing the approach to this research work.) "In the simplest terms, when a researcher does a meta analysis, he or she averages the results of the selected studies to get an overall index of outcome or relationship" (Fraenkel 86). The results of numerous sources of critical success factor material was analyzed and combined to produce the outcome of this study. The more quality sources of information are used as input to the study, the more likely the research will result in an accurate portrayal of the true common critical

success factors.

The individual studies that make up the body of knowledge feeding this meta-analysis also made sampling decisions to obtain their data. Simple random, stratified random, cluster random, and two-stage random, systematic sampling, convenience sampling, and purposive sampling were used in different studies. These sampling techniques influenced the validity of the studies that make up this meta-analysis.

The target population for many of the studies which were inputs to this meta-analysis, went beyond that of the target population available for this meta-analysis. In some cases the target population was all project managers who have experience with managing computer technology projects. An example of another convenience sample is where the researcher chose to send a survey to all the project managers of a particular organization. This type of survey takes on the characteristic of a two-stage sample. The first stage is convenience and the second stage is random, based on using the survey results of those who take the time to fill out and return the survey.

Validity

The meta-analysis method of research lends itself to assuring a more general applicability to all groups and environments of the total population. External validity is "the degree to which results are generalizable, or applicable, to groups and environments outside the research setting" (Fraenkel G-3). A large sample of varied researchers, organizations, and experts have a broader coverage of project influences that should address the large variance in characteristics of

projects – large/small, complex/simple, experienced/inexperienced resources, and others. Another influencer of external validity in this study is the inclusion of international organization literature. The international organizations have representatives from all over the world, covering a vast and varying portfolio of technical projects.

Meta-analysis studies also can be helpful in assuring internal validity. Internal validity is "the degree to which observed differences on the dependent variable are directly related to the independent variable, not to some other (uncontrolled) variable" (Fraenkel G-4). From a statistical perspective, the larger the number of applicable studies are incorporated, the better is the probability that a more accurate result will be obtained. With a single study, an internal validity problem in that study can make the entire study bogus. With two studies, one study could be bogus and the result would contain partially correct information. As the numbers increase, the noise of bogus studies will eventually have a minimal effect on the overall strong signal put forth from the majority of internally valid studies.

There are other concerns associated with meta-analysis studies that should be considered when evaluating the overall validity of the research. "Critics raise a number of objections, some of which have been at least partly remedied by statistical adjustments. We think the most serious criticisms are that a poorly designed study counts as much as one that has been carefully designed and executed, and that the evaluation of the meaning of the final index remains a judgment call, although an informed one" (Fraenkel 86-87). The first objection

was already addressed by the noise of bogus inputs being drowned out by the volume of the correct inputs - when using a large enough discriminated sample. However, concern for objectivity must also be considered because the author utilizes his own judgment when initially weeding out questionable research input in the first place.

Research Procedures

One of the first steps in beginning the meta-analysis was to identify sources of information that address the topic of computer technology project, critical success factors. The sources included research works, standards and guidelines of well known project management organizations, and books by industry experts whose reference was identified from on-line search engines. Some of these materials were already known to exist from the author's experience in the field of project management. In some cases additional reference works were discovered from the works cited in the initially identified works.

In order to obtain these references, search criteria needed to be crafted in such a way as to yield applicable material. The author found a combination of search criteria that proved to be successful in yielding an adequate number of references on most search engines that covered this subject area. The search criteria included a combination of searching the abstract of the document for the phrase "success factors" and the body of the article also containing one or more of these phrases "computer technology" or "information technology" or "information systems".

The results from these searches were then screened for applicability by

reviewing the titles and abstracts. This resulted in a long list of references that was further reduced by obtaining full text or more detailed summaries of the content. This resulting short list was further scrutinized through a cursory read of the full content and an analysis of each work was performed and documented in notes to be used for writing the literature review.

Statistical Treatment of Data

The purpose of this meta-analysis was to identify a common set of critical success factors that are generally applicable to all computer technology projects. For each article the identified success factors were captured and categorized to coincide (mapped into a matrix) with other factors identified from the other studies or a new category was created. This matrix was made using a spreadsheet with success factors along the vertical axis and referenced work along the horizontal axis. Each cell of the work sheet was either blank, if the referenced work did not identify a matching success factor, or contained the specific name of the success factor identified by the reference work. This was done so people desiring to review the meta analysis data can quickly see how the name of the reference work success factor aligns with the common success factor name.

Upon completion of populating the matrix with success factors, from all of the reference works, the numbers of reference works that match an individual common success factor were totaled. This categorical information was then used to create a frequency table and a bar graph to assist in visualizing the findings from this study. The success factors with the largest frequency of occurrences (largest bars) indicated the relative importance of that factor to the other common

success factors.

Summary and Conclusions

The methodology of this study was designed to capture a large body of knowledge to identify the common, computer technology project, critical success factors. A meta-analysis approach was used as the foundation of the study. This involved a two stage sampling. The first sampling stage was a convenience sample followed by a purposeful sampling stage. Each of the reference works obtained their findings through a variety of sampling techniques.

Both external and internal validity, in the author's opinion are aided by the meta-analysis approach. But there are documented, legitimate concerns with meta-analysis studies. Although every effort was made to screen and select appropriate information that was objective and valid for this meta-analysis study, some of the data collected could have introduced errors into the results. Nevertheless, the author does believe the results are valid, both internally and externally, because the data was collected from a vast body of expert knowledge, offsetting the potential impact of the noise introduced by bogus reference work. In addition, the findings were consistent with the author's real world experience.

The data collected from the individual studies was analyzed and categorized to reveal the common success factors across the reference works. The larger frequency indicates the higher priority common success factors. A frequency table and bar chart were utilized to help in visualizing the findings.

Chapter IV

RESULTS

This study seeks to determine if there are Critical Success Factors (CSFs), common to all computer technology projects, which lead to their success. Twenty-nine literature sources from three different categories of literature (Researchers, Organizations, and Experts) were used as input to the analysis. The results obtained from the analysis yielded seventeen CSFs which contribute to the success of a project.

Overall Findings

The input from the literature review was consolidated in a spreadsheet matrix that consists of CSFs along the vertical (rows) and literature sources (divided into Researchers, Organizations, and Experts categories) along the horizontal (columns). The CSFs along the vertical were added as each entity was included in the matrix during the first pass. Because of the variations in names for CSFs, it was necessary, for the author of this study, to map all of the individual variations into a common taxonomy of CSFs along the vertical. In some cases, two or more CSF names were merged into a single CSF. For example, "end user training", "business process re-engineering", and "cultural change" were combined into a single CSF – "Organization Change Management". This process took several additional analysis passes before a satisfactory end point was reached (common CSF taxonomy). The final list of CSFs totaled to seventeen. See the

spreadsheet matrix in the appendix for more details.

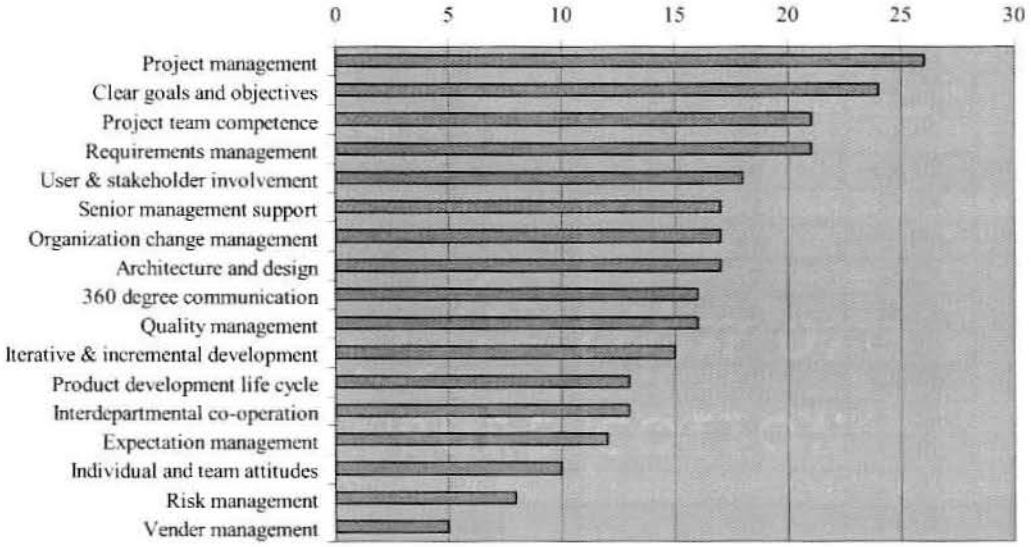
A count was kept of the number of occurrences in which each CSF was included in all literature sources. The CSFs were then ordered by the total occurrences starting with the highest number of occurrences and moving down to the least number of occurrences. In some cases, several CSFs ended up with the same number of occurrences.

The combined results, from merging all three contributing literature categories (Researchers, Organizations, and Experts), resulted in the following CSFs in this specified order (number one representing the most occurrences from all sources, the higher numbered CSFs representing fewer occurrences).

1) Project management
2) Clear goals and objectives
3) Project team competence
4) Requirements management
5) User & stakeholder involvement
6) Senior management support
7) Organization change management
8) Architecture and design
9) 360 degree communication
10) Quality management
11) Iterative & incremental development
12) Product development life cycle
13) Interdepartmental cooperation
14) Expectation management
15) Individual and team attitudes
16) Risk management
17) Vender management

This bar chart provides a visual representation of the number of occurrences for each CSF for the combined categories.

Figure 1 CSF Occurrences from All Sources – Combined Categories



Provided below is a frequency diagram that reveals the percentage of occurrences for each CSF for the combined categories.

Table 1 CSF Occurrences from All Sources – Combined Categories

Item	Critical Success Factor (CSF)	Occurrences	%
1	Project management	26	89.7%
2	Clear goals and objectives	24	82.8%
3	Project team competence	21	72.4%
4	Requirements management	21	72.4%
5	User & stakeholder involvement	18	62.1%
6	Senior management support	17	58.6%
7	Organization change management	17	58.6%
8	Architecture and design	17	58.6%
9	360 degree communication	16	55.2%
10	Quality management	16	55.2%
11	Iterative & incremental development	15	51.7%
12	Product development life cycle	13	44.8%
13	Interdepartmental cooperation	13	44.8%
14	Expectation management	12	41.4%
15	Individual and team attitudes	10	34.5%
16	Risk management	8	27.6%
17	Vender management	5	17.2%

Every one of the literature categories resulted in at least one hit in every CSFs bucket in the matrix. The order of the occurrences for each CSF did vary between the literature categories.

Research Literature Category

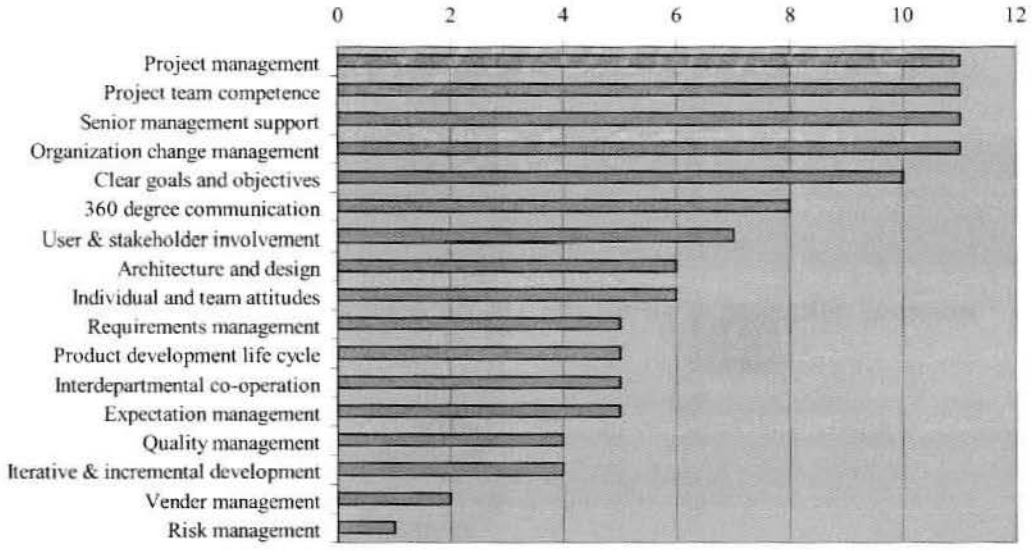
Listed below is an ordered list of CSFs for the research literature category.

1) Project management
2) Project team competence
3) Senior management support
4) Organization change management
5) Clear goals and objectives
6) 360 degree communication
7) User & stakeholder involvement
8) Architecture and design

9) Individual and team attitudes
10) Requirements management
11) Product development life cycle
12) Interdepartmental cooperation
13) Expectation management
14) Quality management
15) Iterative & incremental development
16) Vender management
17) Risk management

The following bar chart provides a visual representation of the number of occurrences for each CSF for the research literature category.

Figure 2 CSF Occurrences from All Sources – Research



Provided below is a frequency diagram that reveals the percentage of occurrences for each CSF for the research literature category.

Table 2 CSF Occurrences from All Sources – Research

Item	Critical Success Factor (CSF)	Occurrences	%
1	Project management	11	91.7%
2	Project team competence	11	91.7%
3	Senior management support	11	91.7%
4	Organization change management	11	91.7%
5	Clear goals and objectives	10	83.3%
6	360 degree communication	8	66.7%
7	User & stakeholder involvement	7	58.3%
8	Architecture and design	6	50.0%
9	Individual and team attitudes	6	50.0%
10	Requirements management	5	41.7%
11	Product development life cycle	5	41.7%
12	Interdepartmental cooperation	5	41.7%
13	Expectation management	5	41.7%
14	Quality management	4	33.3%
15	Iterative & incremental development	4	33.3%
16	Vender management	2	16.7%
17	Risk management	1	8.3%

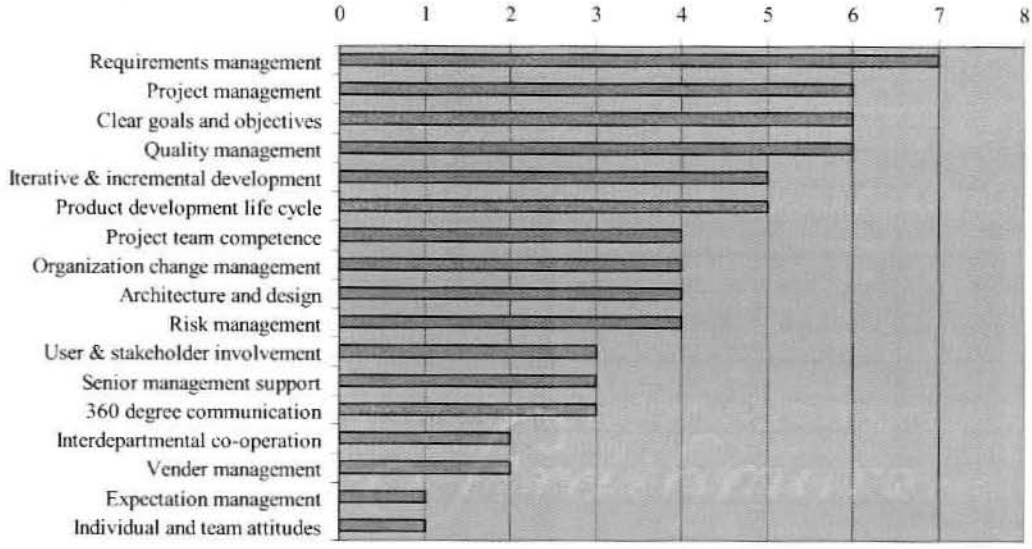
Organization Literature Category

Listed below is an ordered list of CSFs for the organization literature category.

1) Requirements management
2) Project management
3) Clear goals and objectives
4) Quality management
5) Iterative & incremental development
6) Product development life cycle
7) Project team competence
8) Organization change management
9) Architecture and design
10) Risk management
11) User & stakeholder involvement
12) Senior management support
13) 360 degree communication
14) Interdepartmental cooperation
15) Vender management
16) Expectation management
17) Individual and team attitudes

The following bar chart provides a visual representation of the number of occurrences for each CSF for the organization literature category.

Figure 3 CSF Occurrences from All Sources – Organization



Provided below is a frequency diagram that reveals the percentage of occurrences for each CSF for the organization literature category.

Table 3 CSF Occurrences from All Sources – Organization

Item	Critical Success Factor (CSF)	Occurrences	%
1	Requirements management	7	100.0%
2	Project management	6	85.7%
3	Clear goals and objectives	6	85.7%
4	Quality management	6	85.7%
5	Iterative & incremental development	5	71.4%
6	Product development life cycle	5	71.4%
7	Project team competence	4	57.1%
8	Organization change management	4	57.1%
9	Architecture and design	4	57.1%
10	Risk management	4	57.1%
11	User & stakeholder involvement	3	42.9%
12	Senior management support	3	42.9%
13	360 degree communication	3	42.9%
14	Interdepartmental cooperation	2	28.6%
15	Vender management	2	28.6%
16	Expectation management	1	14.3%
17	Individual and team attitudes	1	14.3%

Expert Literature Category

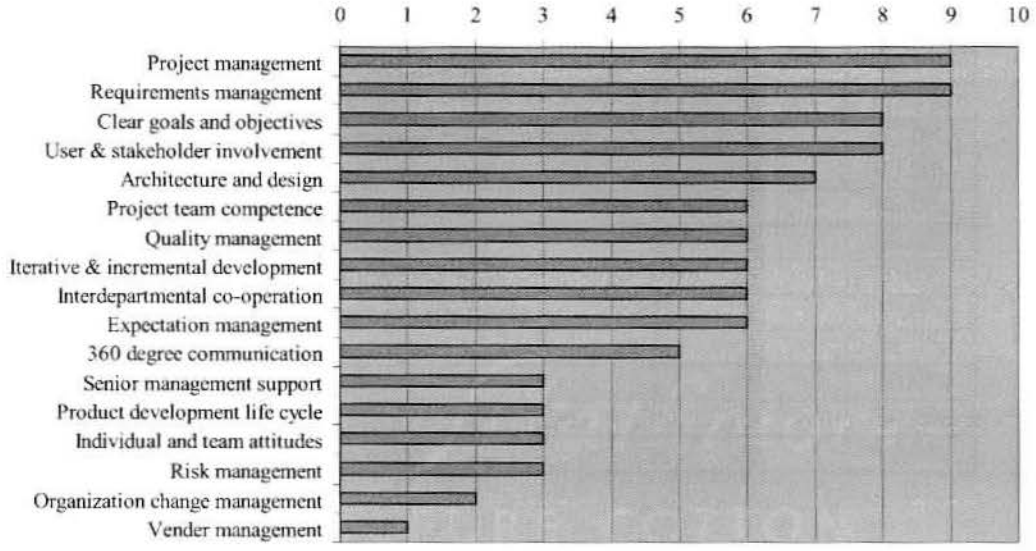
Listed below is an ordered list of CSFs for the expert literature category.

1) Project management
2) Requirements management
3) Clear goals and objectives
4) User & stakeholder involvement
5) Architecture and design
6) Project team competence
7) Quality management
8) Iterative & incremental development
9) Interdepartmental cooperation
10) Expectation management
11) 360 degree communication
12) Senior management support
13) Product development life cycle
14) Individual and team attitudes
15) Risk management

16) Organization change management
17) Vender management

The following bar chart provides a visual representation of the number of occurrences for each CSF for the expert literature category.

Figure 4 CSF Occurrences from All Sources – Expert



Provided below is a frequency diagram that reveals the percentage of occurrences for each CSF for the expert literature category.

Table 4 CSF Occurrences from All Sources – Expert

Item	Critical Success Factor (CSF)	Occurrences	%
1	Project management	9	90.0%
2	Requirements management	9	90.0%
3	Clear goals and objectives	8	80.0%
4	User & stakeholder involvement	8	80.0%
5	Architecture and design	7	70.0%
6	Project team competence	6	60.0%
7	Quality management	6	60.0%
8	Iterative & incremental development	6	60.0%
9	Interdepartmental cooperation	6	60.0%
10	Expectation management	6	60.0%
11	360 degree communication	5	50.0%
12	Senior management support	3	30.0%
13	Product development life cycle	3	30.0%
14	Individual and team attitudes	3	30.0%
15	Risk management	3	30.0%
16	Organization change management	2	20.0%
17	Vender management	1	10.0%

CSF descriptions

A description for each CSF included in the above results follows. The descriptions are provided in the order of number of occurrences in the combined literature category results – most occurrences to least occurrences.

1) Project management – Managing a project involves many activities such as: planning, prioritizing, controlling, leading, directing, organizing, monitoring, estimating, budgeting, scheduling, assigning resources, confronting, communicating, and coordinating. A project can be managed by one project manager or several project managers. A project manager needs to balance cost, schedule, and quality. A common expression used in project management circles

is "plan the work and work the plan".

2) Clear goals and objectives – One of the first steps in beginning a project is establishing the desired end state. The goals and objectives are often captured in a business case or business plan which outlines what the project expects to deliver. Other words often associated with this aspect of a project are: establishing a clear vision, a shared vision, the business purpose, the mission, the project charter, benefits, an aim, a target, expectations, the strategy, or setting the scope of the project. A cost benefit analysis is often associated with this facet of a project.

3) Project team competence – The project team consists of all the human resources utilized to support the activities required to deliver the products and artifacts of a project. Competence is determined by a mixture of hard and soft characteristics. Hard factors include education, skills, and experience. Soft factors may include personality, attitude, self control, and reputation.

4) Requirements management – Requirements are "what" the project deliverables shall consist of and do. There are several types of requirements: functional, performance, design, and other supplemental requirements. Requirements management includes capturing, tracking, and controlling requirements. Capturing or specifying requirements is an iterative activity where several reviews are usually conducted. Each review introduces changes that refine and improve the completeness and conciseness of the specification. At some point the requirements are "frozen", at which point a more formal tracking of changes (change management and configuration management) is instituted to prevent

scope creep. Requirements always support the overall project scope and vision. If at any point the requirements are not aligned with the vision, either the requirements need to change or a reassessment of the vision must be done.

5) User & stakeholder involvement – Every project has users and stakeholders. A user is anyone who will use one or more of the deliverables resulting from the project. A stakeholder is anyone who has an interest in some aspect of the project or the deliverables. A user is a stakeholder, but a stakeholder is not always a user. Users and stakeholders are frequently involved at various points of a project: establishing the scope and requirements, testing, verifying and validating the products. Sometimes the actual end users are not easily accessible for various reasons – there are millions of users, they are remotely located, and/or they are too busy. In this case a surrogate user is appointed to bring the perspective of the end users into various activities such as capturing requirements. Marketing departments often provide the stand-in for these situations.

6) Senior management support – Projects tend to perform better when senior managers within an organization visibly provide their support. The support can be conveyed in several ways: a single champion, a project board (or steering committee) represented by multiple senior managers or a top management recognized list of top priority projects. Top management can become involved at different levels. They can support the project by simply proclaiming the importance of the project to the organization or they can get actively involved in project strategy, scope setting, and monitoring.

7) Organization change management – A computer technology project

delivers products that normally have an affect on the overall organization beyond just the system users. Organization change management is involved in the preparation of an organization to undergo the change that a project's products may have on the entire entity. This may involve end user training, business process re-engineering, and other cultural change preparations. No matter how good the delivered system is, it will not be successful without organizational change management to support the rollout.

8) Architecture and design – Successful systems involve attention to architecture and design. When the requirements are captured for a system, they must be converted into an architecture and design. A best practice is often to use an existing design pattern that has been proven successful on a similar computer technology project. It might involve the selection of a standard development framework or off-the-shelf software package. Designs usually take into consideration: flexibility to accommodate future changes, performance, security, reliability, maintainability, and other important system characteristics. Architecture prototypes and simulation can be used early in a project to prove or disprove a particular concept to prevent finding out something doesn't work at the end of a project.

9) 360 degree communication – A project can involve a lot of people. One of the biggest challenges is communicating the information in such a way that everyone receives the needed information to act upon at the appropriate time. This involves communication upward (senior managers), downward (project team members), and sideways (inter-department, vendors, end users, and others). Many

methods of communication can be used to make sure no one is left out: email, one-on-one phone call, teleconference, in-person meeting, virtual meeting via video, virtual meeting via shared desktop, Intranet project folders with notification, and there are others. Daily, weekly, and monthly status reports and meetings are often used to communicate what has been accomplished and what are the next steps.

10) Quality management – A delivered product needs to conform to the requirements which were specified at the beginning of the project in order to satisfy the user. This requires testing to verify and validate that the user's needs are being met. There are many types of testing used on a computer technology project. These include: unit testing, unit integration testing, system testing, integrated system testing, end-to-end testing, and business cycle testing. The previously mentioned tests are functional tests. There are also non-functional tests such as performance and configuration tests. Most of these tests, aside from unit and unit integration testing, are conducted by an independent entity (could be internal or external) to assure objectivity and accuracy of the testing.

Quality is often considered synonymous with testing when it comes to a computer technology project. However, quality is being managed much earlier in an organization. Requirements, design, and build products should undergo a review process before they get to the test stage. Review can also take on many forms – peer, informal walk through, and formal inspection. All of these methods are used to remove defects and improve quality before arriving at the test stage where rework is more costly to an organization.

11) Iterative & incremental development – The complexity of large projects can be broken down into smaller increments or time-boxes where a portion of the overall functionality is delivered. Each time an increment is delivered, the project team will have iterated through the development process. This enables the team to improve the process during each iteration. Sometimes, higher risk functionality will be delivered during the initial iterations. This allows the team to make adjustments very early if problems are encountered. They can cancel the project with minimal investment if an alternative solution is not possible. It also may be possible to deliver increments into production much earlier than if all functionality were being developed at one time.

12) Product development life cycle – Having a prescribed development life cycle (process or methodology) that is understood and followed by the project team can make a project run much smoother and be less prone to yield errors. There are many best practice methodologies in the market. Some may be better than others for a particular project. However, it can be argued that any product development life cycle will obtain better results than not having one at all.

13) Interdepartmental cooperation – Large projects, and even some smaller ones, require different departments of an organization to work together. Even a small project usually involves a business department and an IT department. Departments tend to polarize people to side with their "own" people when problems are encountered. It is important for information and activities to flow smoothly between departments. Cooperation is needed in order to prevent time delays, increased costs, and reduced quality. Sometimes the organization

structure of projects can be modified to improve cooperation – such as the use of cross functional teams to break down inter-department barriers.

14) Expectation management – It is important that time, cost, and quality expectations be realistic. Very early in a project, it is difficult to provide a very accurate estimation of time and cost. All of the project stakeholders need to be made aware that dates and budgets cannot be held rigid until requirements have been captured and analyzed and estimates have been prepared and reviewed based on these requirements. There will always be a need for some variance to cost and time until late into a project, even when the scope (requirements) is fixed. Sometimes management will promise delivery dates and costs without the project team having an opportunity to capture full requirements and develop estimates based on these requirements. This inevitably leads to failure. It's ok to pursue perfection as long as the stakeholders aren't led to believe it can be achieved.

15) Individual and team attitudes – Positive attitudes in individuals and teams have a significant influence on outcomes. This truth has been understood and leveraged in many aspects of business and athletics for a long time.

16) Risk management – Project teams manage risk even if they don't know that they are doing it. They do it subconsciously. People naturally tend to think through possible hindrances to success and think of ways to mitigate the potential road blocks. This is what risk management is, except it is done in a more systematic fashion. An approach to managing risks includes: identifying risks, analyzing risks, developing a response to each risk, and monitoring risks.

17) Vendor management – Projects can include the delivery of products

from outside organizations. An outside organization that delivers a product is often referred to as a vendor. Vendors require management. Management of a vendor includes activities such as: preparing a request for information and/or proposal, evaluating proposals, defining a statement of work which lays out the scope of the vendor's involvement, jointly developing a schedule for product deliveries, providing requirements, receiving products, reviewing and testing products for compliance with requirements, monitoring time and cost, and auditing the vendor's software development processes.

Summary and Conclusions

The analysis, from all three categories of literature studied, reveals there are 17 common CSFs which influence the success of projects. The 17 CSFs have been ordered by the total number of literature sources which included each CSF. The CSF with more occurrences is considered of higher importance than the CSF with fewer occurrences. The precision of the study is not good enough to say that the first CSF in actuality is of higher importance than the second. It can be inferred that the top CSFs carry more importance than the bottom CSFs. All of the 17 CSF recurred enough throughout the literature to say that each one should be considered of importance to the success of a computer technology projects.

Every project involves complexities and variations that can not be controlled successfully by only managing to a list of CSFs. A project must involve careful planning and execution that adjusts to the variations which prevail as the story unfolds.

Chapter V

DISCUSSION

The underlying hypothesis of this study is "There are Critical Success Factors (CSFs) common to all computer technology projects". The data collected from three categories of literature (Research, Organization, and Expert) upholds this hypothesis. Seventeen CSFs were observed to occur in all three categories. The top half of these seventeen categories seem to be undisputed in their importance to the successful completion of a project. All seventeen CSFs should be carefully considered before dismissing their importance on any project.

The remainder of this chapter is dedicated to a discussion of the emerging CSFs from this study. Each CSF is addressed in the order of their number of occurrences in the consolidated view of the three literature categories. But first, a brief discussion regarding the objectivity of the analysis is provided.

Objectivity

To believe the results of this meta analysis requires belief in the objectivity of the study. The author does not deny that some level of subjectivity was involved in the review and summarization of the many variations of CSFs into what has resulted in seventeen overall CSFs. In addition, the author did not review every detail of every study to harvest the CSFs which were either directly transferred, or in many cases, translated into the final CSFs of this study. There was just not enough time to exhaustively research the vast field of literature and

give full attention to every word of the literature. Many factors influenced the selection of literature and within each document the information included in this study: availability of the literature, affinity with the subject of this study, and the authors own framework of experience.

With that said, the author does feel that a genuine attempt was made to be true to the referenced document's intent. Shaped by his education, skills, work experience, and culture, the author did his best to objectively condense this large body of knowledge into a usable list of CSFs that can be effectively used to improve computer technology projects around the world.

Project Management

It is interesting to note that project management was identified as a CSF more than any other throughout all literature categories combined. Nearly 90% of the literature (26 out of 29 sources) included project management as a CSF. This fact should influence the selection of the project manager put at the helm of an important project.

The project management role should not be filled by a novice. It requires many years of education and experience to become effective in this position. One of the best ways to bring a novice (apprentice) project manager up to a journeyman or master level, is to team them with a master project manager on several projects. It is through observation of more experienced masters, on assignment, that knowledge is best shared. The value of a master project manager goes far beyond the productivity aspect. Productivity experts have long shown that a master can be up to 100 times more efficient than a novice. But what is

more important, is the savings that a master can bring by making the right decision the first time and not going down a wrong path requiring much rework, at best, if not absolute failure of the project. This difference can save a project, or even a company, from failure.

Both the Research and Expert literature categories place project management at the top. The organization category places it second after requirements management. If no other CSF is to be followed, a good project manager will go a long way to deliver success because a good project manager will know that most of the other seventeen CSFs need the project's attention to succeed.

Because of the importance of project management to the health of projects, it is important to provide as much support to this discipline as possible. A PSO (Project Support Office), also referred to as a PMO (Program Management Office), can provide the nurturing environment for upcoming project managers. There is a need for education and a mentoring program for project managers. Another helpful thing for organizations is to encourage project managers to further their education in graduate programs such as an MBA. Part of that encouragement can come in the form of full education reimbursement. This is a modest fee to pay for the return on investment it will yield on future company projects. Project management training is best if it is merged with Product Development Life Cycle (PDLC) education, also referred to as Software Development Life Cycle (SDLC) – such as agile development approaches (SCRUM, Extreme Programming, and RUP). (See the PDLC CSF section for

more details.)

Clear Goals and Objectives

Clear goals and objectives is second to the top on the overall CSFs identified. Clear goals and objectives was 5th in the Research category, 3rd in the Organizations category, and 3rd in the Expert category. This signifies a need for a project manager and team to carefully consider the project goals. The articulation of the goals and objectives can be captured in many variations of documents whether business case, statement of work, or project brief. The important matter is that it is carefully crafted and used as a touch stone throughout the project. Without a clear statement of objectives, it is difficult to formulate a path to get you there – wherever "there" is.

The unfortunate problem with unclear goals and objectives is a ripple effect which can lead to horrible consequences. Requirements depend on goals and objectives, design and architecture depend on requirements, software and hardware depend on design and architecture, user acceptance depends on software and hardware, and success depends on user acceptance. If the goals and objectives are wrong, then the margin of error will be magnified in the chain of dependencies. Get the chain right from the top, or beginning.

Project Team Competence

Project team competence was 2nd in the research category, 7th in the organizations category, and 6th in the expert category. Competent team members can make up for a lot of missing critical ingredients. They bring with them the

inherent knowledge of the things that are critical for the success of the project. Experienced team members will know the importance of the role of project management and will fill in the gap if a void exists. They realize the need for clear goals and objectives and push for clarity in this area. If requirements are not well specified, capable team members will not rest until they are well specified. This enumeration could continue throughout the remaining CSFs.

Competence does not mean technical ability alone. People skills can be just as important, if not more important, as to how valuable a person is to a project. On a project, people need to be team players with proper attitudes toward one another. If a person can't get along with others, they can drag down the whole team's proficiency.

Hire the best people that can be had. Make a case for the Total Cost of Ownership (TCO). Yes. It will cost more to add the best players to the team. However, good players will deliver successful projects, quality products which will be easier to maintain, and in a shorter amount of time. It is better to take a car into shop A which has master mechanics where the hourly rate is three times higher, than to take a car into shop B which has novice or journeyman mechanics. The problem can be fixed much quicker (in some cases it may be as much as one or two orders of magnitude difference) and it will be fixed correctly the first time. The car will not have to be repeatedly brought back to shop B for rework for the same problem. The "pay me now or pay me later", "penny wise and pound foolish", and "a stitch in time saves nine" philosophies apply to project team competence.

Requirements Management

Requirements management was 10th in the Research category, 1st in the Organizations category, and 2nd in the Expert category. It is not clear why the research category was significantly different from the other two categories. Perhaps the research category CSF for clear objectives and goals is thought to include requirements. Regardless of this variance, overall requirement management is in the top ranking of CSFs.

Requirements drive the whole project. If the requirements are bad, the project is going to be bad. There is a long chain of project artifacts which depend on accurate and concise requirement specifications. Architecture and design are derived directly from requirements. Build artifacts (software and hardware) are derived from architecture and design. Deployment specifications and plans depend on build artifacts. Test cases (or scenarios) are directly dependent on requirement specifications. User manuals, administration manuals, training material, and other organizational change management artifacts are derived from requirements and design specifications. When requirements have a problem, there is usually a long chain of events to correct.

Requirements represent the needs of the project's customer. To satisfy a customer, his/her needs must be understood first. Typically, requirements represent "what" the customer wants and not "how" the product(s) are to be built. Occasionally, a customer may want to specify architecture and design parameters which represent the "how". For example, instead of saying the external structure of the house should be low maintenance, a client may indicate they want a house

made of brick and a metal roof.

A good way to gather requirements is by way of scenarios. Scenario-driven development (also popularized as use case specifications or user stories) captures requirements from a user's perspective of how they interact with the system. This involves a step by step capture of interaction of what the user does with the system – the user does this, the system does that, the user does this, the system does that, and on and on until the user derives a completed value from the system. This method also helps to identify alternate scenarios, at each step of the main scenario, which may occur. A primary scenario may comprise eighty percent of the functionality for a particular use case and the remaining twenty percent is wrapped up in alternate scenarios. But it might be that these alternate scenarios are the most often overlooked with other requirement capture techniques and the most difficult to build into the system. It is very important that they are not left out.

Requirements will change. Change management of requirements is always going to be a constant battle – especially for larger projects. There is a synergy between some of the CSFs coming out of this study which helps with change management. Using iterative and incremental development (one of the seventeen CSFs) is one way to help manage the problem of changing requirements. One should not try to get all requirements for the whole project completed at one time. Rather, a subset is selected – perhaps highest risk requirements (risk driven approach). This subset of functionality can be built out, assessed, and corrected as needed before moving on to a next set of requirements where lessons learned

from the previous set can be applied.

If a choice needs to be made, put the best people on requirements capture efforts. The success of the entire project depends on it. Good business analysts are worth their weight in gold.

User and Stakeholder Involvement

User and stakeholder involvement was 7th in the Research category, 11th in the Organizations category, and 4th in the Expert category. Following very closely to the previous topic of requirements management is user and stakeholder involvement. Without the involvement of users on a project, how can one know if the requirements that are being captured are correct? A common problem is obtaining high level objectives from users and leaving the requirement specification to developers without further interaction with the user. The assumption is that the user doesn't really know what they need and the developer needs to help them understand what they need. There may be some truth to this philosophy. However, there is probably more wrong than right. The business analyst, during requirements capture, will undoubtedly need to help the user understand possibilities of what they may be able to do (think outside the box). The analyst will always work to obtain the "real" needs of the user. Otherwise, the project team will not find out what the "real" needs are until test time, when missing the target means circling back to requirements and going through the whole process again.

Senior Management Support

Senior management support was 3rd in the Research category, 12th in the Organizations category, and 12th in the Expert category. The discrepancy between the research category and the other two may be explained by the bias of the literature. The research literature was more focused on management CSFs which would recognize the benefit of senior management support. The organization and expert categories were more focused on development process which would not be prone to notice the value of senior management support.

It is amazing the difference having senior management support can make to a project. People will give greater commitment, whether they are on the project team or supporting the project from the peripheral. Every project should have a champion who holds sway at the top levels of the organization. A senior manager can move proverbial mountains to open doors that are closed to the average organizational level managers. Their support can translate into more money, equipment, new technology, full time resource commitments, higher priority support from support organizations, permission to bring in experts from outside the organization, and much more. When a project does not have a champion at the top level, others in the organization know this. Minus the support from above, priorities for the needs of the project can plummet, leaving the project in want from both team members and external resources. Project risk is significantly increased when this happens. A project can succeed without senior management support, but it will take a lot more energy, compromise, finesse, and skill from the project team to do so.

The responsibility for senior management support should not be left at the foot of the senior managers alone. Senior managers are very busy individuals. They are pulled in every direction all day long. It behooves the project manager, or middle manager overseeing an important project, to get their project on the radar of senior managers. This requires a sales job and frequent contact to keep the senior manager apprised of how the project is progressing and current needs. Organizations (that require each project to be under the governance of a project board composed of senior managers) help to make this an easier undertaking.

Organization Change Management

Organization change management was 4th in the Research category, 8th in the Organizations category, and 16th in the Expert category. The expert category may have yielded a lower ranking because of the focus on development process which does not typically include the subject matter of organization change management.

Organization change management (OCM) is a newer term coined in industry to lump a number of activities under one heading. The other activities have been around for a long time: user training, business process engineering, and organization alignment. When a new system is rolled out, people, processes, culture, and other aspects of an organization are impacted. Organization change management tries to bring a systematic approach for preparing an organization for the rollout of a new system.

One of the most important aspects of OCM is communication. People tend to be adverse to change. Helping people prepare for change, through a carefully

planned campaign of communication, training, and support, makes the transition much easier and acceptable. Letting people know what to expect, with enough time to assimilate the idea, and then providing them the necessary education, will greatly improve the probability of their success with the new system.

Architecture and Design

Architecture and design was 8th in the Research category, 9th in the Organizations category, and 5th in the Expert category. The problem with architectural and design problems is that they don't always rear their ugly heads until it is possibly too late to do anything about them without investing significant time, money, and tolerating organization disturbances to correct them. After a system is deployed to production is when many of the symptoms of the architecture and design problems begin to emerge.

Architecture and design flaws surface in many ways. They can show up as poor system performance – poor interactive user response time, functions that take much longer than expected, and overnight batch processes that run longer than anticipated. Another area which reveals architecture and design problems involves numerous defects observed in data after deployment: one or more users simultaneously modifying the same record resulting in corrupting data and modifying data in a record from one screen, yielding different results when the data in a record is modified from another screen. Lastly, design flaws are exposed when system modifications are requested; a change in one area requires many changes throughout the system (ripple effect) and fixing one problem in the system causes problems elsewhere in the system (collateral damage).

There is an easy way to eliminate these problems – do it right the first time. Hire the best system architects that money can buy; remember to think - pay me now or pay me later. Before acquiring a system from a vendor, perform a development and product architecture/design assessment. Make sure you count the cost before stepping into a long term relationship – treat it like a marriage. Use proven, standard architecture and design patterns. Use component (modular) designs. Very early in the project, build architectural prototypes and do realistic performance analysis (on paper, simulation, and for real). Institute a policy of performing change assessments of all architectures and design. This involves thinking through as many future enhancement requests that could possibly materialize and determining how to modify the design so it can easily accommodate the anticipated changes. Use desk checking, peer reviews, and more formal inspections to further refine the design. Deliver the product incrementally and iteratively through a risk driven approach which will allow the architecture to mature into a clean and stable platform (also known as refactoring). Steer away from the use of unproven technology unless it is a leading edge project which must tolerate the risk of failure. Lastly, keep it simple – don't make the architecture more complex than what is needed.

360 Degree Communications

360 degree communications was 6th in the Research category, 13th in the Organizations category, and 11th in the Expert category. Although this CSF didn't show up at the top of the three categories of literature, in reality it is at the heart of every one of them. Communication is usually involved in some way on every

failure which occurs in a project. Communication needs to be clear and concise. Just the fact that you are communicating is not enough. If the messages are not clear and concise, they can do more harm than good. Messages can also be carried to the recipient with the wrong attitude which can bring about irreparable damage. Once a good opinion is lost, it can not be easily regained.

There needs to be a regular flow of information upward to senior management. This flow needs to be carefully consolidated to share the appropriate level of detail. If it can fit on one page or less, this is usually better. Senior management can usually be provided with very general information if things are going well and activities are being completed on or before their dead lines. When things are not going so well, managers need to know about it as soon as it becomes an issue. Surprises are not well received, especially if there is a long delay before the message is received. The details of the information will also need to be more granular when exceptions occur. Management, by exception, is the typical mode of operation when it comes to senior management.

Communication laterally to team members, other departments, external vendors, and customers will need to be conducted in varying levels of detail. The important consideration in all of these communications is to know your audience. Internal communications can be less formal. As the communication gets further from the project team, the communication will need to become more formal and most of the time will require a written format rather than verbal. In many cases, correspondence with external entities will need to be confirmed with a written response or sign-off.

The downward flow of communication, often in the form of direction from a manager to a subordinate, requires careful consideration about the expectations that are being conveyed. Who, what, when, where, why, and how are some things to think about when assigning responsibilities. Make sure the assignee understands what is expected of them and when it is supposed to be completed. If the reason for the assignment is not self evident, it may be helpful to explain why the assignment is being given and specifically why it is being given to a particular person. In some cases it may be appropriate to indicate how the activity is to be carried out and who could be involved in helping with the assignment.

There are many different modes of communication – verbal, written, and body language. All play a significant part in how a message is received. There are also many mediums today which can be used to communicate - meetings, one-on-one discussions, phone, video conference, virtual meeting, hardcopy memo/letter, email, instant messaging, and project content management site. Unfortunately, everyone doesn't respond well to the same mode or communication media. This is why knowing your audience is so important. Use the mode and media that will best reach your audience with a clearly understood message.

Verbal communication can be a powerful thing and result in lasting impressions and memories. However, verbal communication can be quickly forgotten and is not easily recovered. It is important to back up verbal communication with some permanent form of communication. This might take the form of a complete recreation in written form, notes, or checklist. Don't ever allow sign-offs for important tasks to be verbal only. These situations require

formal documentation – either hardcopy or electronic.

Be very careful to not verbally criticize team members in front of others. This can be an unsettling thing, not only for the person being criticized, but for the team and for the person doing the criticizing as well. Once an arrow is shot, it is irretrievable. So carefully guard the things that spew forth from the mouth and the pen. If needed, set aside a period of time (e.g., the rest of the day) before responding to an upsetting situation. If time doesn't allow, count to ten.

Here are some other ideas that can help with project communication. Set up a bi-weekly, weekly, or daily project status meeting. The meeting should be kept short (30 minutes or less) and should only cover enough detail that is pertinent to the entire project team. Side meetings can splinter off for more detailed conversation as needed. Have regular high light meetings with senior management to keep them apprised of what is going well and of any significant issues. Distribute a written status report to the team so they can keep up to date with all the related activities and plans. Require vendors to provide regular written status reports and verbal status meetings. Meet regularly with the end users to share project status and obtain feedback on incremental product deliveries. Review deliverable products at various stages – preliminary, draft, and final.

Quality Management

Quality management was 14th in the Research category, 4th in the Organizations category, and 7th in the Expert category. The research category, being focused more on management CSFs, would not be as aware of product development life cycle concerns such as quality management. In addition, many

of the research studies dealt with the integration of top end, off-the-shelf ERP systems. These projects may have not been as concerned about the product quality management aspects of a project.

A project should rely on the project team to find defects in the delivered product and not on the end users after the product is delivered. This may seem obvious, but in reality, end users are unfortunately subjected to discovering serious flaws in systems that shouldn't have ever been delivered. There will almost always be defects delivered in a system of any significant complexity. This is not to say a product should not be delivered until it can be proven perfect.

Many people think of testing to be synonymous with quality. A project team should be concerned about quality not just at test time but throughout all activities of development. As a matter of fact, quality control during the early part of development is more important than at the end. As indicated earlier, if the requirements are wrong, development will be wrong, even if the test of the system reveals that the system meets the requirements.

Here are important things to consider in order to establish a foundation to achieve quality products. Use iterative reviews for all documentation associated with the development of the project products – requirements specifications, architecture and design documents, build artifacts, test plans, deployment plans, and organization change management documentation. The reviews should be done for preliminary, draft, and final versions of the artifact. The reviews should involve increasing number of persons and formality as the artifacts progress closer to completion – personal desk check, peer review, and on up to formal

inspection. Standardized check lists are very helpful in reminding the reviewers of what should be considered during a walkthrough of the artifact. Sometimes it is helpful to have an independent group do verification and validation of the system. The independent group, whether from inside the organization or external, are better equipped to provide an objective verification (system meets the requirements specifications) and validation (system solves the true needs of the business – not always the same as the requirements).

There are some things that are frequently not included in quality management during the development of a system. One of these considerations is performance. A product that meets all of the functional capabilities desired by the end users will be useless if the response times are unacceptable. Configuration of the hardware and software on which the system is to be deployed is another consideration. If the system works in the development and test environments but wasn't tested for the precise configuration(s) of the production platforms, and doesn't work, then failure is the outcome.

Before embarking on a system development, be sure the organization knows exactly what the desired business process is and that the goals and objectives of the project support the business process. Then the project needs to be on guard to be sure all of the business and system requirements meet the desired business processes. It doesn't matter if the project team delivers a quality product if it doesn't fit the organization's business process. It will still be considered a failure.

Iterative & Incremental Development

Iterative & incremental development was 15th in the Research category, 5th in the Organizations category, and 8th in the Expert category. The research category was focused more on management CSFs and less on development life cycle categories.

Iterative and Incremental Development (IID) involves a cyclic approach to development where increments of functionality are developed one at a time or in some parallel fashion. For each increment, a typical waterfall approach is followed – capture requirements, analyze and design the system, build the system, test the system, and deploy the system. Each increment of functionality builds upon the previously delivered increment. Each increment developed affords the project team the opportunity to improve not only the previous increment product, but, just as important, the process for developing the incremental product. The waterfall approach usually leaves no room for improvement of the product after it is tested and bugs are fixed. The process for the waterfall approach is only cycled through one time. There is no ability to improve the process in effectiveness or efficiency.

IID is not a new idea. Barry Boehm coined the idea of spiral development several decades ago (the concept of spiral relates to many passes around a circle where one complete circuit of the circle (or spiral) equates to a single pass through the full development process). There are other concepts, of a similar vein, such as Rapid Application Development (RAD). It is unfortunate that too many projects continue to attempt development using the waterfall approach. Can

projects be successfully developed using this approach? The answer is, yes. Would the projects have yielded a better quality product and achieved better user satisfaction had they been developed using IID? The answer will almost always be, yes, for projects of any significant size.

IID projects also frequently use risk driven development. Risk driven development takes on the higher risk functionality first so problems can be fixed during successive iterations. If need be, the project can be cancelled early before extensive time and money has been spent.

The use of scenario driven development is also a regular occurrence with IID projects. One way to break up the deliverable functionality, to accomplish in each increment, is to select specific scenarios (or use cases) to deliver. A scenario, if selected properly, represents a complete interaction of a user with the system to achieve a useful result. This means that the increment can be an actual workable product even though all of the system's functionality is not included. Scenario driven development usually delivers complete and concise specifications because it helps the author of the scenario to logically think through the typical interactions of a user with the system as well as the abnormal (or less frequently traveled) interactions. Breaking up the system into smaller chunks, or increments, helps the project team manage a product's complexity. Newer agile development methodologies also endorse the scenario driven development approach, though they may call them something different (e.g., user stories).

Product Development Life Cycle

Product development life cycle was 11th in the Research category, 6th in

the Organizations category, and 13th in the Expert category.

Without a formalized approach to product development, a project team is left in a state of chaos. This is truer for inexperienced project teams than with skilled workers. Skilled workers will typically know one or more methodologies. Unfortunately, even with skilled workers, there needs to be a sense of a common methodology or Product Development Life Cycle (PDLC) otherwise some amount of chaos will occur regardless of the project team's experience. The adoption of a common PDLC is partly connected with the communication CSF. A PDLC provides a communication framework in which to develop products. Without it no one will know what to expect from the other person. In a sense, a new product development language will need to be conjured up from scratch. It is much easier to adopt a recognized best practice PDLC. Although, some companies and projects have developed their own PDLC.

A PDLC, even if it is waterfall based, will be better than no formalized PDLC. The PDLC will provide direction on how requirements, design, build, test, and deployment artifacts are captured and documented. Having a PDLC is useless unless it is followed. To be followed, it must be understood by the project team which usually requires formal classroom education, on the job training, and mentoring. Sometimes the PDLC becomes so detailed and involved that the volumes of process documentation sit up on shelves in multiple ring binders, never to see the light of day. The PDLC needs to be practical, nimble, well nurtured and supported by the organization. Many developers will resist a formal PDLC until they have experienced its success and often need to be strongly

encouraged from the top down within the organization. A common PDLC throughout an organization is a good idea because resources can come and go from projects without much ramp up during the transition period. A common PDLC for a project should be a mandate.

Inter-departmental Cooperation

Inter-departmental cooperation was 12th in the Research category, 14th in the Organizations category, and 9th in the Expert category.

It is human nature to be competitive. Competition can be good motivator and an inspiration for greatness. When working together on a project, inter-departmental competition is not a good thing. If a project does not have inter-departmental cooperation, the chance of success can be greatly diminished. Lack of cooperation causes delays, bad attitudes, friction, increased costs, health problems, and job dissatisfaction. Stove piped organizations tend to lead to a lack of cooperation between departments. Organization incentives may be structured in such a way that cooperation between departments is discouraged. This problem is not easily addressed at the project level and usually requires senior management intervention in order to achieve the necessary cooperation. This ties in closely to the CSF dealing with senior management support.

There are some things that can improve cooperation that are at the project team's disposal. One, is to build a cross functional team which includes members from other impacted departments. Another is to keep open communication flowing between the departments. Don't keep "secret" information from other departments. The attitude among the project team member needs to be "we are in

this thing together for the good of the organization". Give credit to whom credit is due. This means that if a member of another department contributes something of value to the team, make sure the individual and his/her department hears about it and is given the appropriate credit. Finger pointing between departments is often a result of not having established clear accountability and responsibilities at the beginning. Keep all feedback constructive and not focused on personal character flaws but directed on the issues to be resolved. Keep a project team ownership focus instead of thinking it is his/her problem.

Senior management has other options at their disposal. They can restructure the organization to be more project friendly. Incentives can be changed to encourage inter-departmental cooperation. A campaign and education can be implemented to provide an awareness of how projects are to function across departments. A Project Support Office (PSO) or Program Management Office (PMO) can be established to help educate project teams to work through these types of difficulties. A project board consisting of senior management representation, from each department, can be very helpful in improving cooperation between departments.

Expectation Management

Expectation management was 13th in the Research category, 16th in the Organizations category, and 10th in the Expert category.

It is natural for expectations to develop in the minds of individuals without being expressed openly. Individuals on a project team can't assume that the expectations they have are shared by the group unless the expectations are voiced

and are agreed upon by the team. Expectations are closely dependent on the communications CSF.

A more troubling aspect of expectation setting involves customer expectations and senior management expectations. Customer expectations are often set by the business or marketing end of an organization. These departments are eager to make a sale and sometimes are over enthusiastic about what can be delivered to the customer in a specified period of time. A marketing group should never be allowed to establish dates with a customer without careful scrutiny by the IT and business departments. Once a date is mentioned, even in a vague and soft way, the customer tends to hold on to the date as if it is in stone. It would be much better to possibly lose the business than to promise something, not deliver on the promise, and then lose a hard earned reputation in industry over a failed project.

Senior management will sometimes make commitments for their organizations without the necessary departmental analysis to make a fair assessment of the situation. This may be done because of ego or misunderstanding of what was truly being asked. The unfortunate outcome may be a delivered product at the expense of the staff's personal lives – late evenings and long weekends to deliver on a senior manager's promise. Senior managers should never put their staff in these situations. The typical staff worker is not compensated with salary or incentives that could ever make up for the sacrificed personal life that these unrealistic expectations yield. It is inconsiderate of the staff's personal lives and betrays their trust in the organization they have chosen

to work for. Yes, the employee has a choice, and may opt to move to another organization if they are not treated with respect. Senior managers should never promise product deliveries without putting numerous smart heads together to carefully count the cost.

Individual and Team Attitudes

Individual and team attitudes was 9th in the Research category, 17th in the Organizations category, and 14th in the Expert category. Attitudes are more important within the management focus of the research category than it typically will be in a development life cycle focus of the other two categories.

Attitudes can be either positive or negative toward a project; an "in between" stance is seldom seen. On the other hand, attitudes toward projects are not usually all bad or all good. There are certain things about a project that tend to lead a person to the conclusion that it is a good project or a bad project. Some of the influences on attitude are compensation, empowerment, education, ownership, technical challenge, recognition, cooperation, management support, realistic schedules, work hours, company culture, and personalities of co-workers. A good project manager will try to manipulate these factors to be on the positive side. Not all factors are under his/her control.

Bad attitudes can quickly spread throughout a team and even an organization. A project manager, or senior manager, can have a significant sway in the attitude of others. If the person, in either of these positions, has a bad attitude, their bad attitude can spread quickly to a team, department, or organization. Individual team member attitudes do not usually spread as fast but

given more time, they will.

The solution: hire people with good attitudes and keep them happy by adjusting the factors that influence attitude.

Risk Management

Risk management was 17th in the Research category, 10th in the Organizations category, and 15th in the Expert category.

Project risks should be assessed from the outset of a project. It may be that the risks for a project are strong enough that a project should not even be considered. Risk management is all about counting the cost before moving forward. Every project will have risks associated with it. Some risks can be easily dismissed but others will require careful scrutiny. Risks should be assessed and a brief mitigation plan put in place in case they should occur and become an issue. The risks should be regularly monitored throughout the project.

As mentioned in the iterative and incremental development CSF, risk driven development can be a good idea to minimize project impacts resulting from realized risks. Pick some high risk items and try to implement them during the first iterations. For example, a new technology could be used in the first developed increment to determine if it achieves the expected results. If not, a different technology can be substituted or the project can be cancelled with minimal investment.

Where would the world be if we did not take calculated risks? Therefore, take risks but go in well informed and with eyes wide open.

Vendor Management

Vendor management was 17th in the Research category, 10th in the Organizations category, and 15th in the Expert category.

It is somewhat surprising that vendor management ends up at the bottom of the list – but not really. All projects do not involve vendor management. For the participants of projects involving external technology partners, vendor management would undoubtedly end up toward the top of the list, if not the very top of CSFs.

Taking on an external vendor as a partner is not too different from the dynamics associated with a marriage. It can be a beautiful thing, but it requires work. No doubt there will be good days and bad days. The relationship will require constant nurturing.

Here are some of the important things to consider regarding vendor management. Pick the right vendor. Make sure the objectives and goals, which are to be provided by the vendor, are well documented and understood. The requirements to be satisfied by the vendor's solution should be captured. The requirements should include project management deliverable expectations – status reports, development artifacts, cost boundaries, follow-on support and other communications plans. Criteria by which the vendor solution will be evaluated should be specified and agreed upon by the project team. Identify a candidate long list of vendors based on the information that is available. After an analysis of the long list is complete, select the top three to five vendors for a final selection process. Each one of these vendors will need to provide evidence of their ability

to deliver on all of the project requirements. Solicit input from current and previous clients of the vendor to obtain an objective opinion of the relationships the client had with the vendor. Finally, based on the selection criteria and input from the selection team, identify the vendor of choice.

This is just the beginning, now the relationship must be established through constant communication and skillful management. The vendor needs to become part of the team and not treated as an isolated participant. Monitoring of status is a must. When problems develop, finger pointing needs to be kept to a minimum with the focus put on resolving the issue, leaving both sides with their dignity and respect.

Summary and Conclusions

The author has personally seen the seventeen CSFs in action, or lack there of, for the good and detriment of many projects. Proper application of these seventeen CSFs alone will not deliver a successful project. There are too many complex factors and relationships involved in a project to confidently predict the outcome from just these seventeen CSFs. However, following the advice of the many project management experts, represented by this vast body of knowledge, will give you better results than had you not applied them. The world of project management will be a better place if these tried and true principals are put into play.

The author hopes that this meta-analysis has brought a different perspective to the view of project dependency on CSFs than the referenced works used for the synthesis of this study. By merging the information provided by

researchers, organizations, and expert, a more comprehensive composite result is obtained which expectantly nullifies some of the weaknesses of the individual categories.

This study has confirmed the existence of CSFs common to all computer technology projects. Although a ranking of the seventeen CSFs is provided, based on occurrences of reference in the targeted literature, this ranking is not meant to be used specifically. In other words, generally a CSF with a top three ranking will probably be considered of more importance than a CSF of the bottom three ranking. It is not meant to be used to indicate that the number 1 ranked CSF is more important than the number 2 or 3 ranked CSF. There is not enough rigor in this assessment to rely on the results in this fashion.

Appendix A

CRITICAL SUCCESS FACTOR ANALYSIS MATRIX

Item		Somers	Biehl	Nah
1	Project management	Project management		Project management
2	Clear goals and objectives	Clear goals and objectives	Clear project goals	Business plan and vision
3	Project team competence	* Project team competence * Use of consultants	staff capability	ERP team composition Skills and compensation
4	Requirements management			
5	User & stakeholder involvement			

Item		Bradley	Boghossian	Hartman
1	Project management	Experience of the project manager	* Strong project management * Proper resource and strategic-level planning * Software estimation	* Inconsistent standards and lack of training in project management (F) * Project plan
2	Clear goals and objectives		Clear vision and objectives	* Unclear charter for a project (F) * Minimum scope changes * Business purpose * Project mission
3	Project team competence	* Quantity and quality of training * Experience of the project manager	* Competent, trained, and focused work force * Ownership at all levels	* Management of resources (F) * Technology & expertise
4	Requirements management		Clear statement of requirements	* Misunderstood requirements (F)
5	User & stakeholder involvement		User involvement at the early stages of development	* Owner's consultation * Owner's approval * Stakeholders (F)

Item		Ho	Kim	Legris
1	Project management	* Project management * Cost management	* Detailed project plan * Project leader's experience * Project leader's project monitoring/control	* Primary analysis * System requirements * Preparation * Implementation of the new System * Consolidation
2	Clear goals and objectives		* Clearly state objectives * Alignment of project and corporate goals * Proper project scope	Primary analysis
3	Project team competence	Skills of implementation professionals	* Project leader's experience * Adequate training for the team * Team member experience * Team member self control	* Primary analysis * System requirements
4	Requirements management		Proper project scope	* Primary analysis * System requirements
5	User & stakeholder involvement	Collaborative process design: customers, suppliers, employees	User participation in the project	* Primary analysis * System requirements * Preparation * Implementation of the new System * Consolidation

Item		Mendoza	Umble	Wilson	
1	Project management	Valuable project management	* Excellent project management * Focused performance measures	Define approval procedures which allow for uncertainty	
2	Clear goals and objectives	Adequate management of project scope	* Clear understanding of strategic goals * Focused performance measures	* Ensure market orientation * Address cultural change in project scope * Manage for delivery of benefits, not specification	
3	Project team competence	* Effective project leadership * High expertise project team * Helpful technical support	* A great implementation team * Extensive education and training		
4	Requirements management	* Adequate management of project scope * Change determined and justified at a productivity level			
5	User & stakeholder involvement	Relevant user involvement		* Involve users interactively in system design * Organize round customer	

Item		Six Sigma	PMBOK	PRINCE2
1	Project management		Integration * Management plan * Direct and manage execution * Monitor and control work Scope * Planning Time * Activity definition * Sequencing * Resource assignment * Resource estimating * Schedule development and control Cost * Estimating * Budgeting * Control	* Plans * Controls * Organization
2	Clear goals and objectives	Define the goals of the improvement activity * Measure the existing system	Integration * Charter * Scope statement Scope * Planning	* Business case
3	Project team competence		Human Resource * Acquire * Develop * Manage project team	Project management team roles
4	Requirements management	* Analyze the system to identify ways to eliminate the gap between the current performance of the system or process and the desired goal * Improve the system	Integration * Change control Scope * Definition * Control	* Product-based planning * Change management
5	User & stakeholder involvement		Communication * Manage stakeholders	Senior user

Item		RUP	IEEE 12207	Standish
1	Project management	Plan - manage to the plan	* Management process	* Experienced project manager * Reliable estimates * Financial management
2	Clear goals and objectives	* Vision - Develop a vision * Business case - examine the business case		* Clear business objectives * Minimized scope
3	Project team competence			* Experienced project manager * skilled personnel
4	Requirements management	* Change requests - manage and control changes * Manage requirements * Control changes to software	* Configuration management	Firm basic requirements
5	User & stakeholder involvement			User involvement

Item		MSF		Boehm	Charette
1	Project management	* Project management * Establish clear accountability and shared responsibility * Deliver within project constraints			* Inaccurate estimates of needed resources (F) * Poor reporting of the project's status (F) * Poor project management (F)
2	Clear goals and objectives	* Work toward a shared vision * Focus on delivering business value		* Developing the wrong software functions (F) * Gold plating (F) * Cost benefit analysis	Unrealistic or unarticulated project goals (F)
3	Project team competence	* Empower team members * Establish clear accountability and shared responsibility * Learn from all experiences		* Personnel shortfall (F) * Staffing with top talent; job matching; team building	
4	Requirements management	Delivery to product specifications		* Developing the wrong software functions (F) * Developing the wrong user interface (F) * Scenarios * Requirements scrubbing * Continuing stream of requirement changes (F) * High change threshold	* Badly defined system requirements (F)
5	User & stakeholder involvement			* User surveys	Poor communication among customers, developers, and users (F)

Item		Turk	Taylor	Pattit
1	Project management	* Planning is the project's roadmap and is ongoing * The three primary dimensions - cost, schedule, and quality - must be top concerns * Leadership and management go together * Responsibility with the appropriate authority is necessary for the PM and task leads * Gather the right metrics for the right reasons * Monitor but don't micromanage	* Specify significant milestones and check points * Retain tight control of the project	* Clearly define tasks and role assignments * Confronting and give-and-take conflict management style
2	Clear goals and objectives	* Set priorities; then re-examine them periodically * Focus on the important areas, but don't ignore the rest	Devise a clear specification for the aims, targets, and rationale of the initiative and make sure that everyone involved in the project understands the specification and subscribes to it	
3	Project team competence	* Good people make or break the project * Give people the right tools so they can do their jobs * Using "Outsiders" correctly is a team multi-plier		* Use small, effective teams
4	Requirements management	Requirements are the underpinnings	Devise a clear specification for the aims, targets, and rationale of the initiative and make sure that everyone involved in the project understands the specification and subscribes to it	Track and manage changes to project
5	User & stakeholder involvement	User/customer involvement can prevent misunderstandings	Create a genuine and constructive partnership between the business unit and the IT unit	Feedback from customers

Item		Page	Reel	Spector
1	Project management	Project management	* Keep attrition low * Manage the product more than the people * Track progress * Make smart decisions * Institutionalize post-mortem analysis	* Take an enterprise approach to program management * Use "critical chain project management" to plan and execute projects * Minimize the number of concurrent projects * Don't waste time and resources gathering unnecessary data, performing unnecessary analysis, and creating unnecessary metrics * Prioritize projects based on their impact and use of strategic resources
2	Clear goals and objectives	Share vision	* Set realistic objectives and expectations for everyone	* Improvement programs must align with the company's strategy and objectives * Projects must be focused on a growth strategy
3	Project team competence	Resource allocation	* Build the right team * Give the team what they think they need	
4	Requirements management		* Manage the product more than the people	* Don't waste time and resources gathering unnecessary data, performing unnecessary analysis, and creating unnecessary metrics
5	User & stakeholder involvement	Decision involvement		

Item		Scrum	Extreme Programming	Occurrences
1	Project management	* Product backlog * Effort estimation * Sprint * Sprint planning meeting	* Planning game * Just rules	26
2	Clear goals and objectives	* Product backlog		24
3	Project team competence		* Paired programming * Open workspace	21
4	Requirements management	* Product backlog	Metaphore (shared stories)	21
5	User & stakeholder involvement	Sprint planning meeting	* Planning game * Metaphore (shared stories) * On-site customer	18

Item		Somers	Biehl	Nah
6	Senior management support	* Top management support * Project champion * Use of steering committee	Top management support	Management support and championship
7	Organization change management	* Change management * Education on new business processes * User training on software * Business Process Reengineering	* Organization change management (management of expectations) * Capable and well understood business processes * Training of managers and the system's future users data accuracy	Change management
8	Architecture and design	* Architecture choices * Use of vendors' tools * Data analysis and conversion * Careful package selection * Minimal customization		System analysis, selection and technical implementation
9	360 degree communication	Interdepartmental communication	Maintaining cross functional cooperation and communication	Communication
10	Quality management			
11	Iterative & incremental development			

Item		Bradley	Boghossian	Hartman
6	Senior management support	Effectiveness of project champion	Executive management support through PDLC	* Top management support
7	Organization change management		Well-defined processes	Change management
8	Architecture and design			
9	360 degree communication			* Lack of communication (F) * Communication
10	Quality management		Independent verification and validation	
11	Iterative & incremental development		Small and miniature project milestones	

Item		Ho	Kim	Legris
6	Senior management support		Top management support	* Primary analysis * System requirements * Preparation * Implementation of the new System
7	Organization change management	Change management	Reengineering business process	* Primary analysis * System requirements * Preparation * Implementation of the new System * Consolidation
8	Architecture and design	* Architecture and design * Multilanguage and multi-currency * Hardware landscape optimization * Heterogeneous systems	* Utilizing a prototype * Use of an appropriate technology	
9	360 degree communication		Project leaders feedback to team	* Primary analysis * System requirements * Preparation * Implementation of the new System * Consolidation
10	Quality management		Peer review on project progress	Preparation
11	Iterative & incremental development		Using a prototype	Implementation of the new System

Item		Mendoza	Umble	Wilson	
6	Senior management support	* Significant administrative support for the project * Valuable support by senior management	Commitment by top management	* Gain board awareness of strategic potential of IT * Gain champion/sponsor	
7	Organization change management	* Effective organizationa change management * Effective internal and external training plan * Low impact of Information Systems on the organization	* Organizational change management * Extensive education and training	* Organize round customer * Address cultural change in project scope * Identify need for business system convergence internally & coordination externally * Prototype new processes, not just IT	
8	Architecture and design	* Complete technological infrastructure * Appropriate configuration of communication software * Standard data model documentation, unification, and updating * Appropriate strategy of security		* Design for flexibility * Manage IT infrastructure	
9	360 degree communication	Effective out-going and in-coming communication	Multi-site issues		
10	Quality management		Data accuracy		
11	Iterative & incremental development			* Rapid strategy/action loop to experiment and gain credibility * Prototype new processes, not just IT	

Item		Six Sigma	PMBOK	PRINCE2
6	Senior management support			* Project Board * Executive * Senior User * Senior Supplier
7	Organization change management	* Analyze the system to identify ways to eliminate the gap between the current performance of the system or process and the desired goal		
8	Architecture and design	* Analyze the system to identify ways to eliminate the gap between the current performance of the system or process and the desired goal * Improve the system		
9	360 degree communication		Communication * Information distribution * Performance reporting	* Communication Plan
10	Quality management	* Measure the existing system * Control the new system	Scope * Verification Quality * Planning * Assurance * Control	Quality in a project environment
11	Iterative & incremental development			Stages

Item		RUP	IEEE 12207	Standish
6	Senior management support			Executive support
7	Organization change management	* User support - deploy a usable product	* Operation process * Training process * Operations process * Maintenance process	
8	Architecture and design	* Architecture - design a component architecture * Use component based architectures * Visually model software	* Infrastructure process	* Standard software infrastructure * Standard tools and infrastructure
9	360 degree communication			
10	Quality management	* Evaluation - regularly assess results * Verify software quality	* Audit process * Joint review process * Quality assurance process * Verification process * Validation process * Improvement process	
11	Iterative & incremental development	* Prototype - incrementally build and test the product * Develop software interactively	Development process	* Minimized scope * Iterative and agile process

Item		MSF		Boehm	Charette
6	Senior management support	Empower team members			
7	Organization change management	Readiness management		* Organization analysis * Mission analysis * Task analysis	
8	Architecture and design			* Software reuse * Prototyping * Real-time performance shortfalls (F) * Simulation * modeling * Straining computer science capabilities (F) * Technical analysis * Shortfalls in externally-furnished components (F) * Benchmarking * Inspections * Compatibility analysis	Use of immature technology (F)
9	360 degree communication	Foster open communications			Poor communication among customers, developers, and users (F)
10	Quality management	* Invest in quality * Release after addressing all issues			
11	Iterative & incremental development	Stay agile expect change		* Incremental development	* Inability to handle the project's complexity (F)

Item		Turk	Taylor	Pattit
6	Senior management support	* Leadership and management go together * Selling the project can garner support from above		
7	Organization change management			
8	Architecture and design		Pay particular attention to the user interface of any component of the system that will involve the Internet	Use component based design
9	360 degree communication	Communication - up, down, and side-ways - is a must	Prioritize the need for mutual communication	
10	Quality management	Adequate, thorough, and timely testing with good test plans make for good products		Peer reviews
11	Iterative & incremental development		* Organize and implement a pilot project * Organize modular delivery * Address the toughest design issues first	* Frequent integration of software components (i.e., builds)

Item		Page	Reel	Spector
6	Senior management support	Executive leadership		* Top management mus be committed and involved
7	Organization change management	* Management of system access * Compatibility of workflow processes * Critical mass of data automated		
8	Architecture and design	Management of system access		* Establish a cross-functional, process focused infrastructure
9	360 degree communication	Communication process		
10	Quality management		Monitor quality early on and establish an expectation of excellence	Make data quality an imperative
11	Iterative & incremental development			

Item		Page	Reel	Spector
6	Senior management support	Executive leadership		* Top management mus be committed and involved
7	Organization change management	* Management of system access * Compatibility of workflow processes * Critical mass of data automated		
8	Architecture and design	Management of system access		* Establish a cross-functional, process focused infrastructure
9	360 degree communication	Communication process		
10	Quality management		Monitor quality early on and establish an expectation of excellence	Make data quality an imperative
11	Iterative & incremental development			

Item		Scrum	Extreme Programming	Occurrences
6	Senior management support			17
7	Organization change management			17
8	Architecture and design		* Simple design * Refactoring	17
9	360 degree communication	Daily scrum meeting		16
10	Quality management	Sprint review meeting	* Test driven * Coding standards	16
11	Iterative & incremental development	* Sprint	* Small/short releases * Continuous integration	15

Item		Somers	Biehl	Nah
12	Product development life cycle			
13	Interdepartmental co-operation	Interdepartmental co-operation	Use of cross functional teams	
14	Expectation management	Management of expectations	Organization change management (management of expectations)	
15	Individual and team attitudes	Dedicated resources	User attitude	
16	Risk management			
17	Vender management	* Partnership with vendor * Vendor support		

Item		Bradley	Boghossian	Hartman
12	Product development life cycle		* Defined PDLC (Product Development Life Cycle) * Software development and engineering practices	
13	Interdepartmental co-operation			
14	Expectation management		Realistic expectations on the product and development schedule	* Optimistic schedules and budgets (F)
15	Individual and team attitudes		Ownership at all levels	* Management of resources (F)
16	Risk management			* Inadequate risk assessment and management (F)
17	Vender management			

Item		Ho	Kim	Legris
12	Product development life cycle	* Methodology: design and implementation * Implementation strategy	* Utilizing a prototype * Utilizing an effective methodology	
13	Interdepartmental co-operation	Organization structure		* Primary analysis * System requirements * Preparation * Implementation of the new System * Consolidation
14	Expectation management			* Primary analysis * System requirements * Preparation * Implementation of the new System * Consolidation
15	Individual and team attitudes		* Team member commitment * Team member self control	* Primary analysis * System requirements * Preparation * Implementation of the new System * Consolidation
16	Risk management			
17	Vender management			

Item		Mendoza	Umble	Wilson	
12	Product development life cycle	* Careful strategy of implementation * Helpful technical support		Leverage models of bes practices	
13	Interdepartmental co-operation	Known organizational structure			
14	Expectation management				
15	Individual and team attitudes				
16	Risk management				
17	Vender management	Appropriate outsourcing management			

Item		Six Sigma	PMBOK	PRINCE2
12	Product development life cycle			Product-based planning
13	Interdepartmental co-operation			Project board
14	Expectation management			
15	Individual and team attitudes			
16	Risk management		Risk * Identification * Analysis * Response * Monitoring	* Management of Risk
17	Vender management		Procurement * Purchases * Acquisitions	

Item		RUP	IEEE 12207	Standish
12	Product development life cycle	* Process - adopt a process that fits your project	* Development process * Documentation process * Improvement process	Formal methodology
13	Interdepartmental co-operation			
14	Expectation management			
15	Individual and team attitudes			
16	Risk management	Risks - Mitigate risks and track related issues		
17	Vender management		Acquisition process	

Item		MSF		Boehm	Charette
12	Product development life cycle	* Smooth deployment and ongoing management			Sloppy development practices (F)
13	Interdepartmental co-operation	Establish clear accountability and shared responsibility			Stakeholder politics (F)
14	Expectation management	Establish clear accountability and shared responsibility		* Unrealistic schedules and budgets (F) * Design to cost	* Unrealistic or unarticulated project goals (F) * Inability to handle the project's complexity (F)
15	Individual and team attitudes	* Empower team members * Learn from all experiences			
16	Risk management	Risk management			* Unmanaged risks (F) * Commercial pressures (F) * Inability to handle the project's complexity (F)
17	Vender management			* Shortfalls in externally-performed tasks (F) * Reference checking * Pre-award audits * Award-fee contracts * Team building	

Item		Turk	Taylor	Pattit
12	Product development life cycle			* Utilize a development process * Frequent integration of software components (i.e., builds) * Use multiple best practices
13	Interdepartmental co-operation		Create a genuine and constructive partnership between the business unit and the IT unit	Use multi-functional teams
14	Expectation management	* Transmitting the appropriate urgency is the right kind of motivation * Expectations should be high for your self and your people, and realistic for the stakeholders		
15	Individual and team attitudes	* Use good people skills and people will respond with good work * Don't lose your sense of humor		Proactive company policies toward conflict management
16	Risk management	Manage risk - but take risks when you have to	Address the toughest design issues first	
17	Vender management			

Item		Page	Reel	Spector
12	Product development life cycle	System administration		
13	Interdepartmental co-operation	Decision involvement		
14	Expectation management	Expectation setting		Pursue perfection but tolerate failure
15	Individual and team attitudes			
16	Risk management			
17	Vender management			

Item		Scrum	Extreme Programming	Occurrences
12	Product development life cycle			13
13	Interdepartmental co-operation	Sprint planning meeting	Collective ownership	13
14	Expectation management		Just rules	12
15	Individual and team attitudes		* Paired programming * 40 hour week	10
16	Risk management			8
17	Vender management			5

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