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THESIS

THE EFFECTIVENESS OF SOFTWARE PROJECT MANAGEMENT PRACTICES: A QUANTITATIVE MEASUREMENT

by

Christopher D. Cullen

March 2011

Thesis Co-Advisors:	John Osmundson Man-Tak Shing
Associate Advisor:	Kadir Demir

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THE EFFECTIVENESS OF SOFTWARE PROJECT MANAGEMENT PRACTICES: A QUANTITATIVE MEASUREMENT

Christopher D. Cullen
Flight Lieutenant, Royal Australian Air Force
B.E., University of New South Wales, 2005

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March 2011

Author: Christopher D. Cullen

Approved by: John Osmundson
Thesis Co-Advisor

Man-Tak Shing
Thesis Co-Advisor

Kadir Alpaslan Demir
Associate Advisor (Non NPS)

Peter Denning
Chairman, Department of Computer Science

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I. INTRODUCTION

A. INTRODUCTION

The United States Department of Defense (DoD) recently reported that the development costs of 72 weapons programs had climbed 40 percent from their initial estimates, there was an average delay of 21 months, and the total systems overrun was $2 billion dollars (Government Accountability Office, 2008). Studies show that these development problems are typically not caused by technology issues but are largely due to program management (Office of the Under Secretary of Defense, 2000). Improving program management should be a primary focus of the DoD if there is to be any hope of significantly increasing program performance. One of the key aspects of the DoD's program management is the management of system software development.

Software has become such an integral part of weapon systems that it is virtually impossible to find a weapons system today that does not contain mission-critical software at its core (Welby, 2010). This is not just isolated to the DoD. Reliance on software keeps growing in industries as diverse as transport, medical, communications, energy, space, entertainment, and finance (Allen, 2009). As the world increasingly relies on software-intensive systems, there will be an increased need for effective software project management in order to field successful systems. Ineffective software project management in these industries is among the main reasons for failures in software projects (Jones, 2004).

Effective Software Project management is crucial to a software project's success. It was observed by DeMarco and Lister that for the overwhelming majority of bankrupt projects, there was not a single technological issue to explain the failure (DeMarco & Lister, 1999). Another study in the last decade asserted that a project was never seen to fail for technical reasons. It was always human failures that caused otherwise good projects to grind to a halt (Robertson & Robertson, 2005). Despite these observations most software engineering

research emphasizes technical matters above behavioral matters (Glass, 2002). People and project management are the Achilles' heel of software projects.

So are software project managers just poor at their jobs and solely to blame for project failures? This surely cannot be the case as many project managers are outstanding professionals. But software itself is incredibly complex and so is the management of its creation. A striking proportion of project difficulties stem from people failing to implement known best practices (The Royal Academy of Engineering and The British Computer Society, 2004). To become effective at software project management requires the project team to learn certain practices until they become habits. Good project managers will continually seek ways to improve their methods and learn from experience. But changes in how software is managed do not come quickly or easily. Any project management improvement process needs to be approached deliberately and purposefully. Project managers need tools to help them improve their software project management. A tool that measures and monitors the effectiveness of software project management can be used to identify strengths and weaknesses and guide improvement of the software project management practices in place on the project. Improving technical processes alone cannot ensure a successful project outcome.

B. STATEMENT OF THE PROBLEM

Effective project management involves measurement. Project managers measure schedule, progress, expenditure, effort, productively. These measurements are made to take the pulse of the project, in order to improve the project's health, if need be. But since poor software project management can increase software costs more rapidly than any other factor, as Boehm declared, should not the project's management itself be measured and monitored? Garcia and Suarez stated that project management practices are considered the cornerstone of the software lifecycle (Garcia & Suarez, 2007). If the project management practices can be improved, then a project should increase its

chance of success. However, committing a project to a significant improvement effort requires a thorough understanding of where the project is and, perhaps more importantly, where the project needs to grow (Grant & Pennypacker, 2006). The problem with current project management appraisal methods is that they take a long time to make an assessment, they do not focus on people and they are targeted at the organizational level. For this reason, project managers are not completely equipped with the right software project management effectiveness measurement tools.

1. Effort of Analyzing Project Management Practices

Effective software project managers should appreciate a candid review of how a project is being conducted or was conducted. As humans, we learn from our mistakes and conducting a post-mortem analysis of a project is considered a best practice by many software professionals. This is one method for a project manager to analyze the effectiveness of the software project management on the project. However, it was found by Chemuturi and Cagely Jr. that the project post-mortem evaluation is often skipped (Chemuturi & Cagley Jr., 2010). The reasons for this could be that the time is considered better spent on other income-generating activities. A software project management effectiveness measurement tool could assist with the post-mortem activity and even reduce the time it takes to conduct the activity.

2. Project Manager Performance

In general terms. there are three types of categories of project managers: those that know the best practices and apply them, those that know them and for whatever reason do not apply them, and finally those that do not know them. Surprisingly, there is an absence of collective professionalism in the industry, as well as inadequacies in the education and training of staff at all levels (The Royal Academy of Engineering & The British Computer Society, 2004). The software project managers' network asserts that a big problem in software projects is an

ill-equipped project manager (Phillips, 2000). A software project management effectiveness measurement tool could help project management professionals identify practices at which their project is poor or even practices they do not use at all. Even experienced managers could benefit from this type of tool. Due to the pressure and fog of war of software projects, one can forget to apply best management practices.

3. Maturity Models Lack a People Focus

Currently, there are a number of Maturity Models in widespread use that can be used to appraise a project's processes and guide improvement efforts. While these models assist with improving some software project management processes, they ignore the people side of software development. The first maturity model that comes to most people's minds in the software development industry is the Capability Maturity Model Integration (CMMI) brand. It seeks to make proven software principles part of the organization's culture and is often used to rate organizations' software development capabilities. To most people, there is little doubt that adopting the specific practices recommended by CMMI will improve an organization's ability to manage software projects. However, technical processes alone cannot ensure a successful software project outcome. CMMI-DEV-v1.2 contains a process area that focuses on project management, but this process area is devoid of management practice related to people (Phillips, 2000). CMMI-DEV-v1.2 focuses on an organization's technical processes and not its highly unpredictable and behavioral components—people. The project management practices in CMMI-DEV-v1.2 are only one compartment of the greater software project management framework. This concept is illustrated in Figure 1. Software project management is about people and not just technical processes.

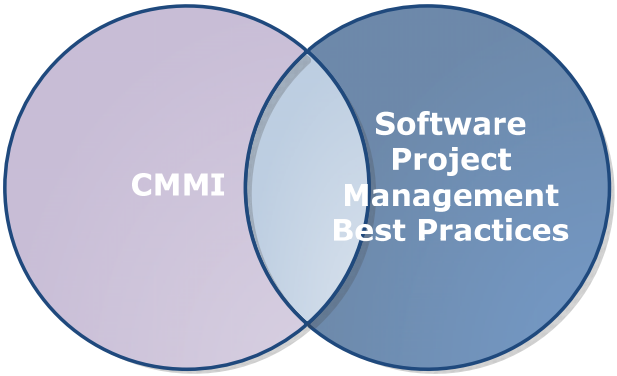

Figure 1. Software Project Management

C. BACKGROUND AND NEED

There is evidence to suggest that deficient project management practices may be one of the principal causes of software project problems. As such, there has been a widespread investment in project management education and tools as organizations strive to become good a delivering projects successfully (Grant & Pennypacker, 2006). There has been avid interest in the creation of models that provide a collection of best practices that managers can compare to their organizations' practices in order to guide improvement. The front-runners in this area are the Project Management Maturity Models (PMMM), but there is also promising research in more lightweight software project management measurement tools.

1. Project Management Maturity Models

Maturity Models have spread quickly across the globe in the last two decades. From the foundation established by CMMI, new models, dubbed PMMMs, have immerged to focus on the project management maturity of organizations. The majority of PMMMs work in a similar way to the CMMI models. PMMMs, however, are concerned with generic project management and do not focus specifically on software project management. Software project management is more different from traditional project management than most

professional managers expect (Fairley, 2009). There are, in fact, very few Software Project Management Maturity Models (SPMMM) in existence today.

While an SPMMM provides a means to assess the level of the software project management effectiveness, it does have a few limitations. A maturity or capability level can only be obtained after an independent, outside group examines the organization against specific criteria. To make an appraisal of an organization usually requires preparation, on-site activities and, finally, reporting. This takes a considerable amount of time. Additionally, maturity models claim to be able to target specific projects but are really focused at the organizational level and although maturity models have exploded onto the market there are many organizations that are still not using them (Garcia & Suarez, 2007). Due to these limitations, there is a need for more tailored, lightweight software project management effectiveness measurement tools. A lightweight appraisal tool can be used in a lot less time than a maturity model and can identify ineffective project management practices in place on a software project.

2. Software Project Management Effectiveness Metric

One such lightweight measurement tool was proposed by Demir in his dissertation entitled Measurement of Software Project Management Effectiveness (Demir, 2008). Demir proposed a Software Project Management Evaluation Model (SPMEM) that provided a standard quantitative measure of software project management effectiveness. The model accepted input data obtained from the application of a questionnaire to a software development project. It produced a standard quantitative measure, between zero and ten, by comparing the practices in place on the project to the best practices in the model. Demir measured sixteen software projects and produced a *software project management effectiveness metric* score for each. Pearson product moment correlation analysis was performed for the metric scores and a subjective rating of the projects' success. It was found that there was a strong positive correlation with the *project success rating* and the *software project management*

effectiveness metric score. In addition, half of the variation in project success could be explained by the metric. Both of these findings indicate that the metric has a strong practical and theoretical foundation to build upon.

The measurement takes significantly less time to perform than a maturity model appraisal and can be used to assist in the postmortem activity of a software project. The measurement can identify weak project management practices on a project and can guide future improvement efforts. It can guide managers by providing a quick assessment of how the project stands against software project management best practices contained in the model. When the tool is used to measure and monitor a project, it can act as a reminder not to let certain practices fall by the wayside. It can also provide objective proof of the project's deficiencies so as to prove to stakeholders what improvement efforts must be made and should be resourced.

The *Software Project Management Effectiveness Metric*, while promising, is still in a developmental stage. The sample size of 16 projects used in Demir's study is not statistically significant. In addition, the previous sample included very few failed projects. Conducting further measurements using the tool will provide more insight into the applicability and limitations of the metric.

D. PURPOSE OF THE STUDY

1. Purpose Statement

The purpose of this study was to measure the software project management effectiveness of software projects using the SPMEM in order to increase the pre-existing sample size and reassess the correlation between the *software project management effectiveness metric* score and the subjective *project success rating*.

The hypothesis to be tested is:

> The success of a software project positively correlates to its software project management effectiveness metric score.

If having a high *software project management effectiveness metric* score is associated with a high *project success rating*, it would indicate that improving a project's score would improve the project's chance of success.

2. Need/Rationale for the Study

The *software project management effectiveness metric* has the potential to assist project managers who are put in charge of software intensive system developments. The metric can assist with the post-mortem analysis of software projects, via identifying areas for improvements on subsequent projects. The metric can provide quantitative evidence to support improvement process decisions rather than just going off of a project managers gut feel. This tool can be used to measure and monitor projects so that project managers do not let best practices fall out of favor on the project.

3. Description of the Study

In order to provide an assessment of the correlation between the *project success rating* and the metric, data from recent software development projects was collected. The data was collected using the Software Project Management Evaluation Instrument (SPMEI). The SPMEI, which is a comprehensive questionnaire, was administered to software project managers, technical managers, software developers and team leaders. The research subjects also provided a subjective *project success rating*. The data collected using the SPMEI was used as input to the Software Project Management Evaluation Model (SPMEM). This model used the raw data from the subjects' responses and produced the software project management effectiveness (PME) score for each project. These two measures were used to test the research hypothesis. In order to understand the measure of association between these two metrics, a parametric correlation analysis was conducted. The testing of the hypothesis was conducted by analyzing the Pearson product moment correlation coefficient (PMCC) between the two measures.

4. Expected Goals and Outcomes of the Study

The goal of this study was to build upon the sample of sixteen software projects in Demir's SPMEI research. With a larger sample size, a stronger argument can be made to use or not use the metric. Another goal was to gain further insight into the usefulness and applicability the metric.

E. RESEARCH QUESTIONS

It was stated by Jones that effective project management is a determinant in the success of the software projects (Jones, 2004). The purpose of the metric is to monitor and improve the effectiveness of software project management. The following questions will be addressed in this study.

1) Will improving a project's PME score increase the project's chance of success?
   - (a) What is the relationship between the PME score (measured) and the project success rating (measured)?
   - (b) What is the relationship between the PME score (measured) and the size of the project (measured)?
   - (c) What is the relationship between an institution's CMMI level (measured variable) and the PME metric (measured variable)?

2) What are software development practitioner's perceptions towards the practicality and usefulness of the metric?
   - (a) What are software development practitioner's perceptions towards the manageability, meaningfulness, actionability, ambiguity, reliability, accuracy, timeliness and predictability of the metric?
   - (b) Will software development practitioners use the metric?

F. SIGNIFICANCE TO THE FIELD

From the literature review conducted in this study, it became evident that the software engineering field contains only limited scientific work that addresses theories of measuring software project management effectiveness. The results of this study have helped substantiate the applicability and usefulness of the SPME metric. The projects surveyed in this study also benefited by receiving metric scores that identified areas of weakness in their software project management.

G. DEFINITIONS

Project Success Rating: A subjective ranking, on a scale of zero to ten, made by a member of the project team on the successfulness of a project (zero being a complete failure and 10 being a complete success).

Effectiveness: Efficiency is doing things right. Effectiveness is doing the right things.

Conceptual Framework: A set of theories widely accepted enough to serve as the guiding principles within a particular discipline.

Project: A group of coordinated work activities and tasks that utilizes resources to achieve specified objectives within a prescribed time frame (Fairley, 2009).

Software Project: A project concerned with developing software for a software intensive system. Software intensive systems include one or more digital devices and associated software.

Software Project Management: The collection of work activities concerned with planning and estimating, measuring and controlling, coordinating and leading, and managing risk factors for a software project (Fairley, 2009).

Best Practices: Best practices are reusable activities or processes that continuously add value to the deliverables of the project. Best practices can also increase the likelihood of success of each and every project. But while all that sounds good, there exists a fundamental question of who defines what is or is not a best practice (Kerzner, 2004).

Process: The steps taken to develop software; a recipe for software. A way of accomplishing one or more work activities and tasks; typically involves procedures and the use of software tools (Fairley, 2009).

Product: The product is the project's final outcome. Products include software, documentation, and training and maintenance services (Phillips, 2000).

H. LIMITATIONS

Further development and modification to improve the SPMEI and SPMEM were considered outside of the scope of this research. The SPMEI was applied to only nine projects due to the difficulty of finding suitable participants willing to participate. The study was conducted on a sample of convenience. Having a small sample size reduces the studies' external validity because of the limited generalizability to other settings and groups.

I. ETHICAL CONSIDERATIONS

As this study involved human subjects, the research required approval from the Naval Postgraduate School's Institutional Review Board (IRB) to ensure that the research was conducted in an ethical manner. Due to the nature of the research, the risk to participants was considered low. A breach of a subject's confidentiality may have resulted in some embarrassment. Informed consent was obtained from all participants and the consent form is contained in Appendix B.

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II. LITERATURE REVIEW

Many research initiatives have emerged that focus on the improvement of software development processes and the technology used during software development. However, one area often underestimated but crucial for every software development effort is project management. (Mandl-Striegnitz & Litcher, 1998). Software developers cannot rely solely on technological advances to achieve better outcomes in the development of software products. Software development houses need to make significant advances in the way they conduct project management in order to achieve better results. Applicable and viable theories on software project management need to be discussed and developed, and models and tools need to be tested and put into practice. Only then can software projects achieve better outcomes. One of the most important steps, for personnel practicing project management, is to look in the mirror and identify how their software project management practices can be improved. This research has identified several tools available in open literature that assess and measure the effectiveness, quality and maturity of software project management practices. Before these tools are discussed, a brief theory of software project management measurement is presented.

A. METRICS IN SOFTWARE PROJECT

Metrics serve only one purpose. We measure to manage (Brotby, 2009). In the management of software projects, it is widely accepted as best practice for managers to measure different components of their projects. For instance, progress is measured using Earned Value Management (EVM), while a product's performance is measured by using Key Performance Indicators (KPI) and software metrics. Quantitative measurements are essential in software engineering and there is a constant effort from academia and industry to improve and discover useful metrics.

A software metric is a measure of some property of a piece of software or its specifications (Singh, 2009). To give an example, here are some software metrics in widespread use:

- Number of Source lines of code
- Faults per lines of code
- Number of lines of customer requirements
- Function Points
- Cyclomatic complexity
- Program load time

The goal of research concerning software metrics is to obtain objective, reproducible and quantifiable measurements of software products. Metrics, measures, and monitoring processes exist only to provide decision support (Brotby, 2009). These measurements can then be used on software projects to assist with schedule and budget planning, cost estimation, and software performance optimization. The measurements can also be used to predict trouble ahead, such as the popular *faults per lines of code* metric.

However, simply measuring the technical aspects of the software itself is only one part of a much larger and complex project. Effective project management is also a determinant in the success of the software projects (Jones, 2004). Measuring and monitoring the behavioral and management side of a software project should also be able to assist in providing decision support. If a project can measure and monitor its software project management capabilities, then the project can take active steps to improve these critical practices. Measurement of one's software project management effectiveness enables the improvement of practices that are known to lead to a greater chance of project success.

B. SOFTWARE PROJECT MANAGEMENT EFFECTIVENESS

It can be strongly argued that the effectiveness of software project management contributes significantly to the outcome of a software project. But

just what is software project management effectiveness? Effectiveness is defined in the Merriam-Webster dictionary as the power to produce a desired effect (Merriam-Webster Inc, 2011). Based on this, the following definition is offered: *Software Project Management Effectiveness is the power of the software project management practices in place to accomplish the objectives of the software project.*

In management, effectiveness relates to getting the right things done (Drucker, 1993). If the right software project management practices are in place and the practices are implemented well, then the software project management is effective. An alternate definition is: S*oftware Project Management Effectiveness is the degree to which the right project management practices are in place to produce the intended or expected result of the software project.*

C. THEORY OF SOFTWARE PROJECT MANAGEMENT EFFECTIVENESS MEASUREMENT

The theory presented in this thesis proposes that it is possible to measure software project management effectiveness by determining:

- if the right software project management practices were in place during a project
- how well the software project management practices were implemented

The right software project management practices are reusable activities or processes that continuously add value to the deliverables of the software project (Kerzner, 2004). By implementing these practices, a software project can increase the likelihood of success.

A generic conceptual approach for measuring software project management effectiveness in this way is presented in Figure 2. This approach requires the development of a software project management framework that describes best practices. A data collection instrument must then be developed to comprehensively sample a project relative to the previously developed

framework. Data is collected using the instrument and analyzed in a systematic way by the software project evaluation model to determine the score of the project's management effectiveness. The project can then take action to improve areas in which it is deficient.

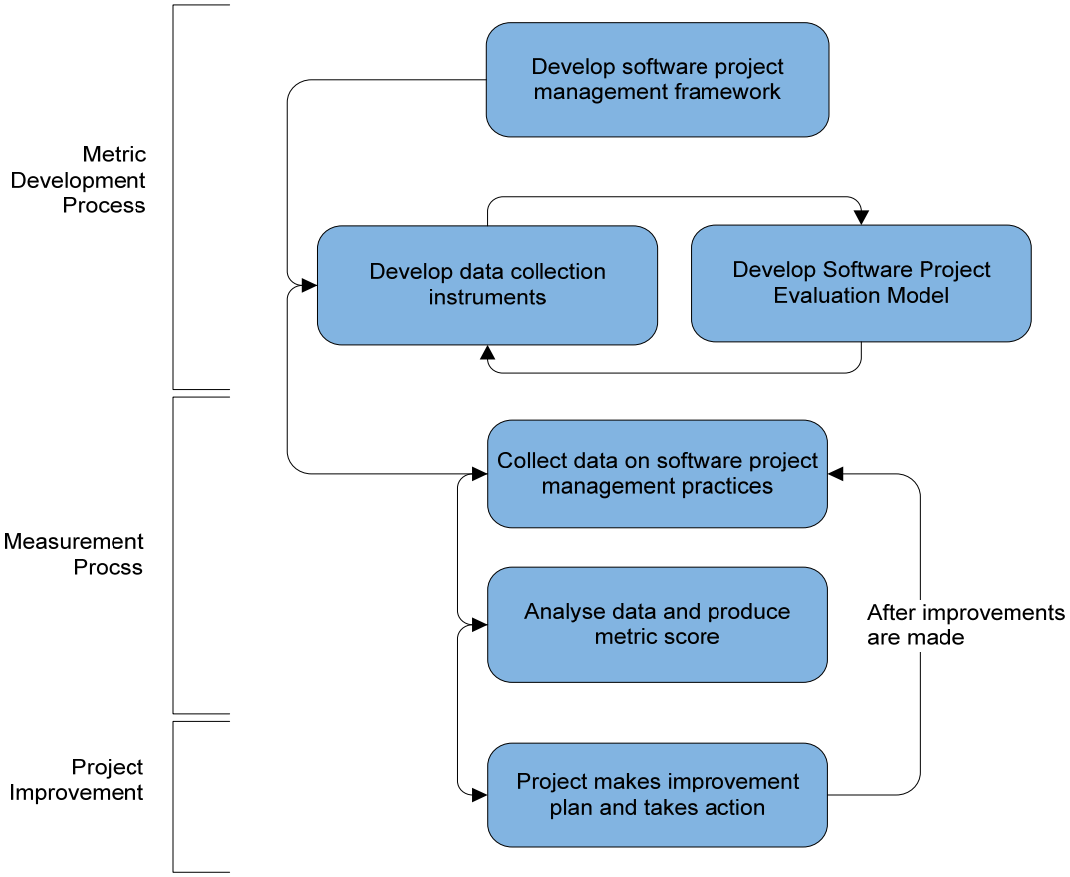

Figure 2. Conceptual Approach to Software Project Effectiveness Measurement

1. Development of a Software Project Management Framework

For the measurement of software project management effectiveness to work, there needs to be a perfect standard of software project management to measure against. While all that sounds good, there exists a fundamental question of who defines what is or is not a project management best practice

(Kerzner, 2004). There is no one correct way to manage a project, due to the extremely complex and diverse nature of software projects. What works well as best practice for one may not work equally well for another. For the measurement to have practicality, there needs to be a framework of effective software project management practices that, if implemented by a project, will increase the chance of success. There are various bodies of knowledge on the theory and practice of software project management that can be used to develop such a framework. The development of a framework for software project management is the first step in creating an objective and repeatable metric.

2. Development an Instrument and Evaluation Model

Secondly, a data collection instrument(s) must be developed to sample the software project management practices of a project in a representative and comprehensive manner. In this study, instrument validity is the extent to which the data collection instrument samples the effectiveness of the software project management in a representative and comprehensive manner. Data must be collected so that it can be analyzed to identify if the project is performing practices as suggested by the project management framework.

There are a variety of data collection instruments and methods that can be used for examining a software project. These include questionnaires, interviews, and documentation reviews, to name a few. Each has its own advantages and disadvantages. Questionnaires were the most commonly used instruments observed in this literature review. This is mainly because questionnaires can be applied to many people and projects in a cost effective manner. Questionnaires are not as invasive as an interview and can provide quantitative data that can be analyzed promptly.

3. Collecting and Analyzing Software Project Management Data

After project data is collected by the instrument(s), it is analyzed to discover how well the software project management practices in place correlate

to the practices defined by the framework. The software project management evaluation model presented in Figure 3 is used to systematically analyze the data and produce a quantitative metric. The metric will give an indication on the effectiveness of the project management practices in place. Once it has been determined where the project is in reality compared to the suggested framework, a report can be generated to explain to the project where their project management deficiencies are.

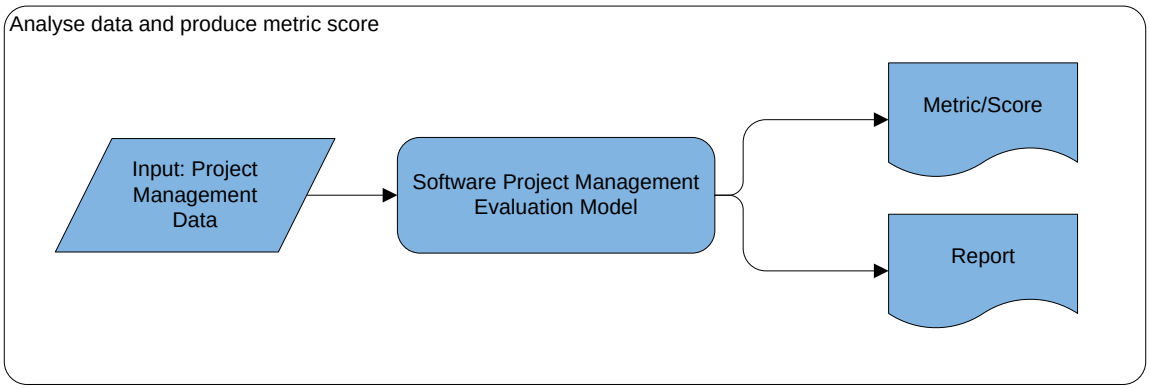

Figure 3. Conceptual Black Box Diagram of Software Project Management Evaluation

4. Making Improvements

The project reviews the report and the metric produced in order to develop their own action plan that aims to implement new management practices or improve existing ones. By improving their practices they should improve their metric score. There are two ways that the metric could be used; and these are shown graphically in Figure 4. For a project that has a long duration, multiple measurements of the software project management effectiveness can be made at periodic intervals to ensure that improvements are being made. For a project of shorter duration, one measurement can be made at the end of the project as part of a post-mortem process so that improvements can be made by the project management and implemented on their next project.

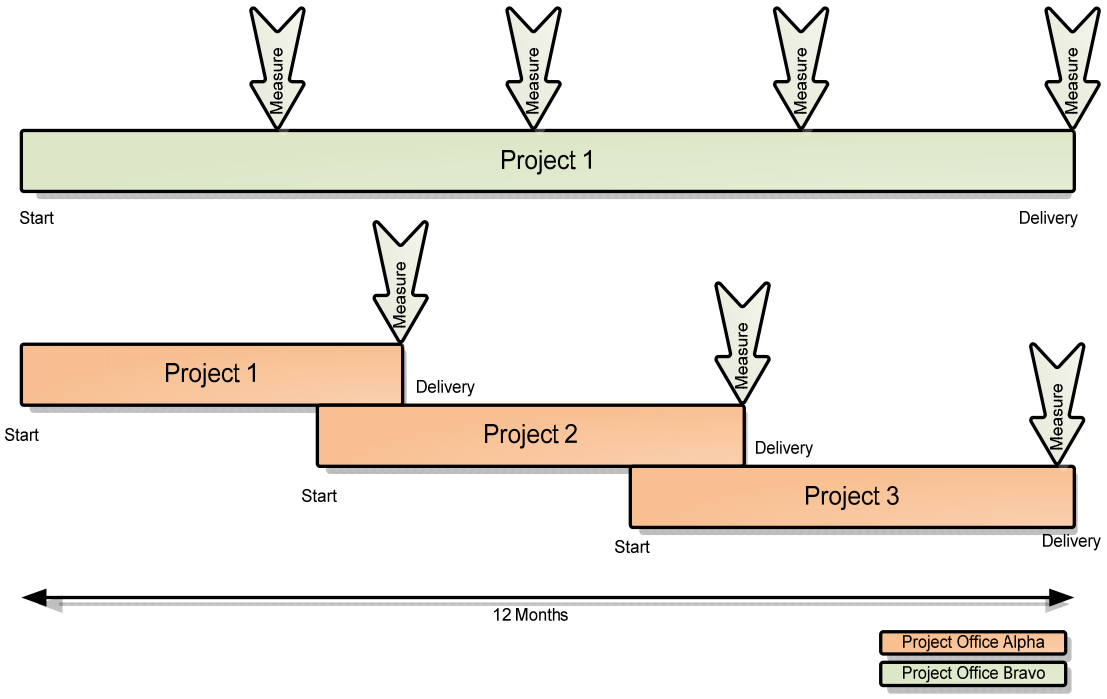

Figure 4. Measurement Timings

The theory of the measurement of software project management effectiveness is summarized in Table 1. A literature review was conducted on open sources to identify studies that are related to the concept of measuring the effectiveness of software project management as presented in this section. The literature review identified that very few studies have been published that concern this topic. Six such studies are summarized and discussed in the following section.

Table 1. Software Project Management Effectiveness Measurement

Software Project Management Effectiveness Measurement	
What is being measured?	➢ The software project management effectiveness: ▪ The amount of "right" management practices that are in place? ▪ How well the management practices in place are being implemented?
Why is it measured?	➢ The chance of software project success is greater when effective project management practices are done.
What does it mean?	➢ A high score means that the project has implemented the right practices and is performing them to a high degree in relation to the theoretical software project management framework. The project has a higher chance of success than a project with a lower score. ➢ A low score means that the project has not implemented the right management practices in accordance with the theoretical software project management framework. The project has a lower chance of success than a project with a high score.
Who are the Recipients?	➢ Software project management practitioners
What action is required?	➢ The project team must implement changes to their project management practices in the areas where they are deficient in order to improve their chances of future project success

D. RELATED WORK

1. Study: Software Project Management Maturity Assessment Model (2007)

In their paper "Software Project Management Maturity Assessment Model to assess the level of Software Project Management Practices," Fuazi and Ramli presented a model to assess software project management practices using their Software Project Management Maturity Assessment (SPMMA) model (Ramli, 2007). The purpose of the SPMMA was to help a company measure the strength and weaknesses of its software project management and develop action plans to make improvements.

a. Framework

The SPMMA was developed using the concepts defined by the Capability Maturity Model Integration (CMMI) and Software Process Improvement and Capability Determination (SPICE) assessment models. The framework only focuses on the project planning, project monitoring and control and risk management process areas. The research was considered to be a pilot program and these three process areas are not deemed to be a completely comprehensive software project management framework.

b. Data Collection Instruments

There were two types of data collection instruments used in the model, a questionnaire and a set of interview questions. The questionnaire was used to gather data indirectly from practitioners. The questions were organized into groups of process areas drawn from the previously mentioned framework, such as project planning and risk assessment. The respondents could select from four possible answers for each question: yes, no, does not apply and don't know. An extract of the questions for the risk management section are presented in Table 2.

Besides the questionnaires, interviews were used to directly obtain data on the software project management practices. The interview was used to give the assessor a better understanding of the project management practices. Related project management documentation was also reviewed to gain a more thorough understanding of the project. An extract of the interview questions is presented in Table 3.

Table 2. Questionnaire: Risk Management Section

Questionnaire: Risk Management Section				
Are risks contingency activities planned?	Yes	No	Does Not Apply	Don't Know
Does the project conduct meetings to identify common causes of defects?	Yes	No	Does Not Apply	Don't Know
Once identified, are common causes of risks prioritized and systematically eliminated?	Yes	No	Does Not Apply	Don't Know
Does the project follow a written organizational policy for risks management activities?	Yes	No	Does Not Apply	Don't Know
Do members of the software engineering group and other software-related groups receive required training to perform their risks prevention activities?	Yes	No	Does Not Apply	Don't Know

Table 3. Interview Extract

Interview Extract
Please tell me about yourself and your experience as it relates to this project?
Please describe your role and responsibilities on the project?
How do you know what you are supposed to be working on?
What training have you had for your job?
Are you involved with any of the estimating and planning of the software project?

c. Data Collection and Analysis

The SPMMA was carried out on one mid-size Information Technology (IT) Company. Based on the questionnaire responses, interviews and discussions among the assessment team, a rating of fully implemented, largely implemented, partially implemented or not implemented was provided for each of the three process areas. Additionally, the assessment team produced a final report on the assessment findings and made improvement recommendations.

d. Results and Summary

The pilot program received the following ratings for the three project management areas:

- Project planning – largely implemented
- Project monitoring and control – largely implemented
- Risk management – partially implemented

A recommendation was made to the project to establish proper risk identification and contingency list. Fuazi and Ramli concluded that the SPMMA could be used as a tool to measure the level of maturity of the software project management practices in an organization (Ramli, 2007). While the SPMMA presents a method to measure the strength and weaknesses of an organization's software project management there are a few concerns. First, only one project consisting of 40 personnel was assessed. Additionally, the tool only assesses project management in three areas and gives each area one of four possible ratings. The three areas in this framework are not considered comprehensive and the ratings do not provide much granularity. A summary of the model is provided in Table 4.

Table 4. Summary of SPMMA

Summary of SPMMA	
What is being measured?	➢ The maturity of the organizations software project management practices
Why is it measured?	➢ To help the organization measure the strength and weaknesses of its software project management and develop action plans to make improvements
What does it mean?	➢ Fully implemented - affirmation exists to confirm the implementation of the project management practice area and no weaknesses are noted ➢ Largely implemented – affirmation exists to confirm the implementation of the project management practice area and one or more weaknesses are noted ➢ Partially implemented – affirmations suggest that some aspects of the project management practice are implemented and one or more weaknesses are noted ➢ Not implemented – no other evidence supports the conclusion that the project practice is implemented
Who are the Recipients?	➢ Project management
What action is required?	➢ The assessed project has to prepare an action plan that specifies how, when and by whom each recommendation is to be implemented

2. Study: What Project Management Practices Lead to Success (2005)

Although not a measurement model, Verner and Evanco conducted relevant research using a questionnaire, in an attempt to determine the factors that lead to successful projects. They claimed that quantitative survey based research regarding software development's early, non-technical aspects is lacking (Verner & Evanco, 2005).

a. Framework

To develop their software project management framework, Verner and Evanco conducted wide ranging, structured discussions with 21 senior software practitioners to document views regarding the software project management practices they considered important.

b. Data Collection Instruments

A questionnaire was developed on the basis of these discussions. The questionnaire was organized into seven project management areas composed of numerous questions. An extract of the questionnaire is provided in Table 5. Respondents were also asked if they considered the project successful.

Table 5. Verner and Evanco's Questionnaire

Verner and Evanco's Questionnaire		
Did the project have a project manager?	Yes	No
Was the PM above average?	Yes	No
Was the PM experienced in the applications area?	Yes	No
Did the PM understand the customer's problems?	Yes	No
Did the PM communicate well with the staff?	Yes	No
Were requirements gathered using a specific method?	Yes	No
Were requirements complete and accurate at the project's start?	Yes	No

c. Data Collection and Analysis

In total, 122 in-house software development projects were analyzed using the questionnaire. The sample was not random, but rather a convenience sample of practitioners that Verner and Evanco knew. The sample size was very large for software engineering research of this nature and was the largest sample size discovered in this literature review. The variables in the survey were analyzed for correlation with project success and failure.

d. Results and Summary

The objectives of Verner and Evanco's research differ from those of the research in this thesis. Instead of attempting to measure the effectiveness of the software project management practices in place on a project the empirical research attempted to identify project management failures that lead to success or failure. It was found that a clear vision of the final product, good requirements, active risk management and post-mortem reviews can all help increase the odds of success (Verner & Evanco, 2005). For all projects, changing the project manager was significantly negatively correlated with project success. If requirements were initially incomplete, completing them during the project was positively associated with success. Because software developers were surveyed, the results were limited to their knowledge, attitudes and beliefs regarding the projects and Project Managers with which they were involved. The method followed in Verner and Evanco's research is an excellent way of developing a solid software project management framework.

3. Project Management Maturity: An Assessment of Project Management Capabilities Among and Between Selected Industries (2006)

Committing an organization to a significant improvement effort requires a thorough understanding of where the organization is and, perhaps more importantly, where the organization needs to grow (Grant & Pennypacker, 2006). One way to address this need is via the use of project management maturity models. The emergence of the project management maturity model can generally be traced to the Capability Maturity Model developed by the Software Engineering Institute (SEI) at Carnegie Mellon (Skulmoski, 2001). Project management consulting firms have played a leadership role in the development of many models, largely because the models are designed to identify areas upon which improvement efforts should focus. There are currently over 30 models in existence (Grant & Pennypacker, 2006).

A typical model works by assessing an organization's project management maturity. Once the initial level of maturity and areas for improvement are identified, the model provides a roadmap, outlining the necessary steps to take toward project management maturity advancement. Grant and Pennypacker conducted research to determine the level of project management maturity based on 42 detailed components among a wide range of industries.

a. Framework

The research conducted used the Project Management Solutions Incorporated's Project Management Maturity Model (PMMM[SM]). The model adopts a two-dimensional framework, as shown in Figure 5. The first dimension reflects the level of maturity and is based on the structure of the SEI capability maturity model. The second dimension depicts the key areas of project management addressed. This dimension adopts the structure of the PMI's nine knowledge areas (Project Management Institute, 2000). Each of the nine knowledge areas were further broken down into key components that provide for a more rigorous and specific determination of the project management maturity. There were 42 components in total.

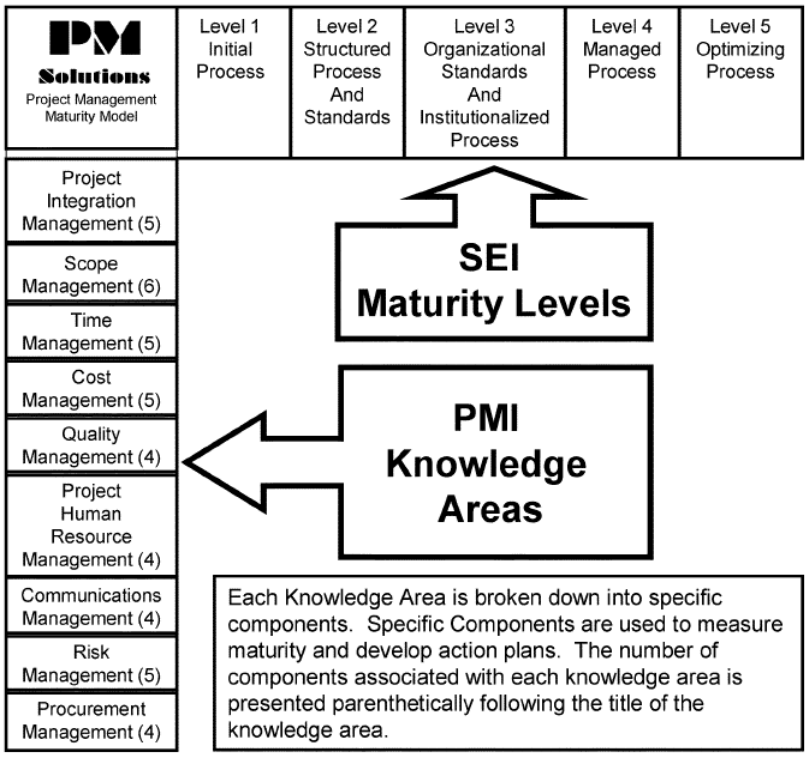

Figure 5. Project Management Maturity Model (From: Grant & Pennypacker, 2006)

b. Data Collection Instruments

A survey was generated that included a specific question for each of the 42 components of project management maturity. To ensure the content validity of the survey instrument, the CBP Knowledge Board reviewed it during the survey development process (Grant & Pennypacker, 2006). An excerpt of the survey is provided in Table 6. One advantage of this behaviorally anchored response scale format is that it has been shown to reduce leniency bias, or the tendency of a respondent to be overly generous or severe in evaluating organizational performance (Grant & Pennypacker, 2006).

Table 6. Cost Management: Resource Planning

Cost Management: Resource Planning
Level 1) Project managers have developed their own way of identifying resources and quantities needed; functional support areas are sometimes overlooked; process is not documented and varies by project.
Level 2) Complete resource listing is for all labor categories, equipment, and material; planning process is developed and documented to include the resource listing and methodologies for determining quantities; planning process is supported by management and is becoming accepted throughout the organization.
Level 3) Planning process is fully implemented within the organization; project's resource requirements are uploaded into the project office's resource repository.
Level 4) All processes are in place, documented, and being fully utilized; process is fully integrated with the project office and the human resources project management process.
Level 5) An improvement process is in place to continuously improve resource planning to completely identify all requirements as early as possible in the right quantities; lessons learned are captured and used to improve resource planning efforts.

c. Data Collection and Analysis

A total of 126 organizations were surveyed using a web-based survey. Each of the 126 respondents was asked to rate the project management maturity of his or her organization with respect to 42 specific components of project management maturity. Nearly 67% of respondents indicated their organizations were operating at level 1—initial processes (13.7%) or at level 2—structured process and standards (53.2%). While a notable portion of respondents rated their organizations as having reached level 3—organizational standards and institutionalized process (19.4%), a mere 7.3% indicated their organizations were operating at level 4—managed process and only 6.5% assessed their organizations as having achieved level 5—optimizing process (Grant & Pennypacker, 2006).

d. Results and Summary

While this study does not rigorously measure project management maturity in the participating organizations, it did serve its purpose of collecting the ratings of numerous organizations' project management maturity. However, this research focuses on organizational project management maturity and effectiveness, which is related remotely to project management effectiveness. It is also concerned with the higher level concept of *project* management and not *software project* management.

Maturity in project management is the development of systems and processes that are repetitive in nature and provide a high probability that each project will be a success (Kerzner, 2004). It was found that there were many Project Management Maturity Models available to organizations wishing to improve their project management. These models focus on generic project management and do not specifically address the unique attributes of software project management.

Table 7. Summary of PMMM

Summary of PMMM	
What is being measured?	➢ Where the organization is concerning their project management maturity
Why is it measured?	➢ A thorough understanding of where the organization is and, perhaps more importantly, where the organization needs to grow is essential in order to make improvements
What does it mean?	➢ Level 1 - Initial (chaotic, ad hoc, individual heroics) - the starting point for use of a new process ➢ Level 2 - Managed - the process is managed in accordance with agreed metrics ➢ Level 3 - Defined - the process is defined/confirmed as a standard business process, and broken down to levels 0, 1 and 2 ➢ Level 4 - Quantitatively managed ➢ Level 5 - Optimizing - process management includes deliberate process optimization/improvement
Who are the Recipients?	➢ Project Managers and Executive Management
What action is required?	➢ Organization takes steps toward project management maturity advancement and performance improvement

4. Study: Quality Management Metric (1999)

Osmundson et al. (2003) developed a method, called the Quality Management Metric (QMM), to measure the quality of software management. The QMM is a composite score obtained using a questionnaire administered to both the program manager and a sample of his or her peers. The QMM is intended to both characterize the quality of software management and be used to improve an individual's and an organization's software project management capabilities.

a. Framework

It was proposed that the following four areas collectively were a suitable framework for the basis of a measurement of the quality of the software management in a project:

- Requirements management
- Estimation & planning management
- People management
- Risk Management

These areas were validated informally by experienced software professionals through the focus groups and one-on-one interviews.

b. Data Collection Instrument

The QMM was built to be an objective, repeatable metric to determine the quality of the software management, measure improvement, and predict future success levels of projects. A two-part questionnaire was developed to quantitatively measure the state of the software management quality.

Table 8. Education/Planning Management

Estimation/Planning Management: choose the most applicable term of the two for each row	
At least one estimation method used in program	No estimates
Formal derivation of product metric for estimation of size	Ad hoc size estimation
Ad hoc process evaluation	Formal derivation of at least one process metric
Develop work breakdown structure	Assign work as needs arise
Estimates are developed to fulfill a data call only	Use estimates to plan program
Use estimates to sell program only	Estimates are useful to the project team for planning purposes
Expert judgment for estimation	Ad hoc estimates

The questions were designed to confine responses. Part one of the questionnaire contained pair choice questions where the respondent had to choose one of two statements that best describe the project. An extract from part one of the survey is provided in Table 8. Often, the pair choices were repeated with different wording to confirm earlier choices and measure the strength of any tendencies. Part two of the questionnaire asks for one of three responses: yes, no or not applicable. This format standardized the response for easier comparison. An extract of part two of the survey is provided in Table 9.

Table 9. People Management Questionnaire

People Management Questionnaire		
PM is accessible in person by each team member	Yes	No
PM is accessible via email by each team member	Yes	No
PM is accessible via phone by each team member	Yes	No
PM acts as facilitator to solving personnel conflicts	Yes	No
PM attempts to spotlight individuals in the program for positive exposure	Yes	No
PM maintains regular communication with users	Yes	No
PM must approve all interactions with users	Yes	No

c. Data Collection and Analysis

The survey was administered to 13 projects in the United States Department of Defense Environment. The projects ranged in size from three software developers to twenty-five software developers. The time frame of the programs surveyed range from 1992 to 2000.

Each choice in the questionnaire had a point value assigned to it based on the relative importance of the question. Point totals for part one and part two were then added together to determine the total points for each area of software project management. The total points of each section were multiplied by its relative importance coefficient to yield a weighted score. After weighted scores were determined for each of the four sections, they were summed together to yield the QMM score.

$$QMM = 0.92RqM + 0.67EPM + 0.55RkM + 1.86PM$$

d. Results and Summary

Each respondent was also asked to rate the success of their project on a scale of zero to ten. The calculated metric from each of the projects was compared to the subjective project success rating. This yielded a positive correlation with the subjective assessments of the project success.

The QMM was the earliest research identified by this literature review to deal with the measurement of software project management effectiveness. The research showed promise but was limited by the sample set only consisting of Department of Defense projects. Additionally the projects were all during the 1990s, and the metric has been further validated since then.

Table 10. Summary of QMM

Summary of QMM	
What is being measured?	➢ Quality of software management
Why is it measured?	➢ Improve organization's estimation process by including management quality as a program attribute ➢ Provide feedback to software program managers as to their management effectiveness
What does it mean?	➢ Highest possible score – 100% - High chance of program success ➢ Lowest possible score – 0% - Low chance of program success
Who are the Recipients?	➢ Project Manager
What action is required?	➢ Improve software management area with the lowest score

5. Study: Two Phase Questionnaire (2007)

Another questionnaire based-model was developed by Garcia and Suarez in 2007. Their approach sought to obtain a baseline snapshot of project management practices in small-to-medium enterprises using a two-phase questionnaire to identify both performed and non-performed practices (Garcia &

Suarez, 2007). The goal was to identify those practices that are performed but not documented, that practices need more attention, and which are not implemented due to bad management or unawareness.

a. Framework

To obtain an accurate picture of the project management practices, Garcia and Suarez based their framework on the Capability Maturity Model Integration for Development (CMMI-DEV) (Software Engineering Institute, 2006). The following seven well-established project management areas were used in the construction of the framework:

- Project Planning
- Project Monitoring and Control
- Requirements Management
- Configuration Management
- Process and Product Quality Assurance
- Supplier Agreement Management
- Measurement and Analysis

b. Data Collection Instruments

A questionnaire was developed using closed questions as the main instrument for collecting data on the proposed framework. It was argued that the application of a questionnaire to an organization's project team can provide useful information related to the current state of the project management practices and indicate those that required immediate attention. The questionnaire was divided into two phases. This division is mainly due to the fact that the CMMI-DEV clearly differentiates between specific practices and generic practices. Another reason for the division into two phases is because each section is applied to a different domain of people. The specific practices phase refers to the series of steps that have to be followed to perform the project

management practices. The generic practices phase refers to the maturity and institutionalization of the project management practices (Garcia & Suarez, 2007).

c. Data Collection and Analysis

The respondent could choose from the range of possible answers provided in Figure 6. Giving a specific weight to each response was proposed to enable the easy analysis of the results of the evaluation and identify which practices were common within the whole organization and which ones were not performed at all. At the time of publication, no such evaluation was undertaken.

Possible Answer	Perform Level	Description
Always	*4*	*The activity is documented and established in the organization. It is always realized, between 75 and 100% of the time, in organization software projects*
Usually	*3*	*The activity is established in the organization but rarely documented. It is usually realized, between 50 and 75 % of the time, in organization software projects*
Sometimes	*2*	*The activity is weakly established in the organization. It is realized sometimes, between 25 and 50 % of the time, in organization software projects*
Rarely if ever	*1*	*The activity is rarely performed in the organization. It is rarely realized, between 1 and 25 % of the time, in organization software projects*
Never	*0*	*The activity is not performed in the organization. No person or group performs the activity in the organization.*
Don't Know		*The person is not sure how to answer the question.*
Not Apply		*The question is not applicable to the organization.*
Comments		*This space is for elaborating or qualifying one's response to a question, and it is mandatory when one selects Don't know or Not Apply options.*

Figure 6. Possible Responses in Two Phase Questionnaire (From: Garcia & Suarez, 2007)

d. Results and Summary

Garcia and Suarez felt that a more accurate picture of the project management practices of an organization could be obtained by administering a questionnaire. The next step in their research was related to the validation of the questionnaire. It was declared that in the future their questionnaire would be

administered to 26 small-to-medium enterprises through a project funded by the Spanish Ministry of Industry, Tourism, and Trade.

6. Software Project Management Effectiveness Metric (2008)

The latest research known to cover the measurement of software project management effectiveness was published by Demir (2008). The metric developed by Demir sought to provide a standard quantitative measure of software project management effectiveness from the start of a project to its delivery. The objective of the metric was to help managers in software development organizations to evaluate, monitor and improve their project management effectiveness.

a. Framework

A software project management framework was developed by Demir, and was validated by surveying 16 software projects. The framework consisted of 15 areas, which included: communication, teamwork, leadership, organizational commitment, project manager, stakeholder involvement, staffing and hiring, requirements management, project planning and estimation, project monitoring and control, scope management, configuration management, quality engineering, risk assessment, and risk control.

b. Data Collection Instruments

The Software Project Management Evaluation Instrument (SPMEI), which was a comprehensive questionnaire, was used to gather project data. The data collection tool was used to gather project data related to fifteen project management areas of the framework.

c. Data Collection and Analysis

Twenty software projects were assessed using the SPMEI in order to investigate the applicability and limitations of the metric. A member of the

project organization who had a broad knowledge on all aspects of the project management was asked to complete the questionnaire. Then the data gathered by the instrument was fed into the software project management evaluation model (SPMEM). Reponses to the questions were assigned specific scores in a similar way to the QMM mentioned previously. SPMEM simply combines these scores in a systematic way to produce a score for each project management area and these scores are then used to compute a software project management effectiveness (PME) score based on a scale from 0 to 10. A score of 0 indicates the least effective project management, while a score of 10 indicates the most effective project management. Each respondent was also asked to provide a subjective success rating from 0 to 10 in the same way as the QMM.

d. Results

The research provided empirical evidence required for the validation of the metric. A Pearson product moment correlation analysis on the data gathered showed that there is a strong positive correlation with success ratings and the software project management effectiveness metric. The result of the analysis on the data indicated that half of the variation in software project success may be explained by the project management effectiveness metric.

Table 11. Summary of SPMEM

Summary of SPMEM	
What is being measured?	➢ Software project management effectiveness
Why is it measured?	➢ Software project success is dependent on effective software project management
What does it mean?	➢ Highest possible score – 10 - A high PME score indicates a high probability of project success ➢ Lowest possible score – 0 – a low PME score indicates a low probability of project success.
Who are the Recipients?	➢ Software project managers
What action is required?	➢ Management takes steps to improve their software project management practices

E. SUMMARY OF MODELS

From the six studies reviewed, it was revealed that there is limited research on the topic of the measurement of software project management effectiveness. All of the studies reviewed are summarized in Table 12. Out of the six studies, only three provided an actual methodology to measure software project management effectiveness or maturity. These three models were all in early developmental stages.

1. Framework

Each study established a framework for software project management, even if it was not specifically called a framework in the study. Three of the frameworks were based upon the Software Engineering Institute's Capability Maturity Models. The others were based upon research and validated through peer reviews.

The different software project management frameworks varied in content and comprehensiveness. There were, however, some recurring themes. Requirements management was considered important in four of the frameworks;

planning and estimation in five; risk management was present in four and monitoring and control stood out in three. The framework for the SPMEM was found to be the most comprehensive framework.

2. Data Collection Instruments

A constant across all the studies was the use of a questionnaire to gather data on the project management practices. In each study, it was argued that the application of questionnaires consumed less time, effort and financial resources than other methods of data collection such as interviews and document reviews. Another common theme was that the questionnaires were written in such a way as to minimize open-ended, subjective essay type answers. Of all the studies reviewed, only one used interviews and document reviews and that was to complement the use of a questionnaire in the data gathering process.

3. Measurement

The SPMMA only provides four possible ratings for the maturity of the measured project management areas. The QMM provides much more granularity, with the highest possible score being 100%. The SPMEM also offered a high level of granularity, with an ordinal scale of 0 to 100.

4. Time to Implement

To make the measurement usable by practitioners in the field, data needs to be gathered quickly and easily. The QMM was the quickest metric to implement at approximately 45 minutes, followed by the SPMEI at approximately 90 minutes. The SPMMA took much longer to get a result. This was due to the interviews, documentation reviews and meetings that were required to make an assessment.

5. Sample Size

The three models that actually involve the measurement of software project management maturity are in their early stages of development. The

SPMMA was tested on only one project. The QMM was used on 13 United States Department of Defense projects. The SPMEI was applied to 20 projects of varying sizes and industries.

The concept of the PMMM was extended by the SPMMA. This model focused specifically on software project management. However where these types of models focus on assessing the organization, the theory of project management effectiveness is concerned with measuring the software management of a single project within an organization. A large organization may claim to have a project management maturity level of 4 when they have multiple business units with hundreds of projects. Does this mean that every business unit and every project operate at a level 4? This is possible but not likely.

At the completion of the literature review the measurement methods were subjectively ranked in order of effectiveness and potential for future use. The results are shown in Table 12. Out of the studies surveyed, the SPMEM showed the most promise for the measurement of software project management effectiveness. The framework and questionnaire developed were the most comprehensive and extensive. The measurements made thus far by Demir have shown a strong positive correlation with project success. The time to implement the questionnaire is reasonable and it has a strong sample base to build upon. The SPMEM is reviewed in detail in the following chapter.

Table 12. Summary and Ranking of Studies in the Literature Review

Rank	Model	framework	Instruments	Ordinal scale of measurement	Time (hrs)	Sample size
1	SPMEM	▪ Communication ▪ Teamwork ▪ Leadership ▪ organizational commitment ▪ project manager ▪ stakeholder involvement ▪ staffing and hiring ▪ requirements management ▪ project planning and estimation ▪ project monitoring and control ▪ scope management ▪ configuration management ▪ quality engineering ▪ risk assessment ▪ risk control	Questionnaire 116 questions	0-100	1.5	16
2	QMM	▪ Requirements management ▪ Estimation and planning ▪ People management ▪ Risk Management	Questionnaire	0-100	0.75	13
3	SPMMA	▪ Project Planning ▪ Project Monitoring and Control ▪ Risk Management	Questionnaire Interview	1-4	~16.0	1
4	Two phase	▪ Project Planning ▪ Project Monitoring and Control ▪ Requirements Management ▪ Configuration Management ▪ Process and product quality assurance ▪ Supplier agreement management ▪ Measurement and analysis	Questionnaire	×	~1.0	0
5	PMMM	▪ Project Integration Management ▪ Scope Management ▪ Time Management ▪ Cost Management ▪ Quality Management ▪ Project Human resource Management ▪ Communications Management ▪ Risk Management ▪ Procurement Management	Questionnaire 42 questions	1-5	~1.0	126

6	In house	▪ Project Management ▪ Requirements elicitation and management ▪ Cost and effort estimation and scheduling ▪ Postmortem	Questionnaire	×	~0.25	122

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III. REVIEW OF THE SOFTWARE PROJECT MANAGEMENT EFFECTIVENESS METRIC

Of the studies reviewed in the previous chapter, Demir's software project management effectiveness metric demonstrated the most potential as a software project management measurement tool. This chapter provides a more detailed review of the metric. The development and validation of the software project management framework used for the metric will be covered and the data collection instrument and the software project management evaluation model will also be discussed. A summary of the results obtained by Demir's research will conclude the chapter.

A. 3PR SOFTWARE PROJECT MANAGEMENT FRAMEWORK

In Demir's study, a simple software project management framework was developed that collected a set of software project management practices to serve as guiding principles for the software project management discipline. The framework was developed by an extensive review of the ubiquitous project management models, bodies of knowledge, standards and guidelines in worldwide circulation. To substantiate the developmental framework a survey was conducted on 78 software practitioners from around the world. Demir's framework consists of four main software project management areas: people, process, product and risk.

- **People.** People management lies at the core of software project management and inclusion in the framework was mandatory. Thomsett (1995) pointed out that most projects fail because of people and project management concerns rather than technical issues.
- **Process.** The CMMI focus is on improving the maturity of organizations by improving their processes (CMMI Product Team, 2006). The process main area focuses on key software project management processes.
- **Product.** The software product is considered the outcome of a software project, which may be a product, service or result. The

objective of a project is to create a product with which the stakeholders are satisfied. This area is concerned with project management practices that focus their attention on the product quality.

- **Risk**: Risk management is an inherent aspect of any software project. Boehm (1991) indicated that in most software project disasters, the problems could have been avoided or reduced if the high-risk elements had been identified and resolved early in the process.

The framework consists of areas that can be measured. Each main area is decomposed into sub areas of project management. The sub areas give a higher level of granularity and assist in more refined measurements. Measurements in the sub areas can help project managers improve specific practices that are lacking. The complete framework is displayed in Figure 7 and is called the 3PR framework.

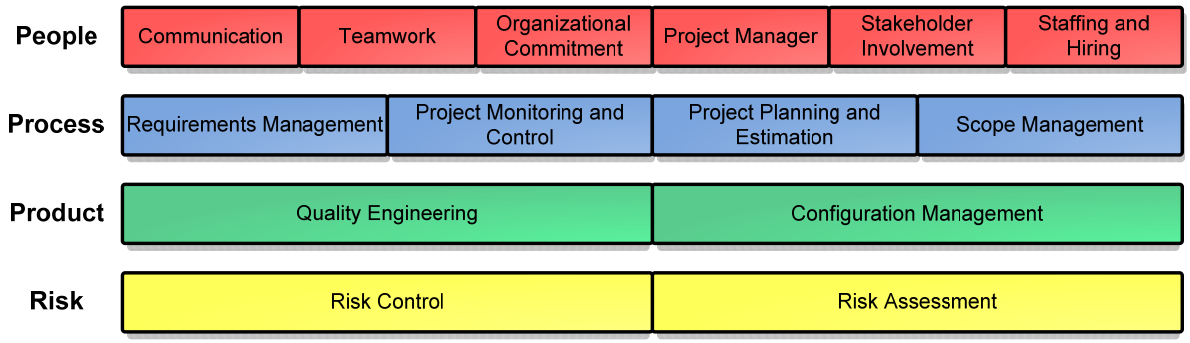

Figure 7. 3PR Software Project Management Framework

1. People - Sub Project Management Areas

The *people* main area includes seven sub areas of software project management. They are communication, teamwork, leadership, organizational commitment, project manager, stakeholder involvement and staffing and hiring.

a. Communication

A successful project requires constant and effective communication between project stakeholders. It is a prerequisite to getting the right things done in the right way. Sharing knowledge empowers project stakeholders. Among all the project management areas listed in the Project Management Book of Knowledge, communications has the largest impact on project results (Muller, 2003).

b. Teamwork

Teamwork is the process through which a collection of individuals cooperates to achieve an expressed common goal (Rasing, 2011). As software is developed by teams, strong teamwork is essential to successfully completing a software project.

c. Leadership

In a software development environment, leadership is how personnel in management positions exert social influence to enlist the aid and support of others in the accomplishment of project goals. The thing great leaders have in common is the ability to get the right things done.

d. Organizational Commitment

In the framework organizational commitment is the employee's psychological attachment to the organization and organizational goals (Brown, 2003).

e. Project Manager

The project manager position is a key role in a software project's organizational structure. A project manager should be a competent manager and leader.

f. Stakeholder Involvement

The stakeholder engagement sub area is concerned with the level of involvement of all the different stakeholders during the project development effort.

g. Staffing and Hiring

In this framework, staffing and hiring is the ability to source human resources and put them in the right project role. Hiring is the process of employing personnel from outside the organization, whereas staffing is the process of sourcing personnel from within the organization.

2. Process—Sub Project Management Areas

This sub area includes requirements management, project monitoring and control, project planning and estimation, and scope management. These areas are more closely aligned to the process areas in the CMMI-DEV model 1.3.

a. Requirements Management

This process involves the management of the software requirements and is not to be confused with the requirements development process. Requirements must be controlled and consistency of requirements must be maintained with plans and work products.

b. Project Monitoring and Control

Comparing progress to plans and applying corrective action as needed. Project monitoring is the process of keeping the project, project-related factors and project metrics under continuous observation. Project control is the process of ensuring that a project goes according to what was planned. Deviations from the plan should be controlled and kept to a minimum.

c. Project Planning and Estimation

Project planning involves establishing and maintaining the plans that define the project work activities. Software project estimation includes establishing estimates of project cost, schedule and resources using various methods, techniques and tools.

d. Scope Management

This is the process of defining the scope of the project and keeping track of any changes to the scope. Scope management was found in the validation of the framework, explained later, to be the most challenging sub area of the software project management framework.

3. Product—Sub Project Management Areas

This main area includes only two sub areas: configuration management and quality engineering.

a. Configuration Management

Software configuration management is the discipline that enables us to keep evolving software products under control, and thus contributes to satisfying quality constraints (Estublier, 2000). Even though configuration management is a process, it comes under this main area because it focuses on the products developed by a software project.

b. Quality Engineering

Quality engineering involves all activities put in place to ensure the development of a high quality product. In this framework, quality engineering is not quality assurance. Quality engineering includes all the procedures and processes used to ensure products or services are designed and produced to meet or exceed customer requirements.

4. Risk—Sub Project Management Areas

This main area includes only two sub areas; risk assessment and risk control.

a. Risk Assessment

Identify potential problems. According to Boehm (1991), risk assessment involves risk identification, risk analysis and risk prioritization.

b Risk Control

Develop and implement strategies and techniques for mitigating them. In order to conduct risk control, an effective risk assessment process has to be in place. Risk control involves risk management planning, risk resolution, and risk monitoring.

Due to the nature of project management, the sub areas are closely tied to each other. For example, an effective risk control can only be achieved as a result of effective risk assessment. Effective teamwork can be achieved via effective communication, an able project manager, effective leadership of various leaders in the project organization and commitment from stakeholders.

5. Validation of the Software Project Management Framework

In order to validate the framework, a survey was distributed to software development practitioners to garner opinions on the framework. This form of empirical evidence was required to substantiate the framework.

A self-administered questionnaire, which contained thirteen questions, was developed by Demir. The purpose of the questionnaire was to identify the importance of the software project management main areas and sub areas. The survey was also used to identify challenging areas of software project management.

The survey was conducted in 2007 and was delivered to approximately 400 software development practitioners. The sample was random and 80 usable

responses were obtained. It was found that all of the sub areas of the software project management framework were deemed to be important by the sample population. On a seven-point Likert scale, the average importance ratings ranged from a minimum of four to a maximum of six. This indicated that all of the areas were felt to be important by the sample population. The *people* sub areas were rated the highest and the *process* sub areas were the second highest. The *product* and *risk* sub areas were rated lower than the others, but were indistinguishable from each other.

Additionally, participants were asked to rate the importance of the four main areas so that the total score added to 100. The mean of the ratings were the following:

- People: 33.00%
- Process: 29.07%
- Product: 20.40%
- Risk: 17.53%

These ratings were used to adjust the software project management framework, as shown in Figure 8. The results of the validation study guided the development of the software project management evaluation instrument and evaluation model.

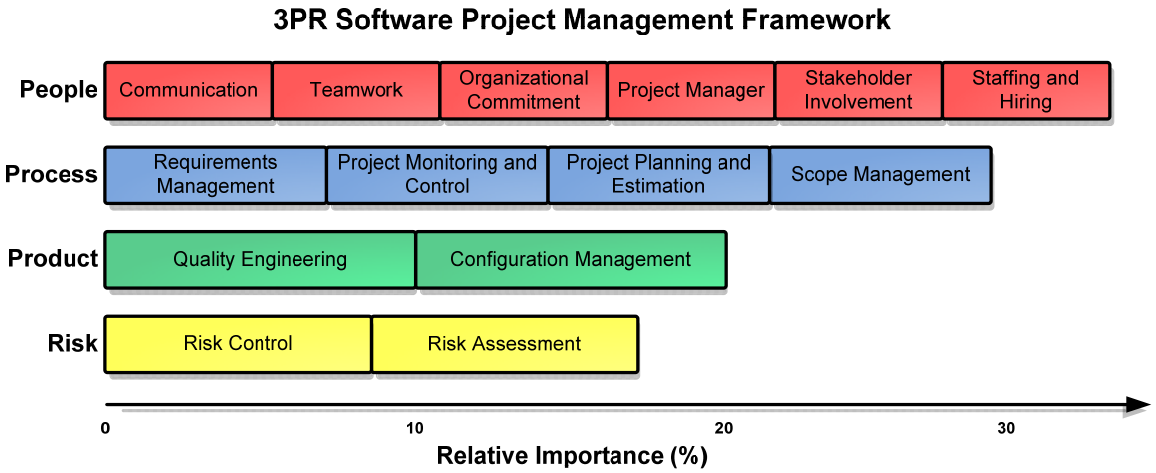

Figure 8. Adjusted 3PR Framework

B. SOFTWARE PROJECT MANAGEMENT EVALUATION INSTRUMENT

The goal of the SPMEI is to gather data on what happened during a software project. The instrument is not used for research as such but is intended to be used as a project management tool on software projects. The SPMEI data collection instrument is a self-administered questionnaire, consisting of the fifteen sections corresponding to the fifteen sub project management areas of the 3PR framework. Each section is comprised of a series of questions. Each question inquires about the effectiveness of an activity or an entity related to software project management. The complete instrument contains over 330 questions and is provided in Appendix B.

1. Software Project Management Evaluation Instrument Design

In every project, there are a set of software project management practices that:

- should have been performed and were
- should have been performed and were not
- should not have been performed but were

The SPMEI investigates the project and collects data on all three of these scenarios. The instrument collects data on:

- The existence of software management practices
- The rigor or quality of the practice

Table 13 presents the different sections in the instrument and the number of questions in each section. In a questionnaire, questions can be classified into open and closed questions. The complexity of analyzing data provided by open questions is higher than those in closed questions (Yamanishi & Li, 2002). Closed questions provide less information but the results can be more easily interpreted in a measurement model. The questions in SPMEI are

closed for this reason. Closed questions also reduce the time required to complete the survey. No one wants to use a metric that takes an annoyingly long time to produce.

The instrument covers the activities between the project conception and the delivery. Conception is the point where the project was established and funded. Delivery is the point in time where the final product is delivered to the customer.

Table 13. SPMEI Question Break Down

Project Management Area	Number of Questions
Communication	23
Teamwork	30
Leadership	17
Organizational Commitment	26
Project Manager	27
Stakeholder Involvement (Market or Contract)	12 or 16
Staffing and Hiring	29
Requirements Management	27
Project Monitoring and Control	19
Project Planning and Estimation	35
Scope Management	16
Configuration Management	13
Quality Engineering	20
Risk Control	17
Risk Assessment (With Subcontracting or Without Subcontracting)	20 or 19
Total	330-335

2. Application of the Instrument

a. Who Can Use the Instrument?

The metric is likely to be used by managers and organizations that are committed to achieving better results from their projects. These types of managers and organizations value candid assessments of their current practices and continuously seek to make improvements.

The instrument can only be used by a project member who has extensive knowledge and understanding of all the aspects of the project management practices. Generally, this type of person will fill the following roles in a software development project:

- Project manager
- Team leader
- Experienced developer
- Software architect

b. What Projects Can Be Measured with the SPMEI?

The instrument is only applicable to software intensive development projects. The instrument is not restricted to either public or private sector projects. The instrument is not applicable to corrective, perfective and adaptive maintenance efforts. Managing these sets of activities is different than managing development activities. The framework and instrument were not designed for software maintenance projects.

c. Temporal Boundaries

The instrument must only be applied to projects conducted after 1980 (Demir, 2008). Until the nature of software projects changes dramatically, the instrument may continue to be used and improved. Demir speculated that the metric will be applicable for at least the next 15 years. The use of the metric is applicable to projects conducted from approximately 1980 to 2025.

d. When Can the SPMEI Be Applied?

The project must be established for a certain period before the instrument can be applied. The earliest that the measurement can be made is when the project has completed the initial requirements phase, or in other terms,

the inception or conceptual phase. By the time the project has reached this point, many of the essential project management related activities are already in place. To be specific, the following must be in place:

- the project manager has been chosen
- the project organization is identified
- stakeholders have been identified
- most planning and estimation activities have been carried out
- the project scope has been established
- configuration management systems, project databases and other automated systems are in place
- quality policy is in place
- project monitoring and control procedures should be in place
- project communication procedures should be in place
- An initial risk assessment has been undertaken

Table 14. SPMEI Summary

Name of the Instrument	Software project management evaluation instrument
Acronym	SPMEI
Main Use of Instrument	Obtain data on what happened during the project development
Type of Instrument	Self-administered Questionnaire
Participants	➢ Project team members who have extensive knowledge of all aspects of the project. ▪ Executive managers overseeing projects ▪ Project managers ▪ Project technical managers ▪ Team leaders
Applicability	➢ Software-intensive development projects ➢ Applicable to any project organization size ➢ Applicable with any software development life-cycle model ➢ Applicable to project after some requirements development activities are conducted
Scope	Project start to project delivery (Project start is the time when the business decision is made)

Number of Sections	15
Number of Questions	330-335
Type of Questions	➢ Multiple choice ➢ Statements with a psychometric scale (5-point Likert item based on agreement to a statement) ➢ All questions are closed form
Time to complete	Average of 90 minutes

C. SOFTWARE PROJECT MANAGEMENT EVALUATION MODEL

The SPMEM and the SPMEI were developed simultaneously. The software project management areas in the previously developed framework correspond to the variables in the SPMEM (Equation 1). The associated weighting of each variable was determined by the results of the framework validation survey. The variables in Equation 1 are calculated based on the data gathered from the SPMEI. For each of the variables (namely the software project main areas) there is an associated model to determine the value. Equations 2, 3, 4 and 5 are used to calculate the main area scores.

1. High-Level Evaluation Model

The high-level evaluation model for the metric is as follows:

$$(1)\ PME\ Score = 0.33PeopleS + 0.2907ProcessS + 0.204ProductS + 0.1753RiskS$$

where:

PME Score: Software Project Management Effectiveness Score,
PeopleS: People Area Score
ProcessS: Process Area Score
ProductS: Product Area Score
RiskS: Risk Area Score

2. Software Project Management Sub Area Evaluation Models

The people main area score (PeopleS) is calculated as follows:

$$(2)\ People\ Area\ Score = \frac{(C + T + L + QC + PM + SI + S)}{7}$$

where:

C: Communication Area Score
T: Teamwork Area Score
L: Leadership Area Score
OC: Organizational Commitment Area Score
PM: Project Management Area Score
SI: Stakeholder Involvement Area Score
S: Staffing and Hiring Area Score

The process main area score (ProcessS) is calculated as follows:

$$(3) Process\ Area\ Score = \frac{(RM + PMC + PPE + SM)}{4}$$

where:

RM: Requirements Management Area Score
PMC: Project Monitoring and Control Area Score
PPE: Project Planning and Estimation Area Score
SM: Scope Management Area Score

The product main area score (ProductS) is calculated as follows:

$$(4)\ Product\ Area Score = \frac{(CM + QE)}{2}$$

where:

CM: Configuration Management Score
QE: Quality Engineering Score

The risk main area score (RiskS) is calculated as follows:

$$(5)\ Risk\ Area\ Score = \frac{(RA + RC)}{2}$$

where:

RA: Risk Assessment Area Score
RC: Risk Control Area Score

3. Software Project Management Sub Area Evaluation Models

The main area scores are derived from the sub area scores. The sub area scores are derived from participant's response to the questionnaire. For each response to a question in the SPMEI, there is an associated score. The

associated scores for each response are provided in Appendix C. Adding all the scores together in a sub area provides an *initial score* for that section (or sub area).

It is possible the *initial score* for a sub area will be a negative number as demonstrated in Table 15. The *initial score* for each section is made positive by adding a *shifting factor*. This shifted score is normalized to a scale of 0 to 10 by multiplying it with a *scaling factor*. Table 16 provides an example of the shifting factors and scaling factors as derived from the values in Table 15.

Table 15. Example Scoring Ranges

People	No of Questions	Lowest Score	Highest Score	Difference
Communication	23	-38	66	104
Teamwork	30	-54	73	127

The steps for calculating the score for a project management area are listed as follows:

1) Sum the scores for each response in the section together. This is the initial score for the sub project management area.
2) Add the shifting factor to initial score. This becomes the shifted initial score for the sub project management area.
3) Multiply the shifted initial score with the associated scaling factor to normalize the score to a scale of 0 to 10. This normalized score for the sub project management area can now be fed into sub area evaluation model.

Table 16. Example Shifting and Scaling Factors

Project Management Sub Area	Shifting factor	Scaling factor
Communication	38	10/104
Teamwork	54	10/127

The generic model to determine a project management area score is:

$$(6)\ Project\ Management\ Sub\ Area\ Score = Scaling\ Factor \times \left(\sum_{i=1}^{n} PMA_i + Shifting\ Factor\right)$$

In Equation 6, n is the number of questions in the section. PMA_i is the sum of the scores for each response in a section. For example, in the communication section of the SPMEI, there are twenty-three questions. Thus, n is 23 for this sub area model. For the communication area score in Equation 7, the scaling factor is 10/104 and the shifting factor is 38. For the complete details of the SPMEM refer to Appendix D.

$$(7)\ Communication\ Area\ Score = \frac{10}{104} \times \left(\sum_{i=1}^{n=23} C_i + 38\right)$$

D. SUMMARY OF RESULTS OF INITIAL STUDY

Sixteen software projects were surveyed by Demir. The graph below shows a plot of project success ratings and PME scores. The trend suggests that there is a relationship between the PME score and the project success rating. At first look, it would appear that the higher the PME score the higher the project success rating.

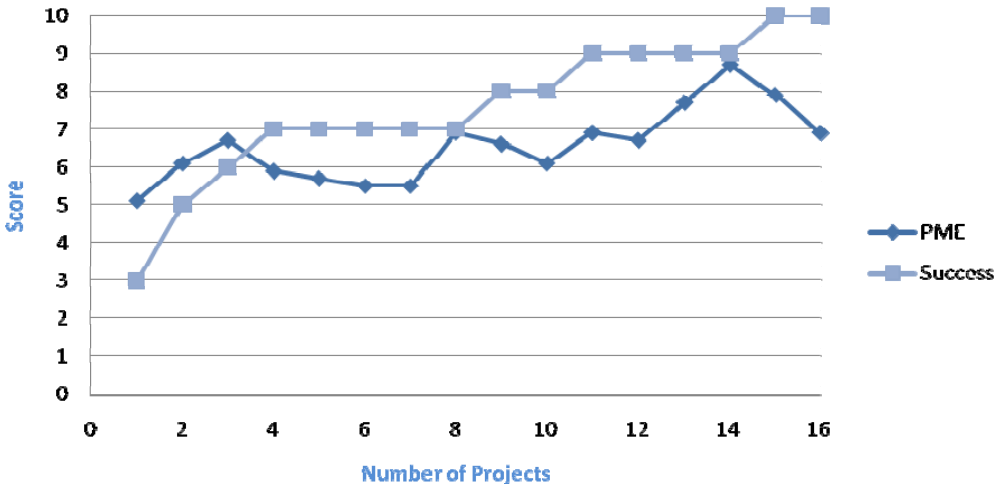

Figure 9. Project Success Ratings and PME Scores

In order to understand the association between the PME score and the project success rating of a project, a correlation analysis was conducted by Demir. The Pearson product-moment correlation coefficient was used to identify the linear relationship between the sets of calculated variables. The Pearson product-moment correlation coefficient between the project success ratings and the PME scores is 0.68. This indicates a strong positive correlation between the two variables. Demir's study suggests that when project management effectiveness is high, project success is more likely. It was demonstrated that it is possible to develop a metric to measure the effectiveness of software project management.

1. External Validity

The small sample size of Demir's study is an obvious limitation and reduces the external validity of the study. It is difficult to make generalizations about the use of the metric on other projects with a sample size of sixteen. Additionally, there is only one project that has a lower project success rating than five and the subjects were only from America and Europe. Increasing the size of the sample and the range of success ratings should prove insightful. The goal of the research in this thesis was to increase the sample size by measuring more projects in order to provide further insight to the applicability and limitations of the metric.

IV. METHODS

A. INTRODUCTION

The development of a tool that measures the software project management effectiveness could prove to be highly valuable to software project managers. The Software Project Management Effectiveness Metric is one of these tools that have shown promise. To discover how promising the metric is, the following research questions were addressed in this study:

1) Will improving a project's PME score increase the project's chance of success?
    (a) What is the relationship between the PME score (measured) and the project success rating (measured)?
    (b) What is the relationship between the PME score (measured) and the size of the project (measured)?
    (c) What is the relationship between an institution's CMMI level (measured variable) and the PME metric (measured variable)?
2) What are software development practitioner's perceptions towards the practicality and usefulness of the metric?
    (a) What are software development practitioner's perceptions towards the manageability, meaningfulness, actionability, ambiguity, reliability, accuracy, timeliness and predictability of the metric?
    (b) Will software development practitioners use the metric?

To answer these questions, the research was conducted in two phases. In phase one, participants used the SPMEI to measure a project they had worked on and the SPMEM was used to obtain the PME score for their project. Phase two was a chance for participants to provide their feedback on

the metric through the completion of a short questionnaire. The data obtained in this study was combined with Demir's for analysis. A visual depiction of the research method is illustrated in Figure 10.

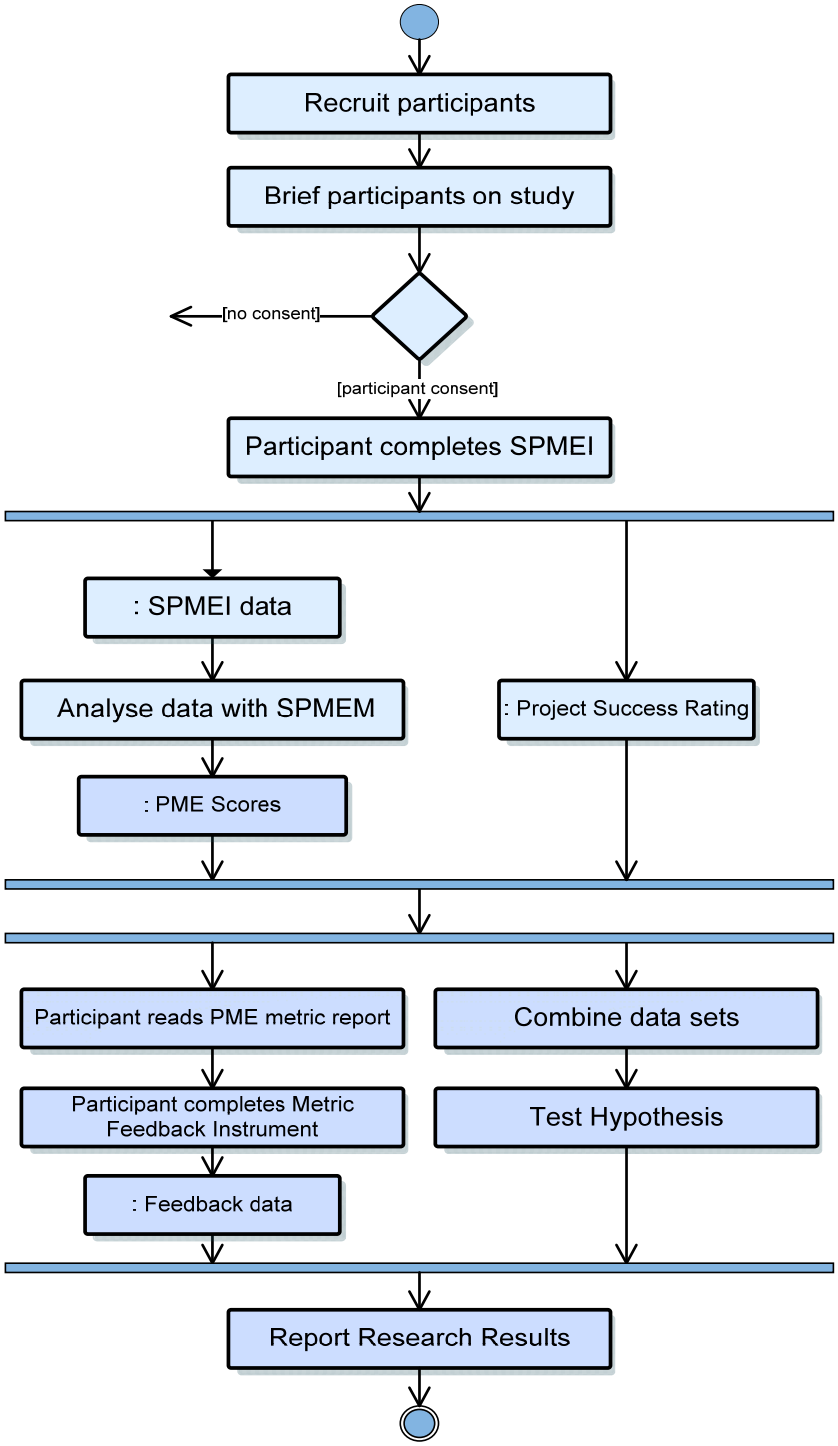

Figure 10. Research Method (Activity Diagram)

B. SAMPLE/PARTICIPANTS

1. Sampling Plan

Research subjects for this type of study are most likely to be found through personal networking, via friends and colleagues (Demir, 2008). Due to the length and content of the SPMEI, potential subjects were recruited from the researcher's professional network. This was the sole means of recruiting subjects for the study and, as such, was a sample of convenience.

2. Description of Participants

In this study, a *combined data set* was obtained by joining Demir's data (henceforth referred to as *existing data set*) and the *new data set,* obtained by the research in this thesis. Nine projects were surveyed to create the new data set and the details of these projects are published in Table 17. The sample contains very recent projects of varying durations. The software products developed ranged from weapon systems software to web applications.

Table 17. New Data Set Sample

Project	Delivery Date	Software Product	Duration (months)
AA	2008	Command and Control	24
BB	2010	Web Application	44
CC	2010	Weapon System	29
DD	2010	Command and Control	28
EE	2011	Information and Data Management	28
FF	2010	Entertainment	NA
GG	2010	Web Application	12
HH	2010	Weapon System	11
I I	2010	Web Application	18

The combined data set contains 25 projects. The duration of the projects in the sample can be seen in Figure 12. The average project duration was 20 months. The combined data set contains projects mainly from the last six years. The time frame for the projects is displayed in Figure 13.

Figure 11 presents the combined sample in terms of the average number of people involved. The projects are divided into four sizes: small, medium, large and very large. More than half of the projects in the combined sample are small size projects. One quarter is medium size and the remaining larger projects make up the rest of the sample.

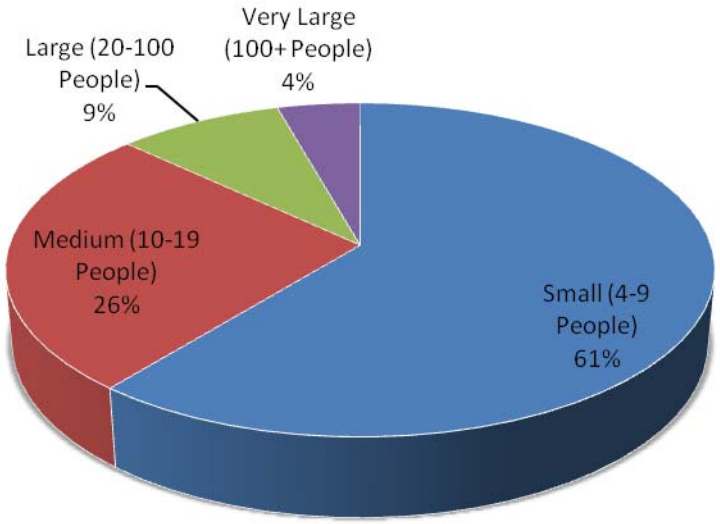

Figure 11. Project Size in Terms of Average People Involved

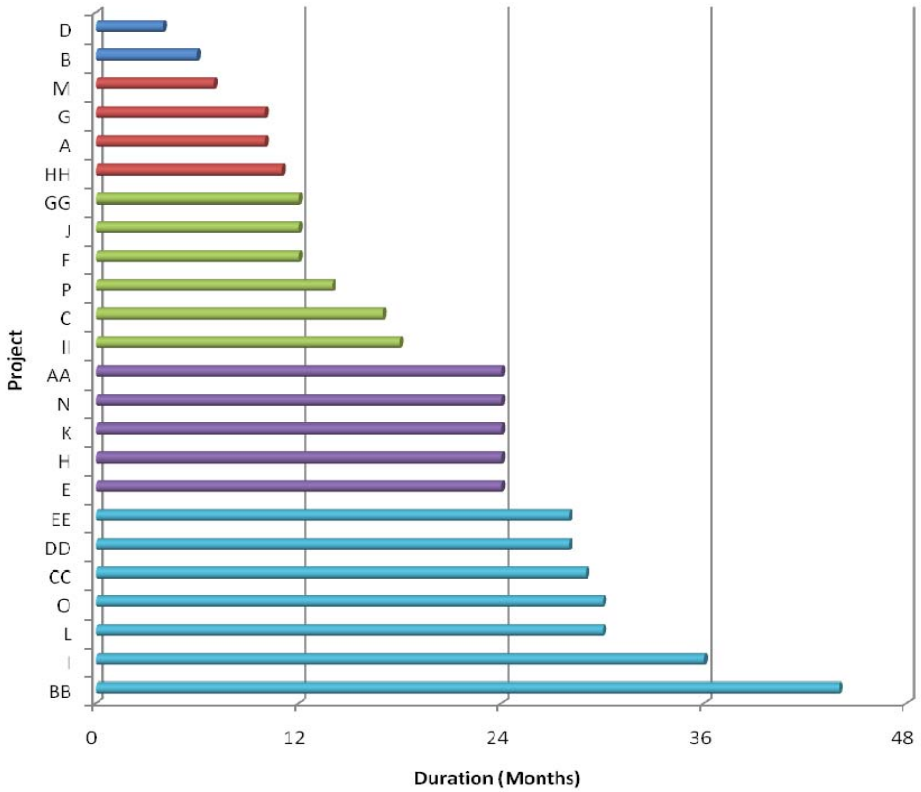

Figure 12. Project Duration

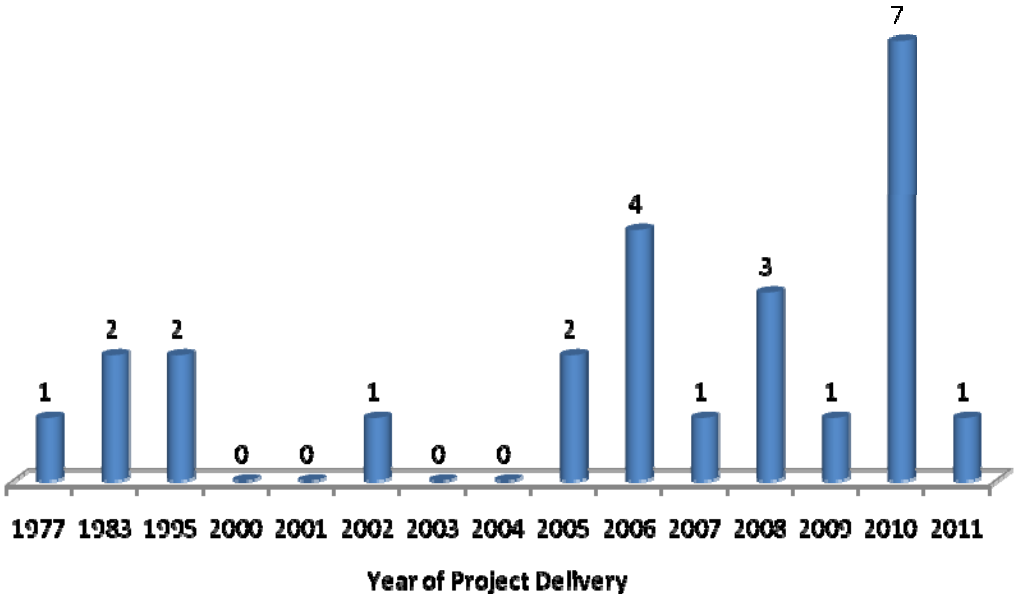

Figure 13. Project Delivery

C. MEASUREMENT INSTRUMENTS

1. Phase 1: Software Project Management Evaluation Instrument

The SPMEI was used for the first phase of the study and is included in Appendix B of this thesis. The SPMEI is scored by using the tables in Appendix C.

2. Phase 2: Metric Feedback Instrument

The second phase of the study used the Metric Feedback Instrument that was specifically developed for this research. The objective of this instrument was to obtain the subject's opinion on the usefulness of the metric. The instrument was created by using the eight attributes of good metrics as published by Brotby (2009). The instrument subjectively measures the manageability, meaningfulness, actionability, ambiguity, reliability, accuracy, timeliness and predictability of the metric. A description of each attribute is printed in Table 18. Each one is subjectively assessed on a scale of one to ten. The participants are also asked to provide their own comments on each attribute of the metric and are queried to see if they would use the PME metric on their next software project. A copy of the instrument is provided in Appendix E.

Table 18. Attributes of Good Metrics (From: Brotby, 2009)

Attribute	Description
Manageability	A metric's information should be available and concise
Meaningful	A metric must be understandable and relevant to the recipient and provide a basis for decisions
Actionable	Useful metrics information makes it clear what response is needed, as a compass makes it clear whether to turn left or right or stay on course
Ambiguity	Information from metrics can have a number of meanings and may be misleading, of little use, or downright dangerous
Reliability	The ability to trust the "instrument" is conditioned on the reliability of the measurement
Accuracy	A reasonable and known degree of a metric's accuracy is essential. The compass showing north when we are going south can be fatal
Timely	Measures that warn of a disaster after it has happened are not useful
Predictive	Some metrics information will signal impending problems much as a drop in oil pressure is the harbinger of engine failure

3. Validity and Reliability

The effectiveness of metric is the extent to which it provides information that meets the previously defined criteria for the recipient. The instrument produces a quantitative score out of 80 on the effectiveness of the metric (not to be confused with the software project management effectiveness). The instrument will also provide qualitative responses on the attributes of the metric. The metric feedback instrument provided a reasonably good and consistent measure of the metric's effectiveness.

D. DATA COLLECTION PROCEDURES

1. Phase 1: Software Project Management Evaluation Instrument

Potential subjects were contacted directly through the previously mentioned networking approach and informed of the study. If they were interested in participating, they were emailed a link to the SPMEI, which was

hosted online by SurveyMonkey. The participant connections to the online SPMEI were protected by VeriSign certificate Version 3 with 128 bit encryption. This provided assurance that participant responses were communicated securely to and from the SurveyMonkey servers.

Risk. Due to the nature of the data obtained from the questionnaire, the risk to the subjects was deemed to be very low. A breach of the subject's confidentiality may result in some embarrassment for the subject.

Consent. It was the investigator's responsibility to obtain informed consent from the subjects before they commenced the survey. A waiver from the requirement to document the informed consent was obtained from the IRB.

Data. The subject's data was retrieved from the SurveyMonkey servers and stored on NPS servers in order to conduct the research analysis. The researchers will ensure that the subject's confidentiality is maintained. No information was made publicly accessible that could identify the participants.

2. Phase 2: Metric Feedback Instrument

After the data was collected from the SPMEI, a metric was produced using the SPMEM for each project. The participant was then provided with a report on their project's PME scores. An example of this report is provided in Appendix F. The report maintains the subject's confidentiality. The instrument was distributed and data was collected in the exact same way as phase 1.

E. DATA ANALYSIS

1. Phase 1: Software Project Management Evaluation Instrument

Before any analysis was conducted, the PME scores for each project in the new data set was calculated and subsequently combined with the PME scores from the existing data set. The subjects recorded a project success rating at the start of the questionnaire and then again at the end. The average project success rating was used for the correlation analysis.

In order to determine the relationship between the PME score and the project success rating, a correlation analysis was conducted. The Pearson product-moment correlation coefficient (PMCC) was used to identify the linear relationship between the two measured variables. This analysis also allowed the researcher to test the hypothesis that the PME score positively correlates to the project success rating.

The calculated PMCC, or r for this sample, will always lie between -1 and 1. The polarity of r indicates the direction of the linear relation. In a positive correlation, when one variable goes up the other variable goes up as well. In a negative correlation, when one variable goes up, the other variable goes down.

The absolute value of r indicates the strength of the linear relationship. The higher the value of r, the stronger the linear relationship between the variables is. When the absolute value of r is 1, this indicates that there is a perfect correlation between the two variables. Perfect relationships are rarely observed in social studies. In social studies, as a rule of thumb, when the absolute value of r is greater than 0.5, then it may be assumed that there is strong correlation between the variables (Demir, 2008). When r is below 0.5, the linear relationship between the variables is weak. A summary of the data analysis is described in Table 19.

Table 19. Will improving a project's PME score increase the project's chance of success?

Research Question	Analysis	Data Collected
What is the relationship between the PME score (measured) and the project success rating (measured)?	Calculated the PME score for the 25 projects. Calculated the PPMC between the PME score and Project Success Rating	25 Project Success Ratings and SPMEI data on 25 projects
What is the relationship between the PME score (measured) and the size of the project (measured)?	Calculated the PPMC between PME score and the size of the project	Obtained data on the size of the project in terms of people involved
What is the relationship between an institution's CMMI level (measured variable) and the PME metric (measured variable)?	Calculated the PPMC between the PPMC between the CMMI level and PME score	Obtained CMMI levels for 9 projects

2. Phase 2: Metric Feedback

The opinion data collected was categorized in terms of research questions and emergent themes. A coding method was used to organize data into a limited number of themes and issues around the questions. Quotations were then selected that illuminated the themes and concepts.

Quantitative data analysis was also performed on the subject scores of the metric attributes. The results of the survey were analyzed using descriptive statistics. The range, mean and standard deviation were obtained for each of the attributes. This statistics were also obtained for the total score for all of the metric attributes.

V. RESULTS

A. PHASE ONE RESULTS

1. Project Success Rating Results

Participants in phase one subjectively reported the success of their project on a scale of 0 to 10 (0 for a complete failure and 10 for a complete success). Figure 14 is a histogram of the rounded project success ratings recorded for the combined data set. The mean rating, for the 25 projects in the combined data set, was 7.2. The mode of the project success ratings was 7. The smallest success rating was 2.5 and the highest was 10. If a score of 5 or above is considered to be a success, then 88% of projects were rated as successful by the participants. Projects with scores of 0, 1 or 2 were not represented in the sample. There were no projects sampled that were cancelled. The external validity of the sample would be increased if the lower range of project success scores was increased in the sample.

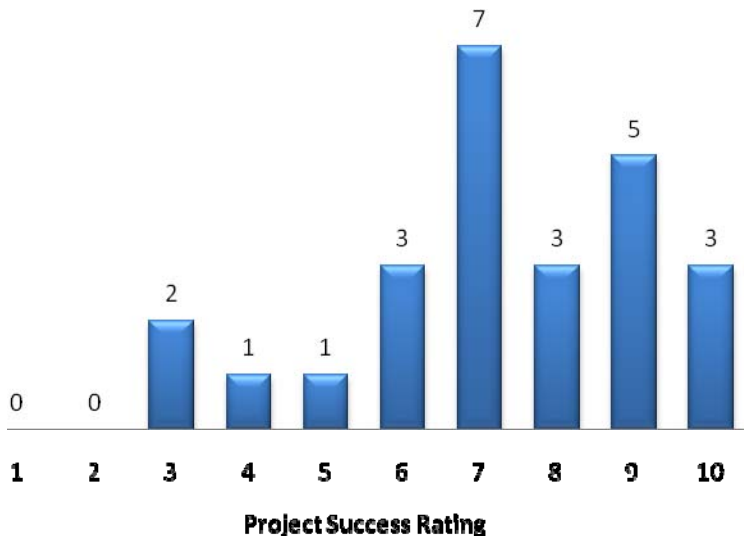

Figure 14. Project Success Rating Histogram

Figure 15 presents the mean performance statistics of the projects (combined data set). On average, the projects delivered 97% of the required functionality, were 31% behind schedule estimated and were 23% over budget. It should be noted that not all projects reported their budget. The complete project statistics are contained in Table 20. In some cases, there were significant cost and schedule overruns; however, the projects were still rated as a success. The project success rating is based on the eye of the beholder. If cost and schedule were not considered a priority, but functionality was crucial to success, then a project can still be rated as successful.

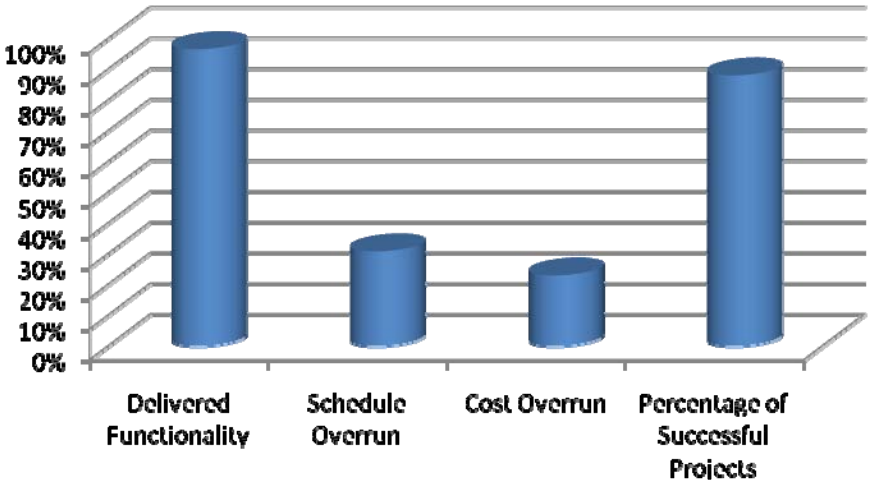

Figure 15. Average Project Performance Statistics

Table 20. General Project Statistics

Project	Delivery Date	Software Category	Duration	KSLOC	Delivered Functionality	Schedule Overrun	Cost Overrun	Project Success Rating
A	2006	Information and Data Management	10	100	100%	43%	50%	6
B	2006	Embedded system	6		95%	0%		9
C	2009	Embedded system	17	100	100%	42%	29%	5
D	2006	Embedded system	4	30	100%	0%	0%	7
E	1995	Supply Chain Management	24		70%	167%		3
F	2008	Customer Service	12		95%	20%		7
G	1983	Command and Control	10	16	70%	0%		8
H	2005	Command and Control	24	10	90%	0%	0%	7
I	1983	Records Management	36		150%	0%		10
J	1977	Internet Utilities and Applications	12		100%	0%	0%	10
K	2008		24	215	100%	0%		9
L	2005	Weapon System	30	440	100%	25%		7
M	2006	Security Applications	7	115	95%	17%		8
N	2002	Weapon System	24		98%	0%	0%	9
O	2007	Security Applications	30		80%	25%		7
P	1995	Scientific Service Delivery	14		100%	17%		9
AA	2008	Command and Control	24		75%	-20%		8
BB	2010	Web Application	44	2000	150%	144%	50%	3.5
CC	2010	Weapon System	29		100%	61%	70%	5.5
DD	2010	Command and Control	28	85	85%	22%		7
EE	2011	Information and Data Management	28		80%	133%		6.5
FF	2010	Entertainment			100%			6
GG	2010	Web Application	12	25	100%	0%	8%	9
HH	2010	Weapon System	11	230	100%	-8%		10

Project	Delivery Date	Software Category	Duration	KSLOC	Delivered Functionality	Schedule Overrun	Cost Overrun	Project Success Rating
II	2010	Web Application	18	20	80%	50%		2.5
Min	1977		4	10	70%	-20%	0%	2.5
max	2011		44	2000	150%	167%	70%	10.0
mode	2010		24	100	100%	0%	0%	7
median			21	100	1	0.17	0.08	7
range	34		40	1990	80%	187%	70%	7.5
mean			20	260	97%	31%	23%	7.2

2. Software Project Management Evaluation Model Results

This section contains various tables showing the sub area scores, main area scores and PME scores for all of the projects in the combined data set. Descriptive statistics are also contained in the tables. Table 22 presents the *People* sub area scores calculated using the SPMEM. Table 23 shows the *Process* sub area scores and Table 24 displays the *Product* sub area scores. Lastly, Table 25 shows the *Risk* sub area scores and Table 26 contains the *PME scores* and *project success rating*.

The People, Process and Product scores all had similar mean scores with 6.6, 6.2 and 6.6 respectively. On average, the Risk area score was measured as the lowest performer with a mean of 5.6. This indicated that the projects in the sample all needed to work on improving their risk management practices. The range of main area scores and the PME score are all close to each other. Two of the projects obtained a score of 10 in different sub areas, indicating that perfect scores are possible. The minimum main area score was the risk area, with 2.5 and the maximum was the product area with a score of 9.7.

The lowest PME score calculated was 3.1, while the highest was 8.8. The mean of the PME scores was 6.3. Figure 16 is a histogram of the rounded PME scores, which has a mode of 6. It is important to highlight that every project in the combined data set with a PME score of 6 or above was successful. In other words, every project with a PME score of 6 or greater had a project success rating of 5 or greater. Table 21 shows the average project success rating for three different brackets of PME scores. It shows a distinct positive increase in success ratings as you move up through the brackets.

Table 21. PME Score Brackets

PME	Average Project Success Rating
>=5 and <6	6
>=6 and <7	7.8
>7	8.5

Table 22. Results of People Area Scores

Project	C	T	L	OC	PM	SI	S	People
A	6.5	6.1	5.9	5.4	7.1	6.8	4.4	**6.0**
B	7.2	7.8	8.4	7.3	7.9	6.6	7.3	**7.5**
C	6.4	6.1	6.2	7.6	5.2	7.7	5.9	**6.4**
D	7.1	7.1	6.6	6.7	8.1	7.7	5.9	**7.0**
E	6.3	7.1	5.0	8.1	6.7	5.7	6.1	**6.4**
F	6.1	6.4	7.9	6.4	7.7	3.4	6.3	**6.3**
G	5.0	5.9	5.9	5.7	6.6	5.4	6.6	**5.9**
H	6.2	5.7	5.9	5.3	6.4	7.2	4.6	**5.9**
I	7.8	8.0	6.9	7.5	9.1	8.9	7.2	**7.9**
J	8.8	7.8	7.9	8.0	8.6	6.8	6.8	**7.8**
K	6.8	6.9	7.4	6.9	7.4	6.0	6.5	**6.8**
L	5.1	5.7	6.6	6.5	6.3	4.2	5.7	**5.7**
M	6.3	7.6	8.1	7.4	7.8	6.3	6.4	**7.1**
N	9.2	7.6	9.1	6.6	9.2	7.5	5.8	**7.9**
O	6.3	6.5	6.3	7.9	8.1	6.5	7.9	**7.1**
P	9.0	9.6	9.1	10.0	9.6	8.3	9.8	**9.4**
AA	7.0	6.4	7.2	6.7	7.5	6.8	7.1	**7.0**
BB	5.7	5.5	7.2	6.0	6.7	3.2	5.7	**5.7**
CC	4.9	6.1	4.3	7.1	6.3	4.4	6.1	**5.6**
DD	7.2	5.6	7.1	6.2	7.0	6.8	6.6	**6.6**
EE	4.4	4.2	5.1	4.4	5.6	4.7	4.6	**4.7**
FF	8.5	8.3	7.9	8.4	8.0	6.3	8.0	**7.9**
GG	6.2	5.7	5.6	5.7	6.9	5.1	5.9	**5.9**
HH	6.6	7.4	6.9	7.1	7.2	6.3	6.7	**6.9**
II	3.0	2.4	2.1	3.5	2.5	5.4	3.1	**3.1**
Min	3.0	2.4	2.1	3.5	2.5	3.2	3.1	**3.1**
Max	9.2	9.6	9.1	10.0	9.6	8.9	9.8	**9.4**
Range	6.3	7.2	7.1	6.5	7.1	5.7	6.7	**6.2**
Mean	6.5	6.5	6.7	6.7	7.2	6.2	6.3	**6.6**
Standard Deviation	1.46	1.44	1.56	1.35	1.46	1.44	1.33	**1.23**
Variation	2.12	2.09	2.44	1.83	2.13	2.07	1.77	**1.50**

Table 23. Results of Process Area Scores

Project	RM	PMC	PPE	SM	PROCESS
A	7.0	7.6	6.4	6.9	**7.0**
B	7.1	5.5	6.8	7.0	**6.6**
C	7.2	6.2	5.6	6.1	**6.3**
D	5.4	6.9	6.7	5.9	**6.2**
E	3.8	5.2	7.1	4.2	**5.1**
F	4.8	6.6	4.9	4.9	**5.3**
G	7.0	7.0	6.3	6.1	**6.6**
H	5.3	5.1	6.2	3.7	**5.1**
I	7.3	7.9	7.9	6.9	**7.5**
J	6.8	7.0	7.4	5.8	**6.7**
K	7.2	6.2	6.6	6.3	**6.6**
L	6.1	5.6	5.2	3.4	**5.1**
M	6.1	6.4	5.9	5.8	**6.0**
N	8.0	8.1	7.3	7.7	**7.8**
O	9.2	5.8	7.1	5.6	**6.9**
P	9.7	8.1	8.7	7.9	**8.6**
AA	5.4	6.6	6.6	5.8	**6.1**
BB	5.1	5.6	5.9	3.1	**4.9**
CC	7.5	6.5	6.7	6.5	**6.8**
DD	5.1	6.4	6.5	5.9	**6.0**
EE	4.4	6.7	5.3	4.9	**5.4**
FF	6.9	6.7	7.2	7.5	**7.1**
GG	6.7	6.6	5.8	5.4	**6.1**
HH	7.1	7.6	6.6	6.9	**7.0**
II	3.8	1.9	2.5	2.1	**2.6**
Min	3.8	1.9	2.5	2.1	**2.6**
Max	9.7	8.1	8.7	7.9	**8.6**
Range	5.9	6.3	6.3	5.8	**6.0**
Mean	6.4	6.4	6.4	5.7	**6.2**
Standard Deviation	1.49	1.27	1.17	1.48	**1.19**
Variation	2.22	1.61	1.38	2.18	**1.41**

Table 24. Results of Product Area Scores

Project	CM	QE	PRODUCT
A	8.7	7.1	**7.9**
B	7.2	6.9	**7.0**
C	4.5	7.8	**6.2**
D	2.2	5.6	**3.9**
E	2.2	7.1	**4.6**
F	4.0	7.2	**5.6**
G	8.2	7.5	**7.8**
H	5.5	5.5	**5.5**
I	8.5	8.1	**8.3**
J	5.5	8.4	**6.9**
K	8.7	6.9	**7.8**
L	8.0	6.2	**7.1**
M	5.0	5.4	**5.2**
N	7.2	7.3	**7.2**
O	8.2	6.8	**7.5**
P	9.3	9.7	**9.5**
AA	4.5	7.1	**5.8**
BB	9.5	6.3	**7.9**
CC	10.0	9.5	**9.7**
DD	4.0	3.5	**3.8**
EE	5.2	4.7	**4.9**
FF	5.7	7.6	**6.7**
GG	8.7	7.2	**7.9**
HH	7.8	5.7	**6.8**
II	7.2	1.8	**4.5**
Min	2.2	1.8	**3.8**
Max	10.0	9.7	**9.7**
Range	7.8	7.8	**6.0**
Mean	6.6	6.7	**6.6**
Standard Deviation	2.26	1.69	**1.61**
Variation	5.12	2.87	**2.60**

Table 25. Results of Risk Area Scores

Project	RA	RC	RISK
A	6.4	6.3	**6.3**
B	5.6	5.9	**5.8**
C	5.5	4.4	**5.0**
D	5.5	5.7	**5.6**
E	3.7	3.7	**3.7**
F	5.6	5.4	**5.5**
G	6.8	5.9	**6.4**
H	5.0	6.3	**5.7**
I	7.6	8.1	**7.9**
J	4.9	6.1	**5.5**
K	6.4	4.6	**5.5**
L	3.8	3.7	**3.7**
M	6.2	5.0	**5.6**
N	8.1	8.0	**8.0**
O	6.2	5.0	**5.6**
P	8.5	5.6	**7.0**
AA	5.6	6.1	**5.9**
BB	2.6	5.2	**3.9**
CC	6.0	6.1	**6.1**
DD	4.8	6.1	**5.5**
EE	6.1	5.7	**5.9**
FF	6.3	6.7	**6.5**
GG	4.9	4.4	**4.7**
HH	6.0	6.5	**6.3**
II	2.8	2.2	**2.5**
Min	2.6	2.2	**2.5**
Max	8.5	8.1	**8.0**
Range	5.9	5.9	**5.5**
Mean	5.6	5.6	**5.6**
Standard Deviation	1.43	1.28	**1.24**
Variation	2.04	1.64	**1.53**

Table 26. Main Area Scores and PME scores

Project	PEOPLE	PROCESS	PRODUCT	RISK	PME	Success Rating
A	6.0	7.0	7.9	6.3	**6.7**	**6.0**
B	7.5	6.6	7.0	5.8	**6.8**	**9.0**
C	6.4	6.3	6.2	5.0	**6.1**	**5.0**
D	7.0	6.2	3.9	5.6	**5.9**	**7.0**
E	6.4	5.1	4.6	3.7	**5.2**	**3.0**
F	6.3	5.3	5.6	5.5	**5.7**	**7.0**
G	5.9	6.6	7.8	6.4	**6.6**	**8.0**
H	5.9	5.1	5.5	5.7	**5.5**	**7.0**
I	7.9	7.5	8.3	7.9	**7.9**	**10.0**
J	7.8	6.7	6.9	5.5	**6.9**	**10.0**
K	6.8	6.6	7.8	5.5	**6.7**	**9.0**
L	5.7	5.1	7.1	3.7	**5.5**	**7.0**
M	7.1	6.0	5.2	5.6	**6.1**	**8.0**
N	7.9	7.8	7.2	8.0	**7.8**	**9.0**
O	7.1	6.9	7.5	5.6	**6.9**	**7.0**
P	9.4	8.6	9.5	7.0	**8.8**	**9.0**
AA	7.0	6.1	5.8	5.9	**6.3**	**8.0**
BB	5.7	4.9	7.9	3.9	**5.6**	**3.5**
CC	5.6	6.8	9.7	6.1	**6.9**	**5.5**
DD	6.6	6.0	3.8	5.5	**5.7**	**7.0**
EE	4.7	5.4	4.9	5.9	**5.2**	**6.5**
FF	7.9	7.1	6.7	6.5	**7.2**	**6.0**
GG	5.9	6.1	7.9	4.7	**6.2**	**9.0**
HH	6.9	7.0	6.8	6.3	**6.8**	**10.0**
II	3.1	2.6	4.5	2.5	**3.1**	**2.5**
Min	3.1	2.6	3.8	2.5	**3.1**	**2.5**
Max	9.4	8.6	9.7	8.0	**8.8**	**10.0**
Range	6.2	6.0	6.0	5.5	**5.6**	**7.5**
Mean	6.6	6.2	6.6	5.6	**6.3**	**7.2**
Standard Deviation	1.23	1.19	1.61	1.24	**1.09**	**2.11**
Variation	1.50	1.41	2.60	1.53	**1.19**	**4.43**

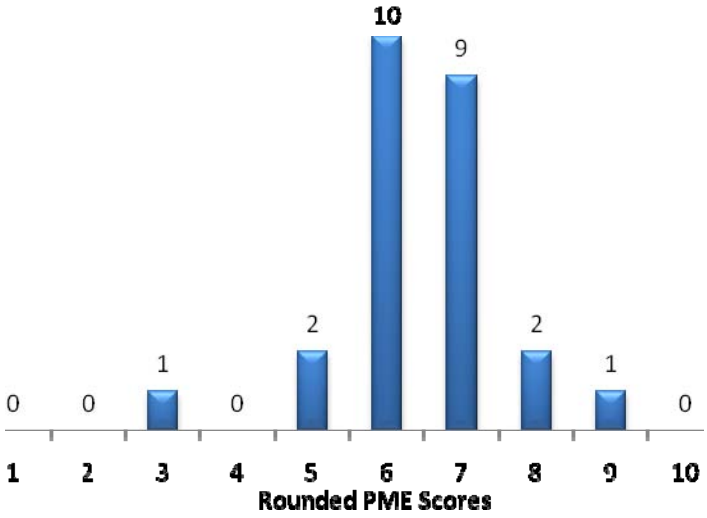

Figure 16. Rounded PME Scores Histogram

3. PME Score and Project Success Rating Relationship

Figure 17 shows a plot of the project success rating and the PME score (sorted by the lowest success rating to the highest). At a glance, it would seem that the higher the project success rating the higher the PME score. An interesting phenomenon appears to be present as well. When the project success rating is 6 or below, the PME score is greater than the success rating. When the project success rating is above 6, the scores invert and the PME score is less than the success rating. It is difficult to make assertions about this trend with the current sample size.

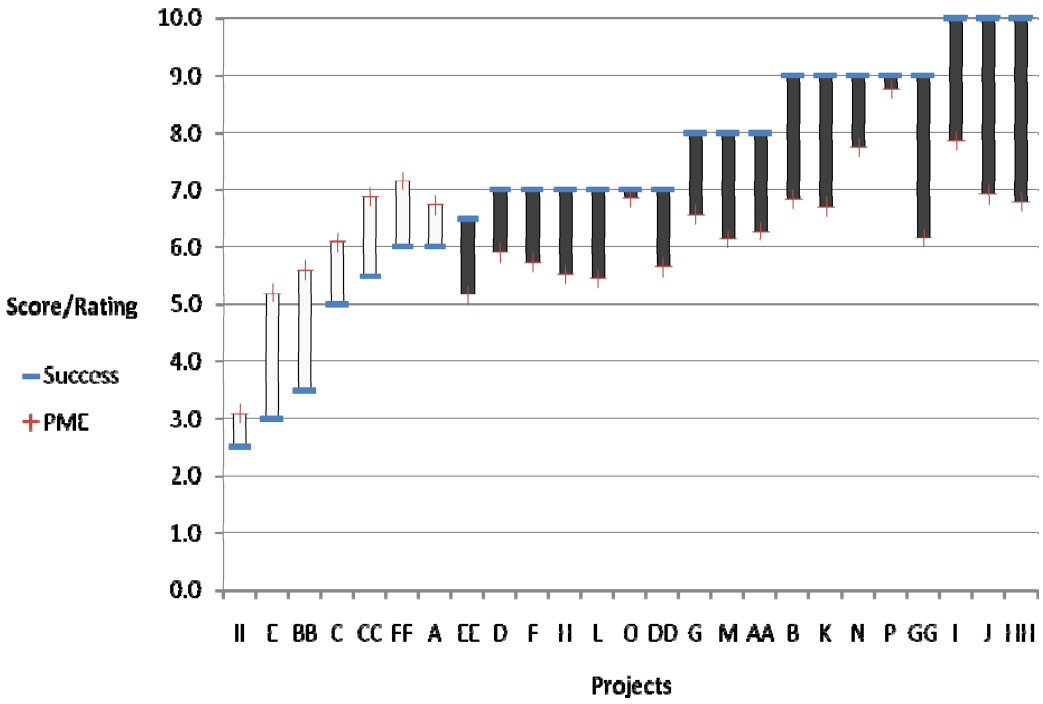

Figure 17. PME Score and Project Success Rating (lowest success to highest)

a. Hypothesis Testing

The results of the PMCC analysis are contained in Tables 27 and 28. The project success rating was graphed against the PME score in Figure 18. A quick look at this plot shows the likely existence of linear relationship between the PME score and the project success rating. The correlation between these two variables was found to be 0.68, which confirms the hypothesis: The success of a software project positively correlates to its software project management effectiveness metric score.

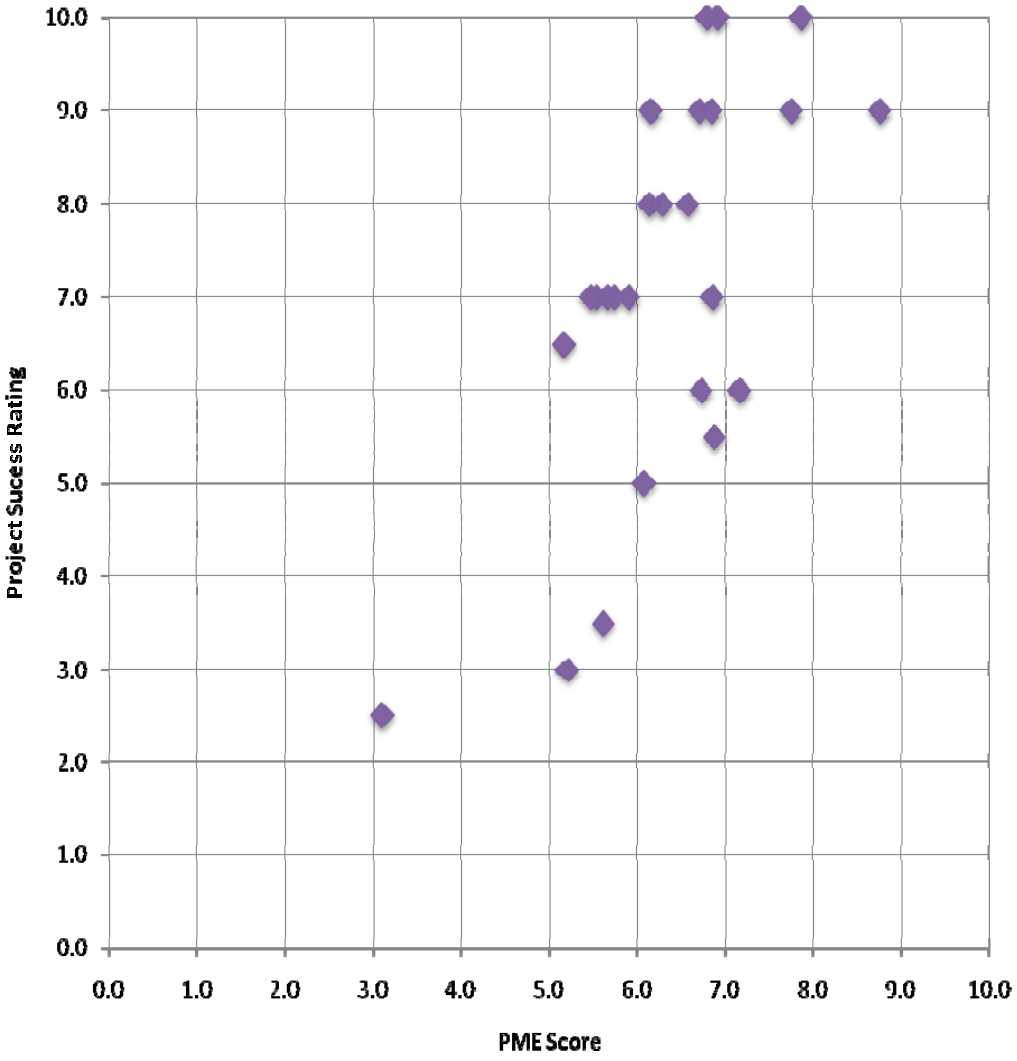

Figure 18. PME Score vs. Project Success Rating

Table 27. PMCC Between Sub Area Scores

	C	T	L	OC	PM	SI	S	RM	PMC	PPE	SM	CM	QE	RA	RC
C	*	0.86	0.82	0.71	0.86	0.64	0.66	0.53	0.67	0.81	0.72	-0.09	0.52	0.56	0.62
T		*	0.80	0.89	0.89	0.51	0.81	0.62	0.68	0.87	0.75	0.02	0.68	0.62	0.53
L			*	0.62	0.84	0.31	0.67	0.47	0.64	0.63	0.60	-0.03	0.43	0.50	0.53
OC				*	0.70	0.40	0.87	0.60	0.47	0.78	0.58	-0.01	0.70	0.43	0.23
PM					*	0.45	0.74	0.59	0.77	0.86	0.71	0.06	0.60	0.66	0.68
SI						*	0.35	0.45	0.37	0.57	0.57	-0.14	0.18	0.57	0.45
S							*	0.65	0.53	0.76	0.64	0.12	0.61	0.53	0.33
RM								*	0.56	0.63	0.72	0.58	0.65	0.71	0.39
PMC									*	0.74	0.80	0.13	0.62	0.77	0.76
PPE										*	0.74	0.10	0.70	0.64	0.65
SM											*	0.16	0.58	0.86	0.69
CM												*	0.31	0.22	0.10
QE													*	0.53	0.39
RA														*	0.67
RC															*

Table 28. PMCC Results for Main Area Scores, PME Score, Success Rating, CMMI and Staff Size

	PEOPLE	PROCESS	PRODUCT	RISK	PME	Success	CMMI	Staff Size
C	0.93	0.77	0.21	0.65	0.78	0.58	0.37	0.17
T	0.96	0.82	0.37	0.63	0.85	0.58	0.66	0.22
L	0.85	0.66	0.21	0.57	0.70	0.62	0.38	0.03
OC	0.86	0.69	0.36	0.37	0.72	0.33	0.56	0.15
PM	0.92	0.82	0.36	0.73	0.85	0.69	0.47	0.28
SI	0.61	0.56	-0.01	0.56	0.51	0.43	-0.14	0.37
S	0.85	0.73	0.41	0.48	0.76	0.50	0.43	0.16
RM	0.65	0.84	0.75	0.61	0.86	0.55	0.67	0.15
PMC	0.69	0.87	0.42	0.84	0.82	0.66	0.53	0.23
PPE	0.88	0.87	0.44	0.70	0.87	0.53	0.46	0.27
SM	0.76	0.93	0.42	0.85	0.87	0.62	0.54	0.14
CM	-0.02	0.29	0.87	0.18	0.38	0.21	0.35	0.18
QE	0.62	0.72	0.75	0.51	0.78	0.35	0.47	0.20
RA	0.65	0.85	0.43	0.92	0.82	0.64	0.47	0.27
RC	0.57	0.70	0.27	0.90	0.69	0.58	0.48	0.41
PEOPLE	*	0.84	0.31	0.67	0.86	0.63	0.46	0.23
PROCESS		*	0.58	0.85	0.97	0.67	0.60	0.22
PRODUCT			*	0.39	0.68	0.33	0.49	0.23
RISK				*	0.83	0.67	0.51	0.37
PME					*	0.68	0.62	0.29

4. PME Score and Project Size Relationship

The correlation, r, between the PME score and the average project staff size was 0.29. This indicates that there is not a linear relationship between the two variables. This inference can also be obtained from observing the plot in Figure 19. The graph in Figure 19 excludes the project that contained an average of 300 project staff in order to focus on the more concentrated data cluster.

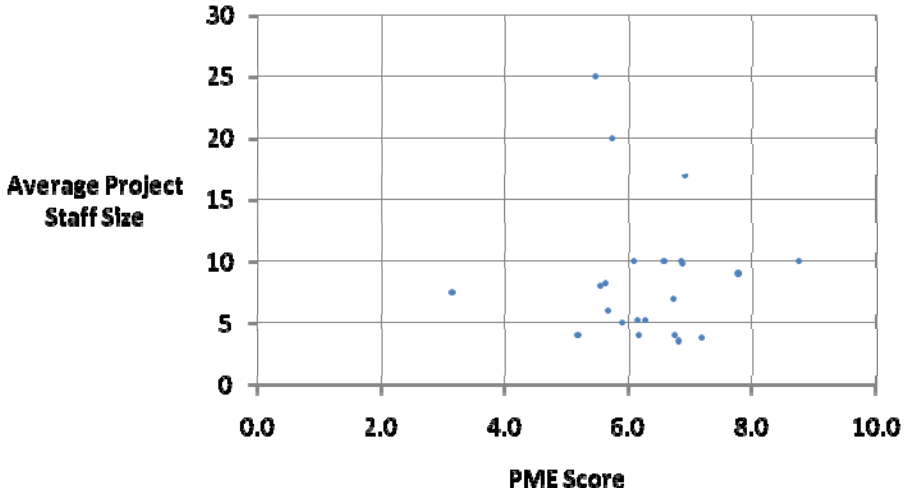

Figure 19. PME Score vs. Average Project Staff Size

5. PME Score and CMMI Level Relationship

The correlation, r, between the PME score and a project's CMMI level was 0.62. This indicated that there is a possible linear relationship between the two variables. This result is also visually represented in Figure 20. This sample size only contained nine projects, which makes it harder to draw solid conclusions about this relationship.

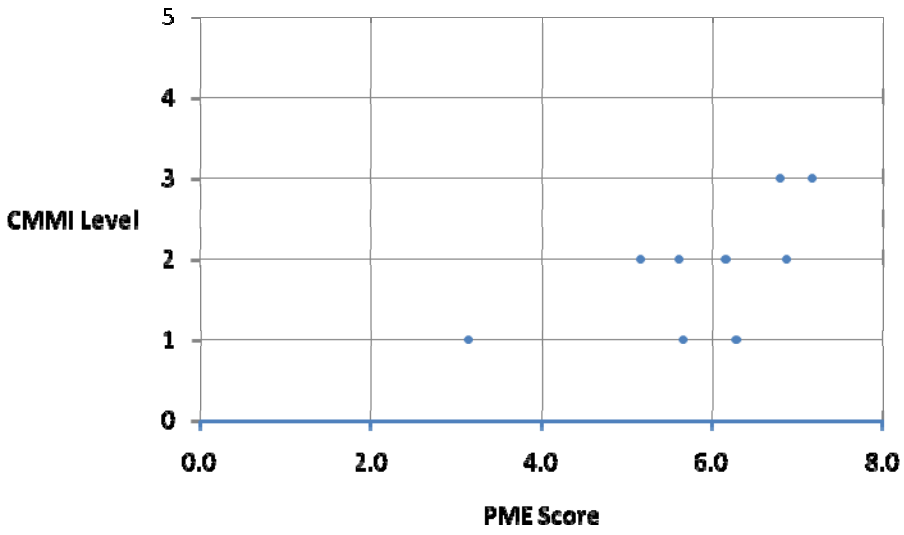

Figure 20. PME Score vs. Project CMMI Level

6. Other Correlation Analysis Results

The correlation between the main area scores and the PME scores were all strong. The correlation between the process area score and the PME score in particular needs to be highlighted, as it is incredibly strong (r=0.97). This means that it could be possible to predict the PME score based on the process area score alone. This does not indicate that only achieving a high process score alone will give a high PME score because people, product and risk all contribute to the score.

The correlation between the product score and the project success rating was 0.33. The other three main areas all had strong correlations with project success (r=~0.65).

The configuration management score had a poor correlation with success at 0.21 and quality engineering was similar at 0.35. Organizational commitment had one of the lowest correlations with success (r=0.33). The project manager score had the highest correlation with the project success rating (r=0.69). Risk assessment and project

monitoring and control also had high correlations with success (r=0.64 and 0.66 respectively). Improving these scores would suggest an increased likelihood of success.

B. PHASE 2 RESULTS

The participants in phase one were all provided with their respective PME scores. After reviewing their PME scores, eight of the original participants provided feedback, using the Metric Feedback Instrument. The quantitative results are displayed in Table 29 and the qualitative responses can be examined in Appendix G. The average effectiveness score of the metric was found to be 59 out of 80 (SD=11.9). The individual scores for each response are presented graphically in Figure 21.

1. Manageable

For manageability, the metric scored a mean of 7. But due to the large range, 6, it would appear that opinions were quite divided over the manageability of the metric. The lowest score was 4 and highest was 10. No comments were provided by the participants on the metric's manageability.

2. Meaningful

The metric scored high for its meaningfulness (M=7, SD=1.7). It could be said that opinions were quite consistent over the meaningfulness of the metric. Opinions were generally positive, as echoed by one participant, "The survey seemed to translate well into scores I could relate to." Another said, "It clearly defines the areas of good performance and the areas of concern." However, another subject quoted, "The metric is meaningless without other data to support it." This was interpreted to mean that the score alone is not helpful but, with supporting data such as the average PME scores, average sub area scores and average project success ratings, the metric could have more meaning.

3. Actionable

The metric was considered actionable by participants (M=7, SD=1.7). The low variability in this score also indicates a strong consensus. It was noted by a subject that the areas where improvement was required was clear; however, it was hard to prioritize which area to target first. The subject stated, “Realistically, I am not going to be able to address each of the low scoring areas simultaneously, so if I have to pick an area of improvement, I want to pick the one that is going to give me the best chance of improving my project success and that may not be the one with the lowest score.” Another subject asserted that when an area is performing poorly, by a large gap, compared to others it provides clear insight for improvement initiatives but in other cases it will be less clear what action to take. The metric does not currently provide specific data on questions in the SPMEI but one respondent provided an excellent idea: “In order to begin self improvement it would be good to see a breakdown of key techniques in each (sub) area and how you scored on each. That way you could begin focusing of (specific) techniques you were lacking in.”

4. Ambiguity

For ambiguity, the metric scored an average of 7 (SD=1.8). It was reported, by one participant, that the scores did not tell if they had done well or not. On a positive note, the sub areas satisfied another respondent, who commented that they created clear boundaries and that the sub area descriptions were simple to understand.

5. Reliability

It was pointed out by a subject that the reliability of the metric is inherently related to the reliability of the source. In other words, the respondent must have a thorough knowledge of the project management practices in place for the metric result to be reliable. One of the assumptions of using the tool is that it should be used by a person who has extensive knowledge on all areas of the project. The reliability score had a mean of 7 with a range of 4.

6. Accuracy

The metric was considered to be accurate by the subjects (M=7, SD=1.6). One respondent found the metric to be very accurate and said that it reflected the weak and strong areas he instinctively felt the project had. The accuracy scores were the most consistent across all of the responses, shortly followed by reliability.

7. Timely

As a timely metric, the PME score was rated similarly to reliability (M=7, S=1.8). It was pointed out by a subject that if the PME score was produced after the initial requirements phase, then it would help the project manager grasp what type of project management activities still need to be carried out. This confirmed an original assumption that the measurement activity should be conducted after the initial requirements phase of the project.

8. Predictability

The metric was considered to have weaker predictive attributes by the subjects (M=6, SD=2.1). One participant commented that some of the sub area scores could be used in a predictive way, such as the stakeholder involvement score; however, other sub areas were considered less predictive (i.e., teamwork). Another participant stated that they would not use the instrument as a predictive tool.

Five out of six participants said they would use the metric on the next project they worked on. Although not seen as a particularly predictive metric, the majority of respondents found the metric useful. It was generally seen to be helpful in identifying strength and weaknesses. The low performing sub-project management areas could be selected for improvement action. It was also generally agreed that the measurement could be used to monitor the evolution of the software project management practices over time. On the negative side, the questions in the SPMEI were considered open to interpretation in certain areas.

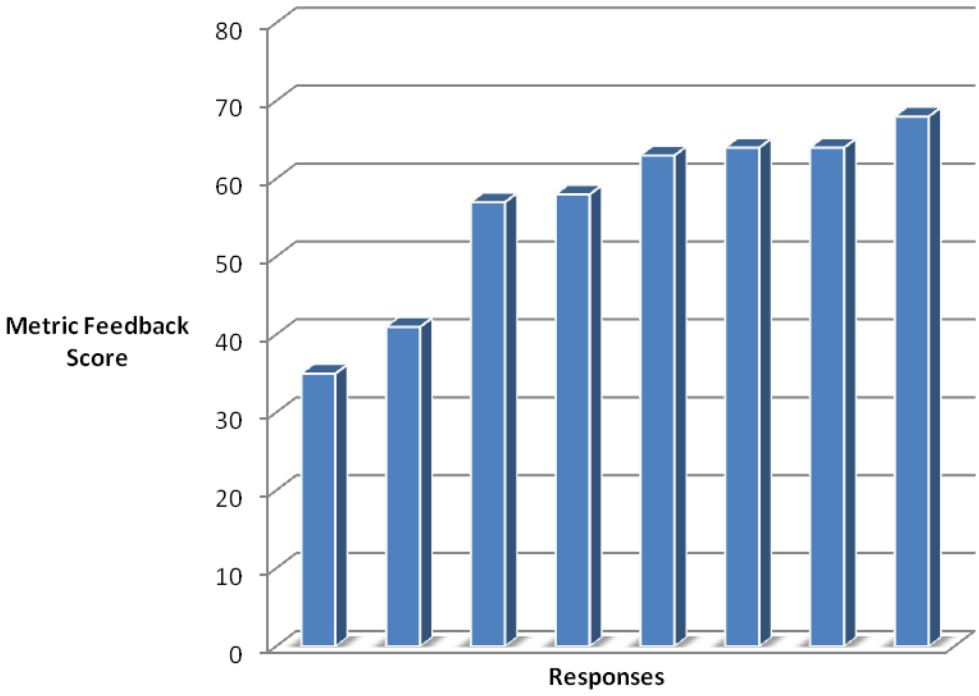

Figure 21. Metric Feedback Scores for Each Participant

Table 29. Metric Feedback Quantitative Results

	Manageable	Meaningful	Actionable	Ambiguity	Reliability	Accuracy	Timely	Predictive	Yes/No	Score	Score(%)
Participant 1	9	7	7	7	9	6	7	6	Yes	58	73%
Participant 2	9	7	7	6	7	6	8	7	No	57	71%
Participant 3	7	8	8	8	8	7	9	9	Yes	64	80%
Participant 4	4	7	6	3	5	7	5	4	Yes	41	51%
Participant 5	8	8	8	8	8	8	8	8	Yes	64	80%
Participant 6	10	8	7	8	9	9	9	8	Yes	68	85%
Participant 7	4	4	3	8	5	4	4	3	No	35	44%
Participant 8	8	10	8	8	8	8	8	5	Yes	63	79%
Min	4	4	3	3	5	4	4	3		35	0.4375
Max	10	10	8	8	9	9	9	9		68	0.85
Range	6	6	5	5	4	5	5	6		33	0.4125
Mean	7	7	7	7	7	7	7	6	75%	56	70%
Std Dev	2.26	1.68	1.66	1.77	1.59	1.55	1.83	2.12	0.46	11.90	0.14

VI. DISCUSSION AND CONCLUSION

With the complexity of software projects increasing every year, project managers need new tools to tackle these new system developments. A tool that measures the effectiveness of software project management could be used to identify the management strengths and weaknesses and allow projects to make improvements to their practices in order to increase their likelihood of success. One tool that does this is the Software Project Management Effectiveness Metric.

The purpose of this study was to measure the software project management effectiveness of recent software projects, using the software project management effectiveness metric, and obtain the opinions of practicing software professionals on the applicability and usefulness of the metric.

Nine software projects were measured using the software project management evaluation instrument and a PME metric report was produced for each. A correlation analysis was conducted on the measured variables, PME score and Project Success Rating, combined with those from previous research. Six of the projects in the study reviewed their respective PME score and then completed a further survey that sought data on the practicality and applicability of the metric.

A. DISCUSSION

An important finding that needs to be highlighted is the relationship between the PME metric and the average staff size of a project. The correlation of this relationship was very low at 0.29. This shows that the metric does not favor projects of any particular size. This indicates that the PME can be used on any project size. However, a project manager should be most comfortable using the metric on projects with a staff size of at least four. This is because a more formal project management approach is typically used and required when project teams approach four or more. When the project staff size is below four it is

assumed that many project management practices in the framework would be unnecessary because the system development complexity would be less. For instance, a three-man web development effort may be a small business with no project manager, quality department or organizational hierarchy. It is recommended that the metric be used on projects with a staff size of four (or more) when a formal project management approach is required and in place.

Some noteworthy results were discovered about specific project management areas and practices. Firstly, the project manager sub area had the highest correlation (r= 0.69) with project success out of every single score. This corroborates well with Verner and Evanco's pronouncement that an above-average project manager was positively associated with project success (Verner & Evanco, 2005). Secondly, the risk management main area was positively correlated with project success (r=0.67). In a similar way, Verner and Evanco surmised that managing risks throughout the project was significantly associated with project success. But ironically, risk management was the least practiced project management discipline (Verner & Evanco, 2005). This was also found to be the case in this research. The average risk management score was 5.6 (approximately one point below the other main area scores). Projects found to be deficient in these areas should concentrate their improvements efforts here.

The relationship between the PME score and the project success rating was identified as having a strong positive correlation (r=0.68). The correlation found in this study's combined data set was exactly the same as the correlation calculated in Demir's study. It was not expected to be the exact same value but the r value found in this study was expected to be above 0.5. This study has independently verified the strong correlation between these two variables as reported by Demir.

The SPMEI itself was generally seen by participants to have a noticeable portion of ambiguous questions. One subject reported, "The (SPMEI) questions need to be less open to interpretation" and another said, "Reduce scope to questions that could be answered objectively." It was suggested that some

examples integrated into the questions would remove the ambiguity. A good example of this type of ambiguity is present in one of the risk control questions, when the subject is asked if the risks are managed as they occur. A risk is a future event that may or may not occur. If a risk occurs, it is a problem impacting on the projects objectives. This type of question can be confusing. The SPMEI should be reviewed for ambiguity.

This is the first study where the metric scores were provided to the participants and they were asked for their feedback on the practicality of the metric. It was found that 75% of respondents would use the metric on the next project they worked on. More research needs to be completed in order for the tool to be used a predictive measure. With more data, the metric can be studied to identify its predictive attributes.

B. LIMITATIONS

The external validity of the study is a weakness due to the small sample size. It was difficult to find participants to complete the SPMEI surveys even if they indicated interest during initial communications. Out of all the people contacted through the networking approach, there was a 53% SPMEI response rate. However, the combined data set of 25 projects now represents the largest sample size for the software project management effectiveness measurement tools covered in the literature review.

Due to vast size of the software industry, it is fair to assume that the sample is not a fair representation of the software project population around the globe. At the same time, it is not possible to identify what a representative sample would be, due to the lack of published data about the software development industry.

The correlation analysis depends on the accuracy of the PME score and the project success ratings. The project success rating is a purely subjective score. Subjects were asked at the start of the SPMEI to provide a rating, and

again at the end. In 66% of responses, the rating given at the end of the survey differed from the rating given at the start of the survey. This is an indication of how subjective the rating is and obviously the correlation analysis is affected by the subjective nature of the success rating. If this research was to be conducted again, it would be beneficial to have multiple opinions on the success rating of the project and then the mean could be used for correlation analysis. Another way could be to provide more objective criteria for project success ratings.

Many participants skipped the essay-type questions posed in the metric feedback instrument. Additionally, many of the essay-type answers were difficult to interpret. If the feedback instrument was to be used again, a post-survey interview should be conducted to ask questions that respondents skipped and to clarify their answers.

C. RECOMMENDATIONS FOR FUTURE RESEARCH

The SPMEI sample size could still benefit from substantial growth. While building numbers is important, it is more critical for future research using the metric to concentrate on unsuccessful projects and projects with medium to large staff size. Sampling these types of projects will fill a visible gap in the current sample and provide new insights to the lower end of the success spectrum.

The SPMEI was not changed at all for this study. As mentioned previously, the SPMEI suffers from a degree of ambiguity in its questions. The SPMEI would benefit from a revision of the questions to decrease ambiguity. Additionally, the SPMEM score weightings for individual questions could be revised based on a correlation analysis of responses and the success ratings. This research could be conducted in a similar way to Ivan and Evanco's study described in Chapter II.

The subjectivity of the SPMEI has still not been quantitatively analyzed. This has reliability and accuracy implications for the SPME metric. To garner

information on the subjectivity of the SPMEI, a study should be conducted where at least two personnel complete the SPMEI and a comparison of the results is made.

The manageability of the SPMEI and SPMEM was a concern. In order to make the metric more manageable, the SPMEI can be broken down into its sub areas or main areas and distributed to different personnel on the project. The results can be combined and a PME score can then be produced. To test the applicability of this approach, one measurement can be obtained from multiple participants and another measurement can be made using a separate single participant. The two PME scores can be compared for accuracy. Splitting the SPMEI up into sub areas for completion shares the burden of completing the survey among the project team members. Such an approach may require some redesign of the SPMEI and SPMEM as it was originally intended to be completed by one person only.

D. CONCLUSION

The present study illuminated some salient findings within the area of software project management effectiveness measurement. First, all the projects that scored a software project management effectiveness metric score of 6 or greater in this study were rated as a success. Out of the 22 successful projects in the study, 72% had a PME score of 6 or above. It was verified that the PME score had a strong positive correlation with the project success rating. From these results, it can be concluded that effective project management is a determinant in the success of the software projects. If a project has a PME score of six or greater, then they are on the right path to improving their probability of project success.

Second, it was revealed by a correlation analysis that the metric can be projects with a wide range of staff sizes. Although it is recommended that projects have at least four members before applying the measurement, it is still a great tool for other relatively small projects who do not wish to invest the time

and effort in getting a CMMI appraisal. The metric can be used as a much more lightweight tool to improve project management practices. On the other hand, it could also assist with preparing for a CMMI appraisal as well.

Lastly, probably the most important conclusion is that the currently practicing software professionals who took part in this study were exceedingly interested in using the metric on their next project. Seventy-five percent of respondents said they wanted to use the metric. It can safely be assumed that this tool needs to be put into practice immediately and, based on the results, project managers should be aiming to achieve a PME score of at least six as soon as practical. The practitioner feedback has helped to further substantiate the accuracy and usefulness of the SPME metric.

Software project management is a relatively new discipline, having only emerged in the latter half of the last century. A new discipline requires new tools. Like any metric, the software project management effectiveness metric should not be the one and only metric used on a project. But project managers should at least consider putting it in their tool kit. A metric that measures the effectiveness of software project management can be used to evaluate, monitor and improve the project management practices. This metric can clearly be used to identify the strengths and weaknesses of current project management practices and produce meaningful quantitative results. The metric shows the most promise as a post-mortem tool. Post-mortem reviews are important for process improvement, but projects seldom perform them. As a result, they tend to repeat the same mistakes project after project. This metric could be the awakening that some software project managers need, and a gateway to more success.

APPENDIX A. GLOSSARY

Term	Description
Communication	It is the exchange of ideas, opinions and information through written or spoken words, symbols or actions.
Configuration Management	A discipline applying technical and administrative direction and surveillance to (1) identify and document the functional and physical characteristics of a configuration item, (2) control changes to those characteristics, (3) record and report change processing and implementation status, and (4) verify compliance with specified requirements.
Leadership	The ability to lead, including inspiring others in a shared vision. Leaders have clear visions and they communicate these visions to their employees. They foster an environment within their companies that encourages risk taking, recognition and rewards, and empowerment allowing other leaders to emerge.
Organizational Commitment	Organizational commitment is the employee's psychological attachment to the organization and organizational goals.
PME Metric	Refer to Software Project Management Metric
Process	A sequence of steps performed for a given purpose; for example the software development process.
Project Monitoring & Control	Project monitoring is the process of keeping the project and project related factors under observation. Project control is to ensure that project goes according to what is planned and deviations from the plan kept under control.
Project Planning/Estimation	Project planning is the process to quantify the amount of time and budget a project will cost. The purpose of project planning is creating a project plan that a project manager can use to track the progress of his team. Estimation includes creating estimates of project cost and schedule using various tools and techniques.
Quality Engineering	In engineering, quality control and quality engineering are involved in developing systems to ensure products or services are designed and

	produced to meet or exceed customer requirements. It involves all activities and commitment towards development of a high quality product to meet or increase the customer/user satisfaction.
Requirements Management	The management of all requirements received by or generated by the project, including both technical and nontechnical requirements as well as those requirements levied on the project by the organization.
Risk Assessment	A process or a set of activities that involves measurement of risks to determine priorities and to enable identification of appropriate level of risk treatment.
Risk Control	That part of risk management which involves the implementation of policies, standards, procedures and physical changes to eliminate or minimize adverse risks.
Scope Management	Scope management is the process of keeping track of scope changes and limiting the changes to the point that they are not disruptive to the success of the project.
Software Project Management Effectiveness Metric	This metric is a measure of the project management effectiveness in a software project. It captures the effectiveness of the project management from the start of the project to the point in time of the measurement.
Staffing & Hiring	Staffing is the practice of finding, evaluating, and establishing a working relationship with future colleagues on a project and firing them when they are no longer needed. Staffing involves finding people, who may be hired or already working for the company (organization) or may be working for competing companies.
Stakeholder Involvement	Stakeholder involvement is the early and extensive engagement of stakeholders in the process of planning, decision making, and implementation of a project.
Supplementary Activities	Supplementary activities are activities conducted which are not directly related to the project outcome. However, these activities indirectly increase the success probability of the project. Such activities include use of project management, development, testing and other types of tools, training of the personnel, logistics,

	increasing the satisfaction of the work environment etc.
Teamwork	Teamwork is the concept of people working together towards a common goal set as a team.
Technical Complexity	Technical complexity refers to the complexity of the design, product, project deliverables and technologies used in the development of the product.

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APPENDIX B. SPMEI

Consent to Participate in Research

Introduction. You are invited to participate in a research study entitled "The Effectiveness of Software Project Management Practices" being conducted by the Naval Postgraduate School.

Procedures. The goal of this study is to gather information on software project management practices. You will be asked to fill out a questionnaire which will take approximately 90 minutes depending on the participant. The questionnaire is only related to the research and serves no purpose other than this research endeavor.

Voluntary Nature of the Study. Your participation in this study is strictly voluntary. If you choose to participate you can change your mind at any time and withdraw from the study. You will not be penalized in any way or lose any benefits to which you would otherwise be entitled if you choose not to participate in this study or to withdraw.

Potential Risks and Discomforts. The potential risks of participating in this study are:

a) A breach of confidentiality may result in embarrassment of the research subject.

Anticipated Benefits. Anticipated benefits from this study are:

a) To assist in the development of project management metrics and improve the software engineering body of knowledge to improve software project management; and
b) To enable the development of a tool for you to monitor, evaluate and improve your projects.

Compensation for Participation. No tangible compensation will be given. A copy of the research results will be available at the conclusion of the experiment.

Confidentiality & Privacy Act. Any information that is obtained during this study will be kept confidential to the full extent permitted by law. All efforts, within reason, will be made to keep your personal information in your research record confidential but total confidentiality cannot be guaranteed. No information will be publicly accessible which could identify you as a participant. Research records will be stored and maintained in electronic form on NPS secure servers only accessible by

the researchers. Any hard copy material containing research findings, including a thesis, will not contain any personal information.

Points of Contact. If you have any questions or comments about the research, or you experience an injury or have questions about any discomforts that you experience while taking part in this study please contact the Principal Investigator, Dr John Osmundson, 831-656-3775, josmundson@nps.edu. Questions about your rights as a research subject or any other concerns may be addressed to the Naval Postgraduate School IRB Chair, CAPT John Schmidt, USN, 831-656-3864, jkschmid@nps.edu.

Statement of Consent. I have read the information provided above. I have been given the opportunity to ask questions and all the questions have been answered to my satisfaction. I have been provided a copy of this form for my records and I agree to participate in this study. I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

Dear Fellow Colleagues,

I sincerely appreciate you taking time to participate in this study. This study is conducted as part of my postgraduate thesis research at the Naval Postgraduate School. My colleagues and I are testing the applicability of a software project management self-evaluation instrument (put simply, a questionnaire). We would like you to apply the instrument on a software project you have worked on. Your participation will be completely anonymous.

How we plan to use your responses
The anticipated benefits of this study are:

a) to assist in the development of project management metrics; and
b) to identify practices which increase the chances of project success; and
c) to assist in the development of a tool for managers to monitor, evaluate and improve their projects.

The only requirements for your participation are the following

a) you have worked on a software intensive development project in the past; or
b) you are currently working on a software intensive development project that has completed the initial requirements/inception/conceptual phase; and
c) you have a broad knowledge of the project management practices in place on your project.

What personal information will be collected:
The questionnaire investigates what happened during a particular project development. This is NOT an evaluation of the project manager, the management team, or any other person. This instrument is not designed for that purpose. Any inference derived for such a purpose will definitely be incorrect and misleading. This is NOT an evaluation of the organization. It focuses on the project only.

How your response will be handled
This study will be conducted with discretion and the highest regard for your confidentiality. In the final published research results it will not be possible to trace the results back to a particular person, organization, or any entity. Your response will only be identified as an identification code on all data collection forms.

Your identification code is: XXX
Please find the questionnaire attached. If you have questions about the study or the research, please do not hesitate to contact me.

Yours Sincerely,

Christopher Cullen
Flight Lieutenant
Computer Science Department
Naval Postgraduate School
Monterey CA 93943

Tel: 1-831-917-5255
Fax: 1-831-333-9277

Email: ccullen@nps.edu

DIRECTIONS FOR FILLING OUT THE QUESTIONNAIRE

- ✓ There are 16 sections in the questionnaire. It takes approximately 90 minutes to complete, depending on the participant. The questionnaire examines from the start of the project until it is delivered to the customer for the first time (or it is cancelled).

- ✓ Choose a project you have worked on and have extensive knowledge. *The project you choose does not have to be a complete success – it may have had moderate success, poor success or could even have been cancelled. We are interested in analysing the entire spectrum of software projects.*

- ✓ You may respond to the questionnaire sections in any order you like and you do not have to complete the survey in one sitting.

- ✓ The questions are straightforward and designed to be simple and easy to understand. There are two main types of questions. In the first type, simply check one or more statements that apply to the project.

Check the STATEMENT that applies to the project. (CHECK ONLY ONE)

☐ X

☒ Y

☐ None

Check the STATEMENT/S that applies to the project. (CHECK ALL THAT APPLY)

☒ X

☐ Y

☒ Z

☐ None

- ✓ In the second type, simply check whether you agree or not on a particular statement.

SI1	STATEMENT	Completely Agree	Agree	Neutral	Disagree	Completely Disagree	Not Applicable
		☐	☐	☒	☐	☐	☐

- ✓ When there are combined statements, consider them as one concept and respond as is, or take an average of the ratings for each of the statement.

- ✓ The questionnaire is designed as a whole. Trying to infer results from just one or more sections will be misleading.

- ✓ Please respond to all questions. Thanks again for your participation!

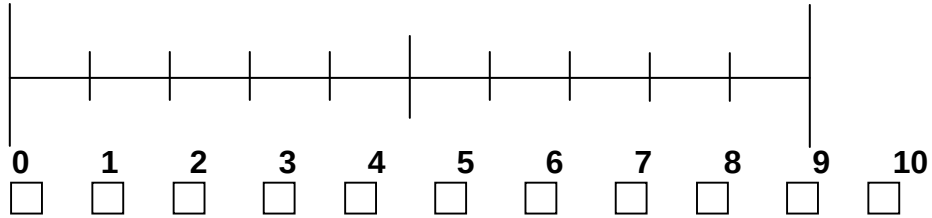
GENERAL PROJECT-RELATED QUESTIONS (17 Questions – About 5 minutes)

Directions: Please provide responses to the following questions to the best of your knowledge.

ENTER THE CODE PROVIDED:

PR1.	**What was the goal of the project? What kind of an application was developed? What were the deliverables? Please briefly state.**	
PR2.	**What was the title of the project (if there is one)?**	
PR3.	**What was the projected/planned effort for the project? (in terms of man-month)**	**Man-month**
PR4.	**What was the actual effort for the project? (in terms of man-month)**	**Man-month**
PR5.	**What was the actual cost of the project?**	**Dollars**
PR6.	**What was the projected/planned budget for the project?**	**Dollars**
PR7.	**How long did the project take?** ***From start (or contract) date to delivery date**	**Months**
PR8.	**What was the projected/planned schedule for the project?**	**Months**
PR9.	**What was the start date of the project? (Month/Year)**	**/**

PR10.	**What was the delivery date of the project? (Month/Year)**	**/**
PR11.	**How much of the functionality (or number of features) are delivered to the customer? (Between the initial baseline and the delivered product)**	**%**
PR12.	**How many people worked on the project? (Including the management, consultants/contractors, etc.)** **Requirements Phase :** **Design Phase :** **Implementation Phase :** **Testing and Delivery Phase :** **Total :** **Or** **Average number of people from start to end :**	
PR13.	**What is the size of the project? (in terms of Lines of Code (KLOC) or function points (FP))**	**KLOC** **FP**
PR14.	**Where was the project developed? Which state, country, or countries?**	
PR15.	**What kind of an organization developed the project? (government, commercial, open source community, government contract, etc.) Organization name?**	
PR16.	**What was the CMMI level of the organization when the project was undertaken? 0- 5**	

PR17.	**How would you rate the overall success of the project? (0 being complete failure and 10 being the complete success.)** 
PR18.	**What is/was your role in the project?**

INDEX (You can click to jump to a section)

COMMUNICATION Section (23 Questions – About 7-12 minutes)

C1. Check the statement/s that applies to the project. (Check all that apply.)

☐ A common glossary/terminology for the project is created.
☐ Communication procedures adapts due to changing project environment.
☐ Communication procedures are always followed as stated in the communication planning documentation (or similar document).
☐ There is a project information distribution list (or a similar document) and it is maintained.
☐ The project budget includes resources for communication and project information distribution efforts.
☐ None

C2. Who are generally present in the project status meetings? (Check all that apply.)

☐ Project manager
☐ Project team leaders
☐ Project team members
☐ Customer/s and/or user representatives
☐ Various stakeholders or stakeholder representatives
☐ Executive management / Project sponsor

C3. Which of the following/s is/are discussion items in project status meetings? (Check all that apply.)

☐ Project schedule
☐ Project budget
☐ Project risks
☐ Project staff problems
☐ Important development events and/or accomplished project deliverables
☐ Requirements
☐ None

C4. Which of the following/s does the project information distribution plan/list (or similar document) contain? (Check all that apply.)

☐ Project information type/context (What will be communicated)
☐ Recipients of various communication items (Stakeholders- who should receive the information)
☐ Project related information distribution frequency
☐ Timeframe of the relevant communication
☐ Communication format and medium (How the communication will be conducted- reports, meetings, teleconferencing etc.)

☐ Responsible project staff for communication
☐ Not available

		(5)	(4)	(3)	(2)	(1)	N/A
C5	**The importance of communication is understood and established between stakeholders and project team members. There is commitment to good communication.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C6	**Stakeholders including project team members' needs for various project data and information are analyzed and identified.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C7	**There have been communication problems due to various reasons.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C8	**Communication is used as a means to resolve conflicts.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C9	**There are designated project team members and representatives of stakeholders responsible for conducting communication.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C10	**Communication procedures are documented and distributed to stakeholders and project team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C11	**Communication and coordination for activities are planned in the project plan.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C12	**The response and acknowledgement procedures are planned and documented in the communication procedures.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C13	**The information needs of stakeholders and project team members are satisfied in a timely manner through appropriate use of communications media.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C14	**As a project manager or a project team member, I can easily communicate my messages and I can be understood.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C15	**A communications and project information/data management system with essential capabilities are in place. (Such as databases, mail servers, or teleconferencing etc.)**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C16	**The project environment facilitates horizontal communication that is between peers.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C17	**The project team operates in a virtual environment rather than on a face-to-face basis.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

C18	**The project status is visible to every stakeholder and project team member.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C19	**The project manager, management team, and team leaders are always accessible to project team members in a timely manner.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C20	**When I report a project problem, I get timely acknowledgement that my message has been received and understood.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C21	**Informal communications within the team and stakeholders are also an important part of project development environment.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C22	**The project environment facilitates free-format meetings for various purposes.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
C23	**The project environment facilitates freedom in reporting of project problems.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

TEAMWORK Section (30 Questions – About 10 minutes)

T1. Which of the following/s are clearly documented in the project plan for each team member? (Check all that apply.)

☐ Responsibility of the team member
☐ Accountability of the team member
☐ Authority of the project manager and team members
☐ Reporting structure
☐ Interfaces and/or communication channels
☐ None

T2. How many project team members stayed with the project until the end according to the project staffing plan? (Check only one.)

☐ All ☐ Most ☐ Some ☐ None

T3. Check the statement/s that applies to the project. (Check all that apply.)

☐ Notable project accomplishments/milestones/deliverables are celebrated with social events or parties.

☐ There are problem-solving meetings with the attendance of relevant project team members and stakeholders.
☐ Organizational culture encourages problem solving sessions with the attendance of project members.
☐ When a project team member left the team or the member is removed, the rest of the team has understood the reasoning.
☐ None

T4. Which of the following activities are carried out throughout the project? (Check all that apply.)
☐ Social events/parties
☐ Team building training
☐ Introduction meetings and parties
☐ Reward and other types of ceremonies
☐ Brainstorming and problem solving meetings and sessions
☐ Meetings for self-assessment of team performance
☐ None

		(5)	(4)	(3)	(2)	(1)	N/A
T5	**The project is adequately staffed during the project development.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T6	**The organization structure and responsibility/task matrix are clearly documented and provided to project team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T7	**There are regular status meetings to self-assess the project team's performance and morale.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T8	**There is an accepted shared vision for the project within team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T9	**Team members are involved in the project planning effort.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T10	**Team members are involved in decision-making process during project development.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T11	**The project status is visible to team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T12	**In order to do the work effectively, all necessary project data and information is easily accessible to project members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

T13	**Training opportunities are created and made available upon need or at the request of team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T14	**There are more experienced project team members than inexperienced team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T15	**The project environment facilitates teaming up inexperienced team members with the experienced team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T16	**Rewards for achievements are handed out justifiably and made the project team happy.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T17	**There is trust and respect among team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T18	**The project team is empowered with adequate resources to do their tasks.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T19	**The support from upper management or project sponsor is visible to the project team.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T20	**The project offers stimulating and challenging work to project team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T21	**The project environment offers professional growth potential for team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T22	**The project suffers from not having enough experienced or qualified team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T23	**Team members are tasked based on their skills, capabilities, ambitions and interests.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T24	**The team members are clear about how their job performance will be evaluated.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T25	**The project team members believe that they have enough resources to accomplish their jobs successfully.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T26	**The orientation procedures and the sponsors are documented and the procedures are followed for the team members joining the team later.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

T27	**Project priorities are always made clear via meetings, presentations and memos; priorities are not constantly changing.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T28	**The project suffers from lack of communication and coordination.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T29	**The project suffers from lack of leadership at various levels.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
T30	**The project team consists of people who has worked together before.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

LEADERSHIP Section (17 Questions – About 3-6 minutes)

		(5)	**(4)**	**(3)**	**(2)**	**(1)**	**N/A**
L1	**The leaders at various levels promote competition rather than coordination within the project organization.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L2	**The leaders at various levels sets example for others.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L3	**After the creation of the shared vision for the project, the leaders at various levels maintain the vision.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L4	**The leaders at various levels are effective problem-solvers in technical and social issues.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L5	**The management protects the team from outside interference.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L6	**The leaders at various levels clearly state their leadership styles upfront with reasons for the style.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L7	**The leaders at various levels assign correct tasks to correct people.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L8	**The leaders at various levels are respected by the team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L9	**The leaders at various levels easily delegates authority when necessary.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

L10	**The leaders at various levels observe the morale of the staff and takes proactive action to boost the morale.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L11	**The project team suffers from coordination problems.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L12	**The project team suffers from communication problems.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L13	**The leaders at various levels welcome communication of project problems at any time.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L14	**The leaders at various levels clearly define what is expected from project team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L15	**The project team members freely share their desires, wishes, and concerns with their leaders.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
L16	**The leaders at various handle project politics well.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

*** Provide response to either L17 or L18.**

L17. (Answer only if the project team mostly consists of inexperienced staff) Check the statement that applies to the project. (Check only one.)

☐ The leaders at various levels have to make most decisions and direct the staff.
☐ The leaders at various levels make most decisions with the consultation of team members and coach the staff.
☐ The leaders at various levels and the team members make decisions together.
☐ The leaders at various levels mostly oversee the decisions made by the staff and delegate the tasks.

L18. (Answer only if the project team mostly consists of experienced staff) Check the statement that applies to the project. (Check only one.)

☐ The leaders at various levels have to make most decisions and direct the staff.
☐ The leaders at various levels make most decisions with the consultation of team members and coach the staff.
☐ The leaders at various levels and the team members make decisions together.
☐ The leaders at various levels mostly oversee the decisions made by the staff and delegate the tasks.

ORGANIZATIONAL COMMITMENT Section (27 Questions – About 7-12 minutes)

		(5)	(4)	(3)	(2)	(1)	N/A
OC1	**The executive management is committed to providing necessary financial support.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC2	**The executive management is committed to providing necessary flexibility on the project schedule.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC3	**The executive management is committed to providing necessary flexibility on the project functionality and quality.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC4	**The executive management and project organization is open to change/adaptation.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC5	**There is encouragement for organizational and personal certifications such as CMMI, PMI, PMP, ISO etc.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC6	**There is commitment to quality by executive management, team members and other stakeholders.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC7	**Adequate resources are set aside for the success of the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC8	**There is support for bringing in expertise when needed (Such as technical, legal, contracting etc.)**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC9	**There is support for quality subcontracting when needed.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC10	**The executive management supports / empowers / enables the project manager to do his job.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC11	**There is continuous and observable support from executive management.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC12	**Leaders at various levels are committed to the success of the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC13	**Leaders at various levels are committed to their team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

OC14	**The project manager and leaders at various levels are committed to providing continuous support in enabling the team members to do their work.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC15	**The project team members are committed to the accomplishment of the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC16	**The project team members show their commitment to staying with the project until the end.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC17	**The project team members put extra effort for the success of the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC18	**The project team members lack motivation due to various reasons including external factors.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC19	**The project manager and the team members don't consider the project as a pleasant challenge.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC20	**The project manager and the team members consider the project as a valuable learning experience.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC21	**There is a friendly-work environment.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC22	**The project team members publicly and explicitly indicate their job satisfaction.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC23	**There is commitment from various stakeholders including project team members, customer, marketing and sales department(if applicable) etc.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
OC24	**Executive management, project manager and project team members are committed to establishing effective project management and control mechanisms.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

OC25. Which of the following item/s does the executive management show commitment to providing support? (Check all that apply.)

☐ Human resources
☐ Training needs
☐ Supplementary needs such as office space, tools, computer systems etc.
☐ None

0C26. Check the statement/s that applies to the project. (Check all that apply.)
☐ The executive management clearly defines the authority and responsibility of the project manager.
☐ The executive management allows for realistic budget and schedule.
☐ Training is made available to all team members.
☐ There are some resignations in the project organization.
☐ The project organization allows for career development.
☐ None

PROJECT MANAGER Section (27 Questions – About 5-9 minutes)

PM1. How many project managers have changed during the project (Turnover)? (Check only one.)
☐ None ☐ 1 ☐ 2 ☐ 3 or more

PM2. How many years of experience does the project manager have? (Check only one.)
☐ Less Than 5 ☐ 5-10 ☐ 10-15 ☐ 15-20 ☐ More Than 20

PM3. Check the statement/s that applies to the project. (Check all that apply.)
☐ The project manager has certification related to project management such as PMP etc.
☐ The project manager has worked on similar projects.
☐ The project manager has worked as a project manager before.
☐ The project manager has worked as a practitioner/developer before, therefore has technical background.
☐ The project manager has worked on different types of projects.
☐ None

PM4. Which of the following/s the project manager has control over? (Check all that apply.)
☐ Budget ☐ Schedule ☐ Product Quality ☐ Process Quality ☐ Hiring and letting go ☐ None

		(5)	(4)	(3)	(2)	(1)	N/A
PM5	**The project manager's role, accountability, and responsibilities are clearly defined and communicated to stakeholders including project team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM6	**The project manager was given adequate authority and control over the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

PM7	**The project manager has adequate project management education, training and experience.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM8	**As a project manager, I have goals and a clear vision related to the project. /As a team member, I observe that the project manager has goals and a clear vision related to the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM9	**As a project manager, I am able to maintain the continuity of the project vision. / As a team member, I observe that the project manager is able to maintain the continuity of the project vision.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM10	**As a project manager, I am deeply committed to the project./As a team member, I observe the deep commitment in the project manager.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM11	**As a project manager, I am communicative and always accessible to team./As a team member, I observe that the project manager is communicative and always accessible to the team.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM12	**As a project manager, I motivate staff and other people well./As a team member, I observe that the project manager motivates the staff and other people well.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM13	**As a project manager, I am a good planner and organizer./As a team member, I observe that the project manager is a good planner and organizer.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM14	**As a project manager, I am an effective problem solver./As a team member, I observe that the project manager is an effective problem solver.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM15	**As a project manager, I consult to and get advice from stakeholders and project team members. / I observe that the project manager consults to and gets advice from stakeholders and project team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM16	**As a project manager, I delegate easily when necessary./As a team member, I observe that the project manager delegates easily when necessary.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM17	**As a project manager, I use rewarding and punishment mechanisms effectively. /As a team member, I observe that the project manager uses rewarding and punishment mechanisms effectively.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

PM18	**As a project manager, I am a people person./As a team member, I observe that the project manager is a people person.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM19	**As a project manager, I am an effective team builder and player./As a team member, I observe that the project manager is an effective team builder and player.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM20	**As a project manager, I support my team members in various aspects./As a team member, I observe that the project manager supports the team members in various aspects.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM21	**As a project manager, I monitor every aspect of the project./As a team member, I observe that the project manager monitors every aspect of the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM22	**As a project manager, I inform the stakeholders and my team members well./As a team member, I observe that the project manager informs the stakeholders and the team members well.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM23	**As a project manager, I clarify when the stakeholders and the team members are confused about an aspect of the project./As a team member, I observe that the project manager clarifies when the stakeholders and the team members are**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM24	**As a project manager, I am able to see the project as a whole./As a team member, I observe that the project manager sees the project as a whole.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM25	**As a project manager, I understand the domain of the project./As a team member, I observe that the project manager understands the domain of the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM26	**As a project manager, I protect my team members so that their work don't get disrupted./As a team member, I observe that the project manager protects us so that our work don't get disrupted.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PM27	**As a project manager, I understand and foresee the project risks./As a team member, I observe that the project manager understands and foresees the project risks.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

REQUIREMENTS MANAGEMENT Section (27 Questions – About 5-9 minutes)

RM1. Check the statement/s that applies to the project. (Check all that apply.)
☐ There is a requirements development document (how they are gathered and developed).
☐ There is a requirements management document (how they are handled).
☐ There is an agreed/negotiated requirements baseline.
☐ There is a requirements baseline document and it is managed.
☐ None

RM2. Check the statement/s that applies to the project. (Check all that apply.)
☐ Oral requirements are used.
☐ Written requirements are used.
☐ Requirements are formal – a standard guides the development; have identifiers and traceability matrix etc.
☐ Requirements are informal – requirements are just identified and listed.
☐ None

RM3. Which of the following activities are conducted in the project? (Check all that apply.)
☐ Market surveys ☐ Customer/User interviews ☐ Prototyping ☐ Scenarios/ use cases ☐ Observation of the user in operation ☐ None

RM4. Check the statement/s that applies to the project. (Check all that apply.)
☐ Stakeholders are identified prior to requirements development activities.
☐ Requirements related documents have versions.
☐ There is a requirements traceability matrix (or a similar document to trace the requirements during all the development activities).
☐ Requirements volatility (number of requirements change/ percent of number of requirements change etc.) metrics are collected and used.
☐ Testing team is involved in the requirement development activities.
☐ None

		(5)	(4)	(3)	(2)	(1)	N/A
RM5	**Requirements prioritization is conducted and used for development decisions.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM6	**All stakeholders are involved in the requirements development.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM7	**Users or user representatives are involved in the requirements development.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

RM8	**Stakeholders show commitment to requirements stability during the project development.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM9	**Automated requirements development and management tools are used.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM10	**All requirements are traceable.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM11	**Product components and project deliverables can be mapped to specific requirements.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM12	**Requirements are clear / unambiguous.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM13	**Requirements are complete.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM14	**There are no inconsistencies among requirements.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM15	**During the project development, requirements related issues are resolved with the negotiation with the customers.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM16	**Requirements are validated with the user, customer and necessary stakeholders.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM17	**There are designated points of contact (people) representing various stakeholders to resolve requirements related issues.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM18	**The procedures are formal for requirements validation (what the customer want).**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM19	**The procedures are formal for requirements verification (the system does what requirements state).**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM20	**There is a formal requirements change procedure and document.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM21	**Requirements history and rationale for requirements changes are recorded.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

RM22	**Requirements are worded simple and each requirement consists of only one concept.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM23	**Extra effort is spent to make the requirements testable.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM24	**There are testing plans to check if the requirements are implemented as intended.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM25	**User/customer profiles are identified and documented.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM26	**Requirements are constantly changing and all changes are being implemented.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RM27	**Requirements are kept stable at some point.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

STAKEHOLDER INVOLVEMENT Section (12-16 Questions – About 3-7 minutes)

		(5)	**(4)**	**(3)**	**(2)**	**(1)**	**N/A**
SI1	**Various users and/or customers are involved in the requirements development and functionality/feature identification process.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SI2	**Various user and/or customer concerns are specified and documented for the project and the product.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SI3	**Various user and/or customer profiles are identified and documented.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SI4	**Prototypes/user stories/paper mock-ups/use cases etc. are prepared with the involvement of users.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SI5	**Executive/upper management is involved in the decision making process regarding the project baselines, cost and schedule variations etc.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SI6	**All stakeholders are identified and documented.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SI7	**There are regular meetings with various stakeholders.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

SI8	**There is an information gathering activity to identify stakeholders and their stakes/concerns.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SI9	**All stakeholders show commitment to the successful outcome of the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

SI10. Check the statement/s that applies to the project. (Check all that apply.)

☐ There is a document guiding the management of stakeholders.
☐ The stakeholder management plan/document lists the primary and secondary stakeholders.
☐ The stakeholder management plan/document lists the concerns and stakes of the primary and secondary stakeholders.
☐ The stakeholder management plan/document provides specific strategies for dealing with various stakeholders.
☐ The users and/or customers participated in the testing phase of the project.
☐ There is a documented procedure for the acceptance of the project deliverables.
☐ None

* **Respond to the following questions(SI11-SI12) only if the project is developed for the market without a specific contract.**

SI11	**The marketing department and necessary functional managers are involved in the decision-making process during development.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SI12	**The marketing department provides timely information regarding users and other competing products.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

* **Respond to the following questions (SI13-SI18) only if the project is developed under a contract with a specific customer.**

SI13	**There are communication and coordination problems between project team members and other stakeholders.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SI14	**When there is a change in the baseline, the cost, schedule, and functionality/features are renegotiated with the customer.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SI15	**Regular updates regarding project variables such as cost, schedule and progress on functionality are provided to the stakeholders.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SI16	**When there is an increase in cost or delay in schedule, the news and the consequences are shared with the stakeholders in a timely manner.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SI17	**Project milestones are considered reached when there is consensus from stakeholders for advancing to the next phase.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

SI18. Check the statement that applies to the project. (Check only one.)

☐ Project team members are allowed to have direct communication with the customers and/or users.

☐ All communication with the stakeholders is conducted via the project manager and/or management.

PROJECT MONITORING AND CONTROL Section (19 Questions – About 4-8 minutes)

PMC1. Check the statement that applies to the project. (Check only one.)

☐ There is a documented project plan. ☐ There is no project plan.

PMC2. Which of the following data and/or metric/s are regularly monitored and documented? (Check all that apply.)

☐ Team/developer performance
☐ Cost and earned value
☐ Risk items and their impacts
☐ Schedule performance
☐ Number of requirements changes
☐ Necessary staff and skill requirements
☐ None

PMC3. Check the statement that applies to the project. (Check only one.)

☐ There are specific project team members assigned for controlling activities such as configuration management, requirement changes etc.
☐ All control activities are handled by the project manager.

PMC4. Check the statement/s that applies to the project. (Check all that apply.)

☐ There are project progress or milestone review meetings.
☐ Key project problems are identified and being monitored.
☐ Key project problems and project progress status is visible to the stakeholders including project team members.
☐ None

PMC5. Check the statement/s that applies to the project. (Check all that apply.)

☐ There is an established requirements change and control process.
☐ There is an established risk management and control process.
☐ There is an established configuration management process.
☐ There is an established baseline tracking and scope change control process.
☐ There is an established project management data and metrics collection and monitoring process.
☐ None

		(5)	(4)	(3)	(2)	(1)	N/A
PMC6	**The project problems are generally proactively addressed (before they happen).**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC7	**The project problems are generally reactively addressed (when they happen).**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC8	**The project resources are closely monitored.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC9	**There is an established project monitoring and control procedure with the acceptance of project team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC 10	**There are established methods/criteria to determine deviations from the project plan.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC 11	**In case of deviations from the plan, corrective action is immediately taken.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC 12	**Project management metrics are effectively collected and used in decision-making. (such as planned versus actual cost, requirements changes, schedule performance etc.)**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC 13	**A project management automated software tool is used to manage project management data and metrics.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC 14	**Earned value management is effectively used.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC 15	**There is communication between management and project staff regarding the project progress data.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC 16	**The commitment and concerns of various stakeholders is being monitored through regular meetings and communication.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC 17	**The subcontractor performance is monitored regularly.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC 18	**There are checklists for critical tasks such testing, version control, requirements change requests etc.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PMC 19	**Corrective actions for problems are timely and effective.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

PROJECT PLANNING AND ESTIMATION Section (35 Questions – About 10-18 minutes)

PPE1. Check the statement/s that applies to the project. (Check all that apply.)

☐ There is a formal documented project plan.
☐ There is an informal project plan.
☐ There project plan and schedule is made visual via diagrams, charts etc.
☐ There is no project plan.

PPE2. Check the statement that applies to the project. (Check only one.)

☐ The project plan is developed as needed during the project. ☐ The project plan is developed up front before any development effort.

PPE3. Check the statement that applies to the project. (Check only one.)

☐ The project budget, schedule, and staff requirements are strictly enforced by the executive/upper management or customer.
☐ The project budget, schedule, and staff requirements are identified via analysis and negotiation.

PPE4. Check the statement that applies to the project. (Check only one.)

☐ The project plan is approved by the stakeholders such as customers, users, project team members, executive management etc.
☐ There is no approval process.

PPE5. Which of the following/s is/are involved in the project planning? (Check all that apply.)

☐ Senior/executive/upper management
☐ Experts and consultants
☐ Project manager and/or management team
☐ Project team members
☐ Customer/user/marketing department
☐ Other relevant stakeholders
☐ None

PPE6. Which of the following/s is/are included in the project plan? (Check all that apply.)

☐ Project scope
☐ Deliverables or products list
☐ Detailed schedule and milestones / various product version delivery dates
☐ Detailed budget and cost analysis
☐ Staffing/personnel/developer requirements
☐ Task responsibility matrix or similar assignment matrix
☐ Required functionality/features of the products or deliverables

☐ Validation and verification plan
☐ Acquisition plan / Subcontracting planning
☐ Deployment or Installation plan/ Marketing plan
☐ Quality requirements / Quality assurance plan
☐ Risk management planning
☐ Project glossary
☐ Project communications planning
☐ Project organization charts
☐ Staff responsibilities and responsibility definitions
☐ Necessary facility, equipment, and component requirements
☐ None

PPE7. Check the statement/s that applies to the project. (Check all that apply.)
☐ There is a statement of work (or a similar document) stating what needs to be accomplished/done.
☐ There is a work breakdown structure or a feature/functionality list (or a similar document) that details the project tasks/activities.
☐ The tasks and activities are identified as the project progresses.
☐ None

PPE8. What kinds of effort, schedule or cost estimation techniques are used? (Check all that apply.)
☐ Experiences of project manager/management team
☐ Inputs from project team members
☐ Expert or consultant judgment
☐ Analogy to similar projects
☐ Historical data
☐ Automated cost estimation tools
☐ None

PPE9. Check the statement/s that applies to the project. (Check all that apply.)
☐ No estimation is needed.
☐ Only one type of estimation technique is used.
☐ Two or more estimation techniques are used.
☐ Estimates from various techniques are compared and analyzed for discrepancies.
☐ None

PPE10. Check the statement/s that applies to the project. (Check all that apply.)
☐ Lines of code (LOC) are used in estimation.
☐ Function points are used in estimation.

☐ Number of functionality/features are used in estimation.
☐ Number of modules and deliverables are used in estimation.
☐ Other advanced metrics used in estimation.
☐ None

		(5)	(4)	(3)	(2)	(1)	N/A
PPE 11	**The project schedule is feasible.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 12	**The funding for the project is adequate.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 13	**The project is adequately staffed.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 14	**Extra funding for unprecedented issues is set aside.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 15	**Slack or buffer time exists in the schedule for unprecedented or extra activities.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 16	**Alternative staff to accomplish critical tasks/activities are considered and incorporated in the project plan.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 17	**All relevant stakeholders are identified before planning activities.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 18	**A certain level of requirements analysis is conducted before planning and estimation.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 19	**All external dependencies are identified and incorporated to the planning. (Such as acquisition of various products and services from outside vendors, required permissions from various authorities, etc.)**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 20	**The project plan is updated throughout the project development.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 21	**The project plan is visible/available to project team members and other relevant stakeholders.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 22	**Various automated project management tools are used in planning the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

PPE 23	**The project team members are consulted in planning and estimation efforts.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 24	**The managers at various levels have project planning and estimation training.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 25	**Each task/activities/work packages are assigned to specific project team member or members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 26	**Critical activities are identified and/or critical path analysis is conducted.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 27	**Various standards, guidelines or checklists are used in planning and estimation.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 28	**Formal analysis is conducted for cost, schedule and effort estimation such as PERT, CPM etc.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 29	**Factors such as staff turnover or loss of key personnel are considered during planning.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 30	**Realistic estimates guide the project planning.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 31	**Testing is carefully incorporated to project plan.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 32	**Effort estimations are provided by those performing the tasks.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 33	**Project risks are carefully analyzed and contingencies are included in the planning.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 34	**A suitable project development approach and process is identified with rationale in the project plan.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
PPE 35	**All necessary skills and expertise needed in the project are identified.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

SCOPE MANAGEMENT Section (16 Questions – About 3-8 minutes)

SM1. Check the statement that applies to the project. (Check only one.)

☐ Project scope never changed. ☐ Project scope frequently changed. ☐ Project scope somewhat changed.

SM2. Check the statement that applies to the project. (Check only one.)

☐ Project scope is ambiguous at first and it becomes clear during the project.
☐ Project scope is ambiguous at first and stays ambiguous due to various reasons.
☐ Project scope is defined and clear at the beginning of the project and it stays clear.
☐ Project scope is defined and clear at the beginning of the project and it become ambiguous due to various reasons.

SM3. Check the statement that applies to the project. (Check only one.)

☐ There is a project scope document and it stayed the same from the project start.
☐ There is a project scope document and it is updated when it is necessary.
☐ There isn't a project scope document.

SM4. What is the effect of project scope changes on the project schedule? (Check only one.)

☐ None ☐ On time without scope change/s ☐ On time with scope change/s ☐ Late without scope change/s
☐ Late with scope change/s

SM5. What is the effect of project scope changes on the project budget? (Check only one.)

☐ None
☐ Within budget without scope change/s
☐ Within budget with scope change/s
☐ Cost overrun without scope change/s
☐ Cost overrun with scope change/s

SM6. What is the effect of project scope changes on the functionality of the deliverables? (Check only one.)

☐ None
☐ Full functionality without scope change/s
☐ Full functionality with scope change/s
☐ Less than planned functionality without scope change/s
☐ Less than planned functionality with scope change/s

SM7. Check the statement/s that applies to the project. (Check all that apply.)

☐ Project scope changes are handled only by the management.
☐ Project scope changes have to follow a formal defined process.

☐ Project scope changes follow a decision-making process that includes management, stakeholders, and team members.
☐ Project scope changes handled informally by the management.

SM8. Which of the following statement/s is/are included in the project scope document, if there is one. (Check all that apply.)
☐ The problem statement
☐ The work to be done or work breakdown structure
☐ The constraints
☐ The resources
☐ Preliminary or detailed schedule and cost analysis
☐ The project deliverables
☐ Clear definition of performance to meet contractual and legal obligations
☐ Glossary
☐ Not Available

SM9. Check the statement/s that applies to the project. (Check all that apply.)
☐ The project scope is defined after stakeholders are identified.
☐ There is at least one project scope identification/definition meeting at the beginning of the project.
☐ There is a project scope change board.

SM10. Who are included while defining and updating the project scope? (Check all that apply.)
☐ Project management team
☐ Project manager
☐ All stakeholders
☐ Some stakeholders
☐ Project team members
☐ Subcontractor representatives if there is subcontracting
☐ None

		(5)	(4)	(3)	(2)	(1)	N/A
SM11	**Before defining the project scope, there is a rigorous information gathering activity about the problem that is to be solved, the resources, the constraints, the deliverables etc.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SM12	**Project scope is not clearly defined due to various reasons.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SM13	**The project has a documented project scope definition and a formal scope change process.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SM14	**Project scope is always visible and clear to stakeholders, project team members, and management.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SM15	**Project scope changes have to go through an extensive decision-making process.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
SM16	**The project scope document is reviewed and approved by all stakeholders.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

RISK CONTROL Section (17 Questions – About 3-8 minutes)

RC1. What is the overall risk level of the project? (Check only one.)
☐ High ☐ Medium ☐ Low ☐ None

RC2. What is the effect of risks on the project budget? (Check only one.)
☐ High cost overrun ☐ Medium cost overrun ☐ Low cost overrun ☐ None

RC3. What is the effect of risks on the project schedule? (Check only one.)
☐ The project delivery is on time. ☐ The project delivery is slightly late. ☐ The project delivery is significantly late.

RC4. What is the effect of risks on the project functionality? (Check only one.)
☐ High ☐ Medium ☐ Low ☐ None

RC5. What is the level of funding and resources set aside for risk management? (Check only one.)
☐ More than enough ☐ Enough ☐ Hardly enough ☐ No funding and resources

RC6. Check the statement/s that applies to the project. (Check only one.)
☐ Adequate slack time is planned in the schedule for consequences due to risks.

☐ There is not any slack time planned for consequences due to risks.
☐ Not enough slack time is planned in the schedule for consequences due to risks.

RC7. Check the <u>statement</u> that applies to the project. (Check only one.)

☐ Risks are handled when they occur. ☐ Risks are addressed before they occur. ☐ Both

RC8. Check the <u>statement/s</u> that applies to the project. (Check all that apply.)

☐ Informal project risk management procedures are in place.
☐ Project risk management is based on formal procedures.
☐ There is not any project risk management and planning.

RC9. Check the <u>statement/s</u> that applies to the project. (Check all that apply.)

☐ Risks are generally avoided. (Risk Avoidance)
☐ Risks are transferred to third parties for example contracting risky development items to consultants or experts. (Risk Transfer)
☐ Risks are managed as they occur.
☐ Risk mitigation (actions reducing the severity/impact of a risk) is the most used option in risk management of the project. (Risk Mitigation)
☐ None

RC10. Check the <u>statement</u> that applies to the project. (Check only one.)

☐ Experts are consulted in the risk management of the project.
☐ Project management handles all the risks.
☐ Project team members and stakeholders are involved in the risk management.

		(5)	(4)	(3)	(2)	(1)	N/A
RC11	**For each identified risk item, there is an information gathering activity.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RC12	**Contingencies and alternative solutions are planned for the critical tasks and portions of the development exposed to high risks.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RC13	**Top risk items list is closely monitored and periodically updated.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RC14	**Risk monitoring is an important activity in the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RC15	**Risk avoidance is primary method of risk control activities.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

RC16	**There are regular project risk monitoring meetings or project risk monitoring is handled through project status meetings etc.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RC17	**There is a risk management plan and course of action for each high-risk items.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

STAFFING/HIRING Section (29 Questions – About 7-13 minutes)

S1. Which of the followings are clearly identified, documented and communicated? (Check all that apply.)

☐ Project Roles ☐ Project Positions ☐ Necessary Qualifications for the project ☐ None

S2. Which of the documents or similar documents exist for the project? (Check all that apply.)

☐ Project staffing management plan
☐ Project responsibility/accountability/interfaces/assignment matrix
☐ Project work breakdown structure
☐ None

S3. What is the experienced-to-inexperienced project team member ratio? (experienced: inexperienced) (Check only one.)

☐ Smaller than 1:2 ☐ 1:2 ☐ 1:1 ☐ 2:1 ☐ Greater than 2:1

S4. Which of the followings for team members are clearly identified, documented and communicated? (Check all that apply.)

☐ Responsibility ☐ Job Interfaces ☐ Reporting Structure ☐ None

		(5)	(4)	(3)	(2)	(1)	N/A
S5	**The work breakdown structure (WBS) or similar document is completed before hiring/staffing.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S6	**The analysis of the required work and resources is conducted rigorously.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S7	**Significant project risks are identified before the hiring/staffing the team.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S8	**There is adequate funding and resources for hiring/staffing.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S9	**There are adequate work force and experts with the necessary skills and expertise available for hiring and/or staffing on this project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

S10	**Expertise on human resources is acquired for staffing and hiring activities.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S11	**Project open positions are made attractive to qualified candidates through incentives etc. The position is made desirable.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S12	**The skills and expertise needed for the project success are acquired with the timely recruitment of team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S13	**The necessary interpersonal skills for the roles are identified and the project team members are recruited also based on their interpersonal skills.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S14	**The ambitions and goals of the project team members are aligned with the project mission and goals.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S15	**The project team members have the necessary educational background.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S16	**The project team members have similar project work experience.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S17	**The productivity of the project team members are within the expectations.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S18	**Project team members are familiar and comfortable with the organizational culture.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S19	**Project team members have difficulties with the organizational procedures.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S20	**Project team members are happy with their roles, positions and career advancement opportunities in the project organization.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S21	**Project team members stay with the project according to the project staffing management plan. Turn-over rate is at minimum.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S22	**Resignations are at minimum.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S23	**Project team members acquire the necessary skills and expertise needed for the project through training and coaching.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

S24	**There are alternative team members with the necessary skills and knowledge to take over some other team member's work for critical tasks in case of team member loss.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S25	**Project positions are filled with qualified individuals.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S26	**Work and task assignments are fair and based on qualifications of the project team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S27	**Removing of project team members for unsatisfactory work performance and/or other reasons are conducted fairly and according to the organizational procedures.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S28	**Orientation or transition activities for the new team members are conducted properly.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
S29	**When necessary, consultants and contractors are used effectively.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

CONFIGURATION MANAGEMENT Section (13 Questions – About 3–7 minutes)

*** In some organizations, configuration management is referred to as version control.**

CM1. Check the statement that applies to the project. (Check only one.)

☐ Configuration management is conducted informally.
☐ Configuration management is a formal and documented activity and it has well-defined procedures.

CM2. Check the statement/s that applies to the project. (Check all that apply.)

☐ There is a configuration management document.
☐ There is a configuration or change control board, committee or team.
☐ There is a configuration items list.
☐ None

CM3. Check the statement/s that applies to the project. (Check all that apply.)

☐ Baselines and configuration items are identified at the beginning of the project and updated as necessary.
☐ The owner or responsible staff is identified for each configuration item.
☐ Every configuration item has a unique identifier.
☐ Important characteristics for each configuration item are identified such as author, type, date, version number etc.

☐ None

CM4. Check the statement/s that applies to the project. (Check all that apply.)

☐ The configuration management procedures includes a detailed change and change request protocols.
☐ The configuration management system has various levels of control (such as only author may release the item, restricted write access etc).
☐ There is not a configuration management system and configuration management is only the responsibility of project team members or developers.
☐ None

CM5. Check the statement that applies to the project. (Check only one.)

☐ The change requests have to go through the change control board or responsible staff.
☐ The change requests are only handled by the developer or the owner of the configuration item.

		(5)	(4)	(3)	(2)	(1)	N/A
CM6	**The project suffers from configuration/version management problems.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
CM7	**An automated configuration management system is used and adequate for the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
CM8	**The configuration management procedures are strictly followed. Project team members do not try to bypass them.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
CM9	**The integrity, security and privacy of configuration items are satisfactory.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
CM10	**The changes and change requests are controlled, and documented in such a way that it enables audit.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
CM11	**Every change request is controlled and extensively reviewed.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
CM12	**Records of configuration management activities, changes to baselines, work products, and change requests are well-maintained.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
CM13	**There is an established and reliable configuration management system including automated tools, databases, protocols etc.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

RISK ASSESSMENT Section (20 Questions – About 5–10 minutes)

RA1. Which of the following does best characterize the risk assessment activities in the project? (Check only one.)

☐ Formal ☐ Informal ☐ Semiformal ☐ Not available

RA2. Check the statement/s that applies to the project. (Check all that apply.)

☐ Risks are assessed as they are identified during the project.
☐ Risks are assessed early and incorporated into a risk management document.
☐ The risk management document is periodically updated.
☐ There is staff specifically assigned to risk assessment activities.
☐ Lessons learned are visited prior to risk assessment activities.
☐ None

RA3. In which of the following categories the risks are assessed and documented? (Check all that apply.)

☐ People ☐ Schedule ☐ Budget and Funding ☐ Technology ☐ Requirements ☐ Subcontractor ☐ None

RA4. There are common objective criteria to assess risks. (Check only one.)

☐ Yes ☐ No ☐ Partially ☐ Not Available

RA5. Check the statement/s that applies to the project. (Check all that apply.)

☐ There is a project risk management plan.
☐ The project risk management plan includes objective criteria for risk identification, analysis and prioritization.
☐ Project risk document is updated frequently along the project.
☐ None

RA6. Check the statement/s that applies to the project. (Check all that apply.)

☐ Experts or consultants are used for risk assessment.
☐ Experienced project staff is used for risk assessment.
☐ Project manager conducted the risk assessment.
☐ There is not any risk assessment activity.

RA7. Check the statement/s that applies to the project. (Check all that apply.)

☐ Risks are identified. ☐ Risks are analyzed. ☐ Risks are categorized. ☐ Risks are prioritized. ☐ None

RA8. Check the statement that applies to the project. (Check only one.)

☐ Risk assessment is based on qualitative methods.

☐ Risk assessment is based on quantitative methods.
☐ Risk assessment is based on the judgment of the management.
☐ Risk assessment is based on both qualitative and quantitative methods.
☐ There is no need for any risk assessment activity.

		(5)	(4)	(3)	(2)	(1)	N/A
RA9	**The projects risks are documented early with details related to their impact on the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RA10	**Risk assessment has a clear impact on project planning and decisions.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RA11	**Sufficient reserve resources and funding are planned and set aside for risk assessment activities.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RA12	**Top risk items list or a similar list is maintained.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RA13	**Risks are assessed with the broad inclusion of stakeholders and project team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RA14	**Project environment facilitates and encourages open and free discussions on project risks.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RA15	**Risks are identified using risk identification tools such as checklists, databases, risk taxonomy, decision-driver analysis, etc.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RA16	**Risks are analyzed based on their probability of occurrence and impact on the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RA17	**Risks are prioritized based on their probability of occurrence and impact on the project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RA18	**Risk assessment information is always visible and they are shared with stakeholders and project team members.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
RA19	**Any stakeholder or project team member may report a risk at any time and there is a mechanism allowing such reports.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

RA20. (Answer only if a portion of the system is subcontracted.) Check the statement/s that applies to the project. (Check all that apply.)
☐ Subcontractor/s is/are free in their risk management decision and activities.
☐ Subcontractor/s is/are contractually responsible to have formal risk assessment procedures.
☐ Subcontractor/s is/are contractually responsible to deliver risk assessment reports.
☐ Subcontractor/s has/have a representative for project risk management meetings.

QUALITY ENGINEERING Section (20 Questions – About 4–10 minutes)

QE1. Check the statement/s that applies to the project. (Check all that apply.)
☐ There is a quality policy.
☐ Quality is not a high priority in this project due to various reasons.
☐ There is a quality planning activity.

QE2. Check the statement/s that applies to the project. (Check all that apply.)
☐ Quality expectations of various stakeholders are identified and documented.
☐ The quality standards and guidelines related to the project are identified. (Such as aviation standards etc.)
☐ Objective quality criteria for the project and its deliverables are identified.
☐ None

QE3. Which of the following quality attribute/s are considered achieved in the project? (Check all that apply.)
☐ Maintainability ☐ Safety ☐ Security ☐ Reliability ☐ Usability ☐ Other ☐ None

QE4. What is the amount of testing conducted during the project development? (Check only one.)
☐ Extensive ☐ Fair ☐ Some ☐ None

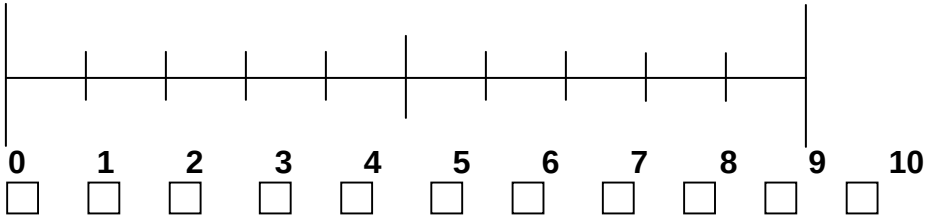
		(5)	(4)	(3)	(2)	(1)	N/A
QE5	**Quality is considered a high priority in this project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE6	**There is support for and commitment to quality from executive management.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE7	**High quality is planned from the start in this project.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE8	**Various quality metrics are identified.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

QE9	**Quality assurance procedures are adequate.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE10	**Quality assurance procedures are documented.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE11	**Adequate amount of resources are set aside for quality engineering activities.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE12	**The requirements are defined with the guidance of quality expectations.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE13	**The project team culture encourages commitment to high quality.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE14	**Project team members are trained in quality assurance.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE15	**There are quality thresholds and expectations for various work products such as system architecture, requirements definitions, designs, testing etc.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE16	**Quality considerations are limited to testing.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE17	**High testing coverage for the product is achieved.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE18	**There are adequate tools, equipment, and resources for testing.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐
QE19	**There are specifically assigned team members for quality related issues.**	Completely Agree ☐	Agree ☐	Neutral ☐	Disagree ☐	Completely Disagree ☐	Not Applicable ☐

QE20. Which of the following activity or activities are conducted during the project development? (Check all that apply.)

☐ Design reviews
☐ Code reviews/inspections
☐ Performance testing
☐ Independent verification and validation
☐ Quality assurance activities
☐ Requirements tracing
☐ Various types of testing
☐ Defect identification and prevention
☐ Simulations and/or prototyping
☐ None

Thank you very much for your time and participation. After completing the questionnaire, please respond the following question again. It does not have to be the same as your initial assessment.

PR18.	**After you completed the questionnaire, how would you rate the overall success of the project? (0 being a complete failure and 10 being a complete success.)**  **0 1 2 3 4 5 6 7 8 9 10**

APPENDIX C. SOFTWARE PROJECT MANAGEMENT EVALUATION INSTRUMENT SCORES

Question Number	A	B	C	D	E	F	G
C1	2	2	2	2	2	0	
C2	1	1	1	1	1	1	
C3	1	1	1	1	1	1	0
C4	1	1	1	1	1	1	0
Question Number	**SA**	**A**	**N**	**D**	**SD**	**NA**	
C5	2	1	0	-1	-2	0	
C6	2	1	0	-1	-2	0	
C7	-2	-1	0	1	2	0	
C8	2	1	0	-1	-2	0	
C9	2	1	0	-1	-2	0	
C10	2	1	0	-1	-2	0	
C11	2	1	0	-1	-2	0	
C12	2	1	0	-1	-2	0	
C13	2	1	0	-1	-2	0	
C14	2	1	0	-1	-2	0	
C15	2	1	0	-1	-2	0	
C16	2	1	0	-1	-2	0	
C17	-2	-1	0	1	2	0	
C18	2	1	0	-1	-2	0	
C19	2	1	0	-1	-2	0	
C20	2	1	0	-1	-2	0	
C21	2	1	0	-1	-2	0	
C22	2	1	0	-1	-2	0	
C23	2	1	0	-1	-2	0	

Question Number	A	B	C	D	E	F	G
T1	1	1	1	1	1	0	
T2	2	0	-1	-2			
T3	2	2	2	2	0		
T4	1	1	1	1	1	1	0
Question Number	**SA**	**A**	**N**	**D**	**SD**	**NA**	
T5	2	1	0	-1	-2	0	
T6	2	1	0	-1	-2	0	
T7	2	1	0	-1	-2	0	
T8	2	1	0	-1	-2	0	
T9	2	1	0	-1	-2	0	
T10	2	1	0	-1	-2	0	
T11	2	1	0	-1	-2	0	
T12	2	1	0	-1	-2	0	
T13	2	1	0	-1	-2	0	
T14	2	1	0	-1	-2	0	
T15	2	1	0	-1	-2	0	
T16	2	1	0	-1	-2	0	
T17	2	1	0	-1	-2	0	
T18	2	1	0	-1	-2	0	
T19	2	1	0	-1	-2	0	
T20	2	1	0	-1	-2	0	
T21	2	1	0	-1	-2	0	
T22	-2	-1	0	1	2	0	
T23	2	1	0	-1	-2	0	
T24	2	1	0	-1	-2	0	
T25	2	1	0	-1	-2	0	
T26	2	1	0	-1	-2	0	
T27	2	1	0	-1	-2	0	
T28	-2	-1	0	1	2	0	
T29	-2	-1	0	1	2	0	
T30	2	1	0	-1	-2	0	

Question Number	SA	A	N	D	SD	NA
L1	-2	-1	0	1	2	0
L2	2	1	0	-1	-2	0
L3	2	1	0	-1	-2	0
L4	2	1	0	-1	-2	0
L5	2	1	0	-1	-2	0
L6	2	1	0	-1	-2	0
L7	2	1	0	-1	-2	0
L8	2	1	0	-1	-2	0
L9	2	1	0	-1	-2	0
L10	2	1	0	-1	-2	0
L11	-2	-1	0	1	2	0
L12	-2	-1	0	1	2	0
L13	2	1	0	-1	-2	0
L14	2	1	0	-1	-2	0
L15	2	1	0	-1	-2	0
L16	2	1	0	-1	-2	0

Question Number	A	B	C	D
L17*	2	2	1	-2
L18*	-2	1	2	2

Question Number	SA	A	N	D	SD	NA
OC1	2	1	0	-1	-2	0
OC2	2	1	0	-1	-2	0
OC3	2	1	0	-1	-2	0
OC4	2	1	0	-1	-2	0
OC5	2	1	0	-1	-2	0
OC6	2	1	0	-1	-2	0
OC7	2	1	0	-1	-2	0
OC8	2	1	0	-1	-2	0
OC9	2	1	0	-1	-2	0
OC10	2	1	0	-1	-2	0
OC11	2	1	0	-1	-2	0
OC12	2	1	0	-1	-2	0
OC13	2	1	0	-1	-2	0
OC14	2	1	0	-1	-2	0
OC15	2	1	0	-1	-2	0
OC16	2	1	0	-1	-2	0
OC17	2	1	0	-1	-2	0
OC18	-2	1	0	-1	-2	0
OC19	-2	1	0	-1	-2	0
OC20	2	1	0	-1	-2	0
OC21	2	1	0	-1	-2	0
OC22	2	1	0	-1	-2	0
OC23	2	1	0	-1	-2	0
OC24	2	1	0	-1	-2	0
Question Number	**A**	**B**	**C**	**D**	**E**	**F**
OC25	2	2	2	0		
OC26	2	2	2	-2	2	0

Question Number	A	B	C	D	E	F
PM1	0	-2	-4	-6		
PM2	0	1	2	3	4	
PM3	1	1	1	1	1	0
PM4	1	1	1	1	1	0
Question Number	**SA**	**A**	**N**	**D**	**SD**	**NA**
PM5	2	1	0	-1	-2	0
PM6	2	1	0	-1	-2	0
PM7	2	1	0	-1	-2	0
PM8	2	1	0	-1	-2	0
PM9	2	1	0	-1	-2	0
PM10	2	1	0	-1	-2	0
PM11	2	1	0	-1	-2	0
PM12	2	1	0	-1	-2	0
PM13	2	1	0	-1	-2	0
PM14	2	1	0	-1	-2	0
PM15	2	1	0	-1	-2	0
PM16	2	1	0	-1	-2	0
PM17	2	1	0	-1	-2	0
PM18	2	1	0	-1	-2	0
PM19	2	1	0	-1	-2	0
PM20	2	1	0	-1	-2	0
PM21	2	1	0	-1	-2	0
PM22	2	1	0	-1	-2	0
PM23	2	1	0	-1	-2	0
PM24	2	1	0	-1	-2	0
PM25	2	1	0	-1	-2	0
PM26	2	1	0	-1	-2	0
PM27	2	1	0	-1	-2	0

Question Number	A	B	C	D	E	F
RM1	2	2	2	2	0	
RM2	-2	2	2	-2	0	
RM3	1	1	1	1	1	0
RM4	2	2	2	2	2	0
Question Number	**SA**	**A**	**N**	**D**	**SD**	**NA**
RM5	2	1	0	-1	-2	0
RM6	2	1	0	-1	-2	0
RM7	2	1	0	-1	-2	0
RM8	2	1	0	-1	-2	0
RM9	2	1	0	-1	-2	0
RM10	2	1	0	-1	-2	0
RM11	2	1	0	-1	-2	0
RM12	2	1	0	-1	-2	0
RM13	2	1	0	-1	-2	0
RM14	2	1	0	-1	-2	0
RM15	2	1	0	-1	-2	0
RM16	2	1	0	-1	-2	0
RM17	2	1	0	-1	-2	0
RM18	2	1	0	-1	-2	0
RM19	2	1	0	-1	-2	0
RM20	2	1	0	-1	-2	0
RM21	2	1	0	-1	-2	0
RM22	2	1	0	-1	-2	0
RM23	2	1	0	-1	-2	0
RM24	2	1	0	-1	-2	0
RM25	2	1	0	-1	-2	0
RM26	-2	1	0	-1	-2	0
RM27	2	1	0	-1	-2	0

Question Number	SA	A	N	D	SD	NA	
SI1	2	1	0	-1	-2	0	
SI2	2	1	0	-1	-2	0	
SI3	2	1	0	-1	-2	0	
SI4	2	1	0	-1	-2	0	
SI5	2	1	0	-1	-2	0	
SI6	2	1	0	-1	-2	0	
SI7	2	1	0	-1	-2	0	
SI8	2	1	0	-1	-2	0	
SI9	2	1	0	-1	-2	0	
Question Number	**A**	**B**	**C**	**D**	**E**	**F**	**G**
SI10	2	2	2	2	2	2	0
SI11	2	1	0	-1	-2	0	
SI12	2	1	0	-1	-2	0	
SI13	-2	-1	0	1	2	0	
SI14	2	1	0	-1	-2	0	
SI15	2	1	0	-1	-2	0	
SI16	2	1	0	-1	-2	0	
SI17	2	1	0	-1	-2	0	
SI18	2	-2					

Question Number	A	B	C	D	E	F	G
PMC1	2	-2					
PMC2	1	1	1	1	1	1	0
PMC3	2	-2					
PMC4	2	2	2	0			
PMC5	2	2	2	2	2	0	
Question Number	**SA**	**A**	**N**	**D**	**SD**	**NA**	
PMC6	2	1	0	-1	-2	0	
PMC7	-2	1	0	-1	-2	0	
PMC8	2	1	0	-1	-2	0	
PMC9	2	1	0	-1	-2	0	
PMC10	2	1	0	-1	-2	0	
PMC11	2	1	0	-1	-2	0	
PMC12	2	1	0	-1	-2	0	
PMC13	2	1	0	-1	-2	0	
PMC14	2	1	0	-1	-2	0	
PMC15	2	1	0	-1	-2	0	
PMC16	2	1	0	-1	-2	0	
PMC17	2	1	0	-1	-2	0	
PMC18	2	1	0	-1	-2	0	
PMC19	2	1	0	-1	-2	0	

Question Number	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
PPE1	2	-2	2	-4														
PPE2	-2	2																
PPE3	-2	2																
PPE4	2	-2																
PPE5	1	1	1	1	1	1	0											
PPE6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
PPE7	2	2	-4															
PPE8	1	1	1	1	1	1	0											
PPE9	-4	0	2	4	0													
PPE10	1	1	1	1	1	0												
Question Number	**SA**	**A**	**N**	**D**	**SD**	**NA**												
PPE11	2	1	0	-1	-2	0												
PPE12	2	1	0	-1	-2	0												
PPE13	2	1	0	-1	-2	0												
PPE14	2	1	0	-1	-2	0												
PPE15	2	1	0	-1	-2	0												
PPE16	2	1	0	-1	-2	0												
PPE17	2	1	0	-1	-2	0												
PPE18	2	1	0	-1	-2	0												
PPE19	2	1	0	-1	-2	0												
PPE20	2	1	0	-1	-2	0												
PPE21	2	1	0	-1	-2	0												
PPE22	2	1	0	-1	-2	0												
PPE23	2	1	0	-1	-2	0												
PPE24	2	1	0	-1	-2	0												
PPE25	2	1	0	-1	-2	0												
PPE26	2	1	0	-1	-2	0												
PPE27	2	1	0	-1	-2	0												
PPE28	2	1	0	-1	-2	0												
PPE29	2	1	0	-1	-2	0												
PPE30	2	1	0	-1	-2	0												
PPE31	2	1	0	-1	-2	0												
PPE32	2	1	0	-1	-2	0												
PPE33	2	1	0	-1	-2	0												
PPE34	2	1	0	-1	-2	0												
PPE35	2	1	0	-1	-2	0												

Question Number	A	B	C	D	E	F	G	H	I
SM1	2	-2	0						
SM2	-2	-4	2	-2					
SM3	0	2	-2						
SM4	Not	Included	in	the	Model				
SM5	Not	Included	in	the	Model				
SM6	Not	Included	in	the	Model				
SM7	-2	2	4	-4					
SM8	1	1	1	1	1	1	1	1	0
SM9	2	2	2						
SM10	1	1	2	1	1	1	0		

Question Number	SA	A	N	D	SD	NA
SM11	2	1	0	-1	-2	0
SM12	-2	-1	0	1	2	0
SM13	2	1	0	-1	-2	0
SM14	2	1	0	-1	-2	0
SM15	2	1	0	-1	-2	0
SM16	2	1	0	-1	-2	0

Question Number	A	B	C	D	E	F	G
RC1	Not	Included	in	the	Model		
RC2	Not	Included	in	the	Model		
RC3	Not	Included	in	the	Model		
RC4	Not	Included	in	the	Model		
RC5	2	1	-1	-2			
RC6	2	-2	-1				
RC7	-1	1	0				
RC8	0	2	-2				
RC9	1	1	-2	1	0		
RC10	2	-2	2				

Question Number	SA	A	N	D	SD	NA
RC11	2	1	0	-1	-2	0
RC12	2	1	0	-1	-2	0
RC13	2	1	0	-1	-2	0
RC14	2	1	0	-1	-2	0
RC15	2	1	0	-1	-2	0
RC16	2	1	0	-1	-2	0
RC17	2	1	0	-1	-2	0

Question Number	A	B	C	D	E	
S1	1	1	1	0		
S2	2	2	2	0		
S3	-2	-1	0	1	2	
S4	1	1	1	0		
Question Number	**SA**	**A**	**N**	**D**	**SD**	**NA**
S5	2	1	0	-1	-2	0
S6	2	1	0	-1	-2	0
S7	2	1	0	-1	-2	0
S8	2	1	0	-1	-2	0
S9	2	1	0	-1	-2	0
S10	2	1	0	-1	-2	0
S11	2	1	0	-1	-2	0
S12	2	1	0	-1	-2	0
S13	2	1	0	-1	-2	0
S14	2	1	0	-1	-2	0
S15	2	1	0	-1	-2	0
S16	2	1	0	-1	-2	0
S17	2	1	0	-1	-2	0
S18	2	1	0	-1	-2	0
S19	-2	-1	0	1	2	0
S20	2	1	0	-1	-2	0
S21	2	1	0	-1	-2	0
S22	2	1	0	-1	-2	0
S23	2	1	0	-1	-2	0
S24	2	1	0	-1	-2	0
S25	2	1	0	-1	-2	0
S26	2	1	0	-1	-2	0
S27	2	1	0	-1	-2	0
S28	2	1	0	-1	-2	0
S29	2	1	0	-1	-2	0

Question Number	A	B	C	D	E	
CM1	-2	2				
CM2	2	2	2	0		
CM3	2	2	2	2	0	
CM4	2	2	-2	0		
CM5	2	-2				
Question Number	**SA**	**A**	**N**	**D**	**SD**	**NA**
CM6	-2	-1	0	1	2	0
CM7	2	1	0	-1	-2	0
CM8	2	1	0	-1	-2	0
CM9	2	1	0	-1	-2	0
CM10	2	1	0	-1	-2	0
CM11	2	1	0	-1	-2	0
CM12	2	1	0	-1	-2	0
CM13	2	1	0	-1	-2	0

Question Number	A	B	C	D	E	F	G
RA1	2	-2	0	0			
RA2	-2	2	2	2	2	0	
RA3	1	1	1	1	1	1	0
RA4	2	-2	0	0			
RA5	2	2	2	0			
RA6	2	1	1	-2			
RA7	1	1	1	1	0		
RA8	0	1	0	2	-4		
Question Number	**SA**	**A**	**N**	**D**	**SD**	**NA**	
RA9	2	1	0	-1	-2	0	
RA10	2	1	0	-1	-2	0	
RA11	2	1	0	-1	-2	0	
RA12	2	1	0	-1	-2	0	
RA13	2	1	0	-1	-2	0	
RA14	2	1	0	-1	-2	0	
RA15	2	1	0	-1	-2	0	
RA16	2	1	0	-1	-2	0	
RA17	2	1	0	-1	-2	0	
RA18	2	1	0	-1	-2	0	
RA19	2	1	0	-1	-2	0	
Question Number	**A**	**B**	**C**	**D**			
RA20	-4	2	2	2			

Question Number	A	B	C	D	E	F	G			
QE1	2	-2	2							
QE2	2	2	2	0						
QE3	1	1	1	1	1	1	0			
QE4	2	0	-2	-4						
QE20	1	1	1	1	1	1	1	1	1	0
Question Number	**SA**	**A**	**N**	**D**	**SD**	**NA**				
QE5	2	1	0	-1	-2	0				
QE6	2	1	0	-1	-2	0				
QE7	2	1	0	-1	-2	0				
QE8	2	1	0	-1	-2	0				
QE9	2	1	0	-1	-2	0				
QE10	2	1	0	-1	-2	0				
QE11	2	1	0	-1	-2	0				
QE12	2	1	0	-1	-2	0				
QE13	2	1	0	-1	-2	0				
QE14	2	1	0	-1	-2	0				
QE15	2	1	0	-1	-2	0				
QE16	-2	-1	0	1	2	0				
QE17	2	1	0	-1	-2	0				
QE18	2	1	0	-1	-2	0				
QE19	2	1	0	-1	-2	0				

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APPENDIX D. SOFTWARE PROJECT MANAGEMENT EVALUATION MODEL IN DETAIL

TABLE OF QUESTIONS AND SCORES USED TO ESTABLISH SCALING AND SHIFTING FACTORS

Sub Project Management Area	Number of Questions	Lowest Score	Highest Score	Difference between the highest and lowest score
Communication	23	-38	66	104
Teamwork	30	-54	73	127
Leadership	17	-34	34	68
Organizational Commitment	26	-50	62	112
Project Manager	27	-52	60	112
Stakeholder Involvement – Contract	16	-30	42	72
Stakeholder Involvement – Market	12	-22	34	56
Staffing and Hiring	29	-52	64	116
Requirements Management	27	-50	73	123
Project Monitoring and Control	19	-32	54	86
Project Planning and Estimation	35	-70	104	174
Scope Management	16	-26	45	71
Configuration Management	13	-22	38	60
Quality Engineering	20	-36	57	93
Risk Assessment – No Subcontracting	19	-34	57	91
Risk Assessment – With Subcontracting	20	-38	63	101
Risk Control	17	-26	28	54

SHIFTING FACTORS AND SCALING FACTORS

Sub Project Management Area	Shifting Factor	Scaling Factor
Communication	38	10/104
Teamwork	54	10/127
Leadership	34	10/68
Organizational Commitment	50	10/112
Project Manager	52	10/112
Stakeholder Involvement - Contract	30	10/72
Stakeholder Involvement - Market	22	10/56
Staffing and Hiring	52	10/116
Requirements Management	50	10/123
Project Monitoring and Control	32	10/86
Project Planning and Estimation	70	10/174
Scope Management	26	10/71
Configuration Management	22	10/60
Quality Engineering	36	10/93
Risk Assessment – No Subcontracting	34	10/91
Risk Assessment – With Subcontracting	38	10/101
Risk Control	26	10/54

SUB PROJECT MANAGEMENT AREA EQUATIONS

Communication Area Evaluation Model

$$Communication\ Area\ Score = \frac{10}{104} \times \left(\sum_{i=1}^{n=23} C_i + 38 \right)$$

Teamwork Area Evaluation Model

$$Teamwork\ Area\ Score = \frac{10}{127} \times \left(\sum_{i=1}^{n=30} T_i + 54 \right)$$

Leadership Area Evaluation Model

In the leadership section of SPMEI, the respondent has to choose to respond to one of two questions: L17 and L18. If the project team mostly consists of inexperienced staff then the respondent should answer question L17. If the project team mostly consists of experienced staff, then the respondent should answer question L18. The choices for these questions are identical. However, the scoring is different. The model for both cases is presented below. If the team mostly consists of inexperienced staff, then the leadership area model is as follows:

$$Leadership\ Area\ Score = \frac{10}{68} \times \left(\sum_{i=1}^{n=17} L_i + 34 \right)$$

If the team mostly consisted of experienced staff, then the leadership area model is as follows:

$$Leadership\ Area\ Score = \frac{10}{68} \times \left(\sum_{i=1}^{n=16} L_i + L_{18} + 34 \right)$$

Organizational Commitment Area Evaluation Model

$$Organizational\ Commitment\ Area\ Score = \frac{10}{112} \times \left(\sum_{i=1}^{n=26} OC_i + 50 \right)$$

Project Manager Area Evaluation Model

$$Project\ Manager\ Area\ Score = \frac{10}{112} \times \left(\sum_{i=1}^{n=27} PM_i + 52 \right)$$

Stakeholder Involvement Area Evaluation Model

In the stakeholder involvement section of SPMEI, the questions after SI10 are divided into two sections. If the project is developed for the market without a specific contract, then the respondent should answer questions SI11 and SI12. If the project is developed under a contract with a customer, then the respondent should not answer the questions SI11 and SI12, but the questions from SI13 to SI18 instead. If the project is developed for the market, then the stakeholder involvement area model is as follows:

$$Stakeholder\ Involvement\ Area\ Score = \frac{10}{56} \times \left(\sum_{i=1}^{n=12} SI_i + 22 \right)$$

If the project is developed for the market, then the stakeholder involvement area model is as follows:

$$Stakeholder\ Involvement\ Area\ Score = \frac{10}{72} \times \left(\sum_{i=1}^{n=10} SI_i + \sum_{i=13}^{n=18} SI_i + 30 \right)$$

Staffing and Hiring Area Evaluation Model

$$Staffing\ and\ Hiring\ Area\ Score = \frac{10}{116} \times \left(\sum_{i=1}^{n=29} S_i + 52 \right)$$

Requirements Management Area Evaluation Model

$$Requirments\ Managment\ Area\ Score = \frac{10}{123} \times \left(\sum_{i=1}^{n=27} RM_i + 50 \right)$$

Project Monitoring and Control Area Evaluation Model

$$Project\ Monitoring\ and\ Control\ Area\ Score = \frac{10}{86} \times \left(\sum_{i=1}^{n=19} PMC_i + 32 \right)$$

Project Planning and Estimation Area Evaluation Model

$$Project\ Planning\ and\ Estimation\ Area\ Score = \frac{10}{174} \times \left(\sum_{i=1}^{n=33} PPE_i + 70 \right)$$

Scope Management Area Evaluation Model

$$Scope\ Management\ Area\ Score = \frac{10}{71} \times \left(\sum_{i=1}^{n=16} SM_i + 26 \right)$$

Configuration Management Area Evaluation Model

$$Configuration\ Management\ Area\ Score = \frac{10}{60} \times \left(\sum_{i=1}^{n=13} CM_i + 22 \right)$$

Quality Engineering Area Evaluation Model

$$Quality\ Engineering\ Area\ Score = \frac{10}{93} \times \left(\sum_{i=1}^{n=20} QE_i + 36 \right)$$

Risk Assessment Area Evaluation Model

In the risk assessment section of the SPMEI, there is an additional question at the end of the section for the projects in which subcontracting is used. The question identifier is RA20. If the project does not utilize subcontracting, then the risk assessment area model is as follows:

$$Risk\ Assessment\ Area\ Score = \frac{10}{90} \times \left(\sum_{i=1}^{n=19} RA_i + 34 \right)$$

If the project utilizes subcontracting, then the risk assessment area model is as follows:

$$Risk\ Assessment\ Area\ Score = \frac{10}{100} \times \left(\sum_{i=1}^{n=20} RA_i + 38 \right)$$

Risk Control Area Evaluation Model

In the risk control section of the SPMEI, there are four questions that are excluded from the evaluation model: RC1, RC2, RC3, and RC4. These questions

are included in the instrument to enable a consistency check among the responses and for other research purposes. Therefore, for the risk control area model, only the responses from RC5 to RC17 are included in the evaluation model:

$$Risk\ Control\ Area\ Score = \frac{10}{54} \times \left(\sum_{i=1}^{n=17} RC_i + 26 \right)$$

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APPENDIX E. METRIC FEEDBACK INSTRUMENT

Consent to Participate in Research

Introduction. You recently participated in a research study entitled "The Effectiveness of Software Project Management Practices" conducted by the Naval Postgraduate School. You are now invited to provide feedback on the study.

Procedures. The data you provided has helped assist with the development of a software project management effectiveness (PME) metric. The research into the usefulness and the applicability of this metric is ongoing. The PME metric for your project was calculated from the responses in your survey and provided to you. The purpose of this additional survey is to inquire into the usefulness and applicability of the original survey and the PME metric so that it can be improved in the future.

Voluntary Nature of the Study. Your participation in this study is strictly voluntary. If you choose to participate you can change your mind at any time and withdraw from the study. You will not be penalized in any way or lose any benefits to which you would otherwise be entitled if you choose not to participate in this study or to withdraw.

Potential Risks and Discomforts. The potential risks of participating in this study are:

b) A breach of confidentiality may result in embarrassment of the research subject.

Anticipated Benefits. Anticipated benefits from this study are:

a) To assist in the development of project management metrics and improve the software engineering body of knowledge to improve software project management; and

b) To enable the development of a tool for you to monitor, evaluate and improve your projects.

Compensation for Participation. No tangible compensation will be given. A copy of the research results will be available at the conclusion of the experiment.

Confidentiality & Privacy Act. Any information that is obtained during this study will be kept confidential to the fullest extent permitted by law. All efforts, within reason, will be made to keep your personal information in your research record confidential but total confidentiality cannot be guaranteed. No information will be publicly accessible which could identify you as a participant. Research records will be stored and maintained in electronic form on NPS secure servers only

accessible by the researchers. Any hard copy material containing research findings, including a thesis, will not contain any personal information.

Points of Contact. If you have any questions or comments about the research, or you experience an injury or have questions about any discomforts that you experience while taking part in this study, please contact the Principal Investigator, Dr John Osmundson, 831-656-3775, josmundson@nps.edu. Questions about your rights as a research subject, or any other concerns, may be addressed to the Naval Postgraduate School IRB Chair, CAPT John Schmidt, USN, 831-656-3864, jkschmid@nps.edu.

Statement of Consent. I have read the information provided above. I have been given the opportunity to ask questions and all the questions have been answered to my satisfaction. I have been provided a copy of this form for my records and I agree to participate in this study. I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

Metric Feedback Instrument

Please read the Software Project Management Effectiveness Metric provided to you. Then hypothetically consider using the previous survey questions on the next software project you work on and respond to the following questions.

Manageability: A metric's information should be available and concise. How manageable is the PME metric? (1 being unmanageable and 10 being easily manageable)

1 2 3 4 5 6 7 8 9 10

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Please provide any comments you may have on the metric's manageability:

Meaningful: A metric must be understandable and relevant to the recipient and provide a basis for decisions. How meaningful is the PME metric? (1 being not meaningful and 10 being very meaningful)

1 2 3 4 5 6 7 8 9 10

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Please provide any comments you may have on how meaningful the metric is:

Actionable: Useful metrics information makes it clear what response is needed, as a compass makes it clear whether to turn left or right or stay on course. How actionable is the PME metric? (1 being not actionable at all and 10 being easily actionable)

1 2 3 4 5 6 7 8 9 10

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Please provide any comments you may have on the metric's actionability:

Ambiguity: Information from metrics can have a number of meanings and may be misleading, of little use, or downright dangerous. How ambiguous is the PME metric? (1 being very ambiguous and 10 being completely unambiguous)

1 2 3 4 5 6 7 8 9 10

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Please provide any comments you may have on the metric's ambiguity:

Reliability: The ability to trust the "instrument" is conditioned on the reliability of the measurement. How reliable is the PME metric? (1 being completely unreliable and 10 being completely reliable)

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please provide any comments you may have on the metric's reliability:

Accuracy: A reasonable and known degree of a metric's accuracy is essential. The compass showing north when we are going south can be fatal. How accurate is the PME metric? (1 being completely inaccurate and 10 being completely accurate)

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please provide any comments you may have on the metric's accuracy:

Timely: Measures that warn of a disaster after it has happened are not useful. Consider measuring the PME of a project after the initial requirements development phase of a project. How timely is the PME metric? (1 being far too late and 10 being right on time)

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please provide any comments you may have on the metric's timeliness:

Predictive: Some metrics information will signal impending problems much as a drop in oil pressure is the harbinger of engine failure. Consider measuring the PME of a project after the initial requirements development phase of a project. How predictive is the PME metric? (1 being completely non predictive and 10 being very predictive)

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Please provide any comments you may have on the metric's predictability:

Would you use, or would you like to see, the PME metric used on the next software project you work on?

Yes **No**
☐ ☐

Please briefly explain why or why not.

Thank you for your participation!

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APPENDIX F. SOFTWARE PROJECT MANAGEMENT EFFECTIVENESS METRIC REPORT CARD

In a recent study on the effectiveness of software project management practices, you completed a survey on the project management practices in place on a project you have worked on. The data you provided has helped assist with the development of a software project management effectiveness (PME) metric. The research into the usefulness and the applicability of this metric is ongoing. The PME metric for your project was calculated from the responses in your survey. For your information, the results are presented here.

Legend	
Area:	The specific area of software project management measured.
Score:	Calculated rating from 0 to 10 (0 being the lowest and 10 being the highest).
Average:	Average score of projects in the study.
Explanation:	Standard comments to explain the area score.

Area	Score	Average	Explanation
Communication	**4.9**	6.9	A successful project requires constant and effective communication between project stakeholders. This score is an indication of the effectiveness of the communication in the project.
Teamwork	**6.1**	7.0	As software is developed by teams, strong teamwork is essential to successfully completing a software project. This score is an indication of the effectiveness of the teamwork in the project.
Leadership	**4.3**	7.1	In a software development environment leadership is how personnel in management positions exert social influence to enlist the aid and support of others in the accomplishment of project's goals. This score is an indication of the effectiveness of the leadership in the project.
Organizational commitment	**7.1**	7.1	Organizational commitment is the employee's psychological attachment to the organization and organizational goals. This score is an indication of the effectiveness of the organizational commitment in the project.
Project Manager	**6.3**	7.6	The project manager position is a key role in a software project's organizational structure. This score is an indication of the effectiveness of the project manager in the project.
Stakeholder involvement	**4.4**	6.6	Stakeholder engagement is concerned with the level of involvement of all the different stakeholders during the project development effort. This score is an indication of the effectiveness of the stakeholder engagement in the project.
Staffing and Hiring	**6.1**	6.5	Staffing and hiring is the ability to source human resources and put them in the right project role. This score is an indication of the effectiveness of the staffing and hiring in the project.

People	**5.6**	7.0	The people score is the average of the communication, teamwork, leadership, organizational commitment, project manager, stakeholder involvement, staffing and hiring scores.

Area	Score	Average	Explanation
Requirements management	**7.5**	6.7	This process involves the management of the software requirements and is not to be confused with the requirements development process. This score is an indication of the effectiveness of the requirements management in the project.
Project Monitoring and Control	**6.5**	6.6	Project monitoring is the process of keeping the project, project related factors and project metrics under continuous observation. This score is an indication of the effectiveness of the project monitoring and control in the project.
Project planning and estimation	**6.7**	6.6	Project planning and estimation is the process of establishing and maintaining the plans that define the project's work activities. This score is an indication of the effectiveness of the project planning and estimation in the project.
Scope management	**6.5**	5.9	This is the process of defining the scope of the project and keeping track of any changes to the scope. This score is an indication of the effectiveness of the scope management in the project.
Process	**6.8**	6.4	This score is the average of the requirements management, project monitoring and control, project planning and estimation and scope management scores.

Area	Score	Average	Explanation
Configuration management	**10**	6.3	Software configuration management is the discipline that enables us to keep evolving software products under control, and thus contributes to satisfying quality constraints. This score is an indication of the effectiveness of the configuration management in the project.
Quality engineering	**9.5**	7.1	Quality engineering involves all activities put in place to ensure the development of a high quality product. This score is an indication of the effectiveness of the quality engineering in the project.
Product	**9.7**	6.7	The product score is the average of the configuration management and quality engineering scores.

Area	Score	Average	Explanation
Risk assessment	**6.0**	6.0	Risk assessment involves risk identification, risk analysis and risk prioritization. This score is an indication of the effectiveness of the risk assessment in the project.
Risk control	**6.1**	5.6	Risk control involves risk management planning, risk resolution, and risk monitoring. This score is an indication of the effectiveness of the risk control in the project.
Risk	**6.1**	5.8	Risk management is an inherent aspect of any software project. This score is the average of the risk assessment and control scores.

PME Score	**6.9**	**6.5**	**The project management effectiveness score is the weighted sum of the people, process, product and risk scores. It gives an indication of the effectiveness of the software project management in the project.**

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APPENDIX G. FEEDBACK METRIC INSTRUMENT RESPONSES

Score	Manageability Comments
9	Nil
9	Nil
7	Nil
4	Nil
8	Nil
10	It's a short list easily manageable and areas and overall scores can be clearly be identified.
4	While getting back the "score" was interesting, not having any explanation of why or how the score was derived limits
8	I am not sure what you mean by manageable

Score	Meaningfulness Comments
7	As a high-level indicator, I think it clearly defines the areas of good performance and the areas of concern. I'm not quite sure whether we can treat these metrics as values, and while I notice that the final score was a weighted sum, it's not quite apparent which areas are given the most weighting, especially since the unweighted average came out so close to the final score. Realistically, I am not going to be able to address each of the low scoring areas simultaneously, so if I have to pick an area of improvement I want to pick the one that's going to give me the best chance of improving my project success, and that may not be the one with the lowest score. While knowing the average score is probably a great metric for you, I'm not sure what I can do with it. I would like to see target bands or something similar that that gives me a clearly defined goal to aim for. I'm not too concerned about beating the average (commercial world might look at this differently, i.e., better than average makes them look good when to win a contract), I want to know how a certain score will impact my project. Perhaps you can use the data from your surveys to work out some bands, it's entirely subjective, but in reality so was the survey.
7	Nil
8	Without the average, these metrics are meaningless, so the point is how significant and precise is the average ?
7	Nil
8	Nil

8	The scores are clear and simple; you can easily assess how well the surveyed group performed and how well you did. The areas are straightforward along with their explanations. However, in order to begin self improvement it would be good to see a breakdown of key techniques in each area and how you scored on each if it's available. That you could begin focusing on some techniques that you were lacking in. Though this extra information may work adversely against the manageability of the report which is really concise at the moment.
4	For some of my scores, I know enough that I agree - good score for CM, not so good for risk management. But I'm not sure why I got a poor score for Leadership.
10	Nil

Score	Actionability Comments
7	As before, the areas where we need to improve are clear, but its hard to prioritize which ones to go after first.
7	When a project is performing very poorly by a rather large gap, the metric provides clear insight; in other cases it will be less clear what action to take.
8	Nil
6	Nil
8	Nil
7	I touched on this a bit in the last question, I think for some areas that are a bit broader - what you're doing well and what you need to improve on may not be so clear. But for the areas that are based on a technique, like 'Configuration Management', which is one I need to improve on, I can clearly see how to improve that. And coincidently my company it currently working hard to improve our standard of configuration management.
3	Nil
8	Nil

Score	Ambiguity
7	I don’t think the PME metric is ambiguous but I think it is still lacking in definition. It tells me how I scored compared to the average, but it does not tell me if the scores are good or not. My projects final PME score was higher than average, but I know we performed atrociously, so am I to assume that because we beat the average we are actually doing alright? What projects did you use to create your average, did you get a good spread of projects or just a whole bunch of bad projects? Did we only beat the average because most of the projects sampled were bad projects?

6	The generated report is unambiguous, but some of the questions in the original survey could have a wide variance in interpretation.
8	Examples would remove ambiguities in certain cases
3	Nil
8	Nil
8	The areas create clear boundaries and the scores that relate to them are simple to understand. I think there's only a little and maybe not even crucial ambiguity, like I stated in the earlier questions, where within a broad area such as 'Communication' you may not know what you are doing right and what you need to improve on within that area.
8	Nil
8	Nil

Score	Reliability Comments
9	I am convinced that the scores from the survey will produce reliable metrics. The problem comes from getting a reliable source of data to produce the metrics
7	Nil
8	Nil
5	Nil
8	Nil
9	The survey seemed to translate well into scores I could relate to.
5	Nil
8	Nil

Score	Accuracy Comments
6	here is an inherent inaccuracy that comes from doing something subjective like a survey and that comes from the bias of the person completing the survey. This could probably be combated by surveying a wide sample of people from the same project and getting someone independent to make an assessment
6	Nil
7	For some cases the scale of assessment could have been a percentage rather than a five level scale
7	Nil
8	Nil
9	I found it very accurate. The areas I consider myself good at or lacking were reflected spot on in the report.
4	Nil
8	Nil

Score	timeliness Comments
7	I disagree with the statement that measures warning of disaster after it has happened are not useful. In my opinion it depends entirely on how you intend to use the measures. Back on topic, this metric would be considered timely if produced just after the initial requirements development phase of a project, but I would not be using these metrics as a predictive tool.
8	Nil
9	Nil
5	Nil
8	Nil
9	I think you'd need that real grasp of what work is to be carried out and the risks involved with getting it to the requirements first. So I think this is a good time.
4	Would you know enough to get meaningful answers to the questions? Just because a good CM infrastructure was in place, suppose developers stopped using CM and checked in code updates less and less often?
8	Nil

Score	Predictive Comments
6	While this metric could possibly be predictive, I would not use this metric as a predictive tool. I would be using these metrics at the end of a project as a way of assessing how we did in the project and identifying what areas we need to improve for our next project. I think there are better predictive measures out there, PSM has made a successful business out of determining the best measures to use at different stages of a project. As far as I know, organizations make money out of running multiple software projects, they are not normally interested in starting up a company to complete one project before shutting down again
7	For some areas, low scores will be very predictive of problems (e.g., Stakeholder involvement). Others I would give less weight to that early on in the project (e.g., Teamwork).
9	Could be proactive if the PM is confronted to higher risks in the upcoming projects
4	Nil
8	Nil
8	This is a tough one. It reinforces a lot of management techniques that need to be considered at the requirements stage of development and has the chance to improve predicting aspects of the project.

3	Nil
5	Nil

Yes/No	Please briefly explain why or why not
1	This is the sort of metric you need to use at the end of each project. It clearly identifies strengths and weakness, and from that you can select areas that need improvement. You can compare previous results with later results to see if the processes you have introduced have actually resulted in improvements to those weaker areas. I think you have created a great tool to analyze strengths and weaknesses of an project/organization but your metrics report probably needs a bit of work before you could use it as a predictive management tool. This tool is perfect for use at the end of a project because you can use it to identify areas that need to improve to make your next project work better.
0	No, not as is. The original questions need to be less open to interpretation. I would likely begin with a metric reduced in scope to questions that could be answered objectively, then as the team is allowed time to build trust and establish relationships, introduce the more subjective question areas
1	At least I can evaluate whether the process is evolving or not. and also helps to fix problems per domain
1	Nil
1	Nil
1	Yes. I found the survey very useful as a chance to reflect on my last project and I've found it's made me think about my current projects.
0	Since not feedback was given on how survey answers were converted into PME metrics, it is not possible for me to understand what behaviors were good and which behaviors need to be changed. Also, as for the leadership questions, senior leadership is not something that I or a typical project leader can really influence, control, or change.
1	Yes, if the metrics is available throughout the projects

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