Engineering Management Master's Theses

Department of Mechanical and Industrial Engineering

January 01, 2008

Examining agile management methods and non-agile management methods in global software development projects

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EXAMINING AGILE MANAGEMENT METHODS AND NON-AGILE MANAGEMENT METHODS IN GLOBAL SOFTWARE DEVELOPMENT PROJECTS

A Thesis Presented

by

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to

The Department of Mechanical and Industrial Engineering

in partial fulfillment of the requirements

for the degree of

Master of Science

in the field of

Engineering Management

Northeastern University
Boston, Massachusetts

August 2008

Abstract

Global software development (GSD) undertakings, whether set up as one time projects or continuous operational structures, are growing in popularity and becoming more common in organizations. With globally distributed software teams implementing projects there are risks and challenges that do not affect the outcome of co-located team software development projects. The present study is concerned with understanding more about the project management characteristics associated with global software development project success. Specifically, the way Agile and Non-Agile management methods coupled with project management characteristics related to project success were investigated. The data collection instrument for this study was a web based survey, consisting of 21 questions. To understand how software management methods impact GSD project success, project management characteristics, including culture, language, communication, experience, tools, and requirements were treated as independent or predictor variables in this study. The dependent variable examined was project success.

The results of this study indicate that GSD projects managed using Agile software development project management methods do not experience different levels of project success than GSD projects managed using Non-Agile software development project management methods. The findings of this study show that less frequent changes of requirements on projects, providing appropriate project tools to project team members, and building cultural synergy among the globally distributed team positively affects the outcome of GSD projects, particularly in terms of time, scope, and customer satisfaction.

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Chapter 1

Introduction

Global software development (GSD) undertakings, whether set up as one time projects or continuous operational structures, are growing in popularity and becoming more common in organizations. For example, Siemens, a global electronics corporation, spends approximately three billion Euros annually on software development throughout its world wide organization (Bass, Herbsleb, and Lescher, 2007). It is expected that the global marketplace for information and technology will reach close to four trillion dollars by 2009 (Greenwald, 2006), with growth rates varying by regions.

The benefits that drive organizations to take advantage of GSD are coupled with risks and challenges requiring organizations utilizing GSD approaches to increase the depth and breadth of their skills. Creating and sustaining a coherent globally distributed team is challenging given the following factors: language and cultural differences, communication, and temporal distance (Holmstrom, Conchuir, and Agerfalk, 2006). These challenges are in addition to the regular risks and constraints that non-global projects have to overcome, including scope creep, project team member experience and proficiency.

Similar to co-located software development projects, GSD projects are subject to continuous struggles with tight schedules, budgets, and failure to accomplish all the project goals. To become more successful some companies have tried to adapt new management models to overcome these various project failures. Specifically, there are few general software management models being used on GSD projects, such as the Waterfall model and Agile methods. There are many other models and methods,

including hybrid versions using a combination of both Waterfall and Agile. For example iterative management is a version of the Waterfall model in which the sequence of requirements gathering and testing is done three or more times before the project is complete and released to the client (Pressman, 1997).

The Waterfall model has been used since the 1970's. In this approach the development cycle follows a sequential order of steps and is traditionally composed of the following steps: (1) requirements gathering; (2) design; (3) implementation; (4) testing; (5) maintenance/release to the client (Pressman, 1997).

Agile software development project management methods have been in use since 2000. These methods utilize a less linear approach to software development, than previous methods of software development. The core principles of Agile methods are focused on frequent communication between clients and developers, short iterations with very specific goals, and frequent interactions between the team members themselves. There has been some use of Agile methods to manage GSD projects; however, it is unclear how successful these attempts were because few studies, if any have been conducted to investigate the success of Agile methods in managing GSD projects (Paasivaara and Lassenius, 2006). In turn, this study investigates how project factors and utilizing Agile methods in GSD projects affects project success.

As the global IT marketplace continues to grow and the number of globally distributed organizations increases, it is imperative to know what the risks and challenges are in this environment and how to best overcome them. Thus, this study aims to provide insight into the impact of GSD project management characteristics on project success and how Agile and Non-Agile management models overcome these challenges.

Chapter 2

Review of Literature

This chapter provides a brief overview of project management, software development, Agile software development methods, and globalization. The goal is to illustrate the complexities of global software development (GSD) projects. In addition, critical project management characteristics of GSD projects are discussed, as well as what constitutes GSD project success.

2.1 Project Management Overview

The Egyptian Pyramids, the Grand Canal of China, and St. Petersburg, Russia are ancient marvels of humankind, which represent some of the earliest technical projects accomplished by humans (Cleland, 2005). However, modern project management techniques were recently developed by the military; with the Manhattan Project or the building of the first nuclear bomb, being one of the first of the modern projects (Shtub, Bard, and Globerson, 1994).

As companies realized the benefits of applying military management techniques to their projects, the military's project management techniques began to spread into the commercial sector. Initially these techniques were only applied to projects developing products; however, over time these project management techniques spread to other areas outside of product development including, organizations producing services as well as the nonprofit sector (Meredith and Mantel, 2006). As numerous project-oriented organizations began to form, a demand for project management as a profession emerged (Williams, 2005); coupled with this, professional associations in the field of project management, particularly the Project Management Institute, PMI, which was established

in 1969 with the mission to share professionalism and establish a body of knowledge in

the field of project management (Meredith and Mantel, 2006). As of May 2008 the PMI

had 260,000 members in 171 countries[1].

The Project Management Institute (PMI) defines a project as "a temporary

endeavor undertaken to create a unique product, service, or result" (PMI, 2004). A

project is specific and composed of finite subtasks that must be carried out in a set

sequence to achieve the project goal or goals (Shtub, Bard, and Globerson, 1994). These

subtasks are coordinated and monitored in terms of time, arrangement, cost, and

performance.

Project management is "the application of knowledge, skills, tools and techniques

to project activities to meet project requirements" (PMI, 2004). Project managers apply

project management principles and guide projects through initiation, planning, execution,

monitoring and controlling, and closing in order to achieve the project goals. To

maintain project quality and achieve the project objectives project managers balance what

is known as the "the triple constraint", the project scope, time, and cost (Meredith and

Mantel, 2006). In addition, project managers are also tasked with balancing the human

element on projects; the difficulty of this task varies with the size of the project team and

the complexity of the project (PMI, 2004).

Knowledge, Skills, Challenges Unique to the Field of Project Management

According to the PMI, effective project management requires that the project

teams be versed in five areas of knowledge including; 1.) Project management

knowledge, consisting of the project life cycle, project management process groups that

cover processes for project initiation, planning, executing, monitoring and control, and

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[1] Retrieved March 30th, 2008, from *http://www.pmi.org/aboutus/Pages/Default.aspx*

closing, and the nine knowledge areas covering project integration, project scope, project time, project cost, project quality, project human resource, project communication, project risk, and project procurement; 2.) Application area knowledge, standards and regulations, where application areas provide groups of projects that share important elements with the project; 3) Project environment, or the cultural, political, and physical environments in which the projects are planned and implemented; 4) General management knowledge and skills as a base for building project management skills; 5) Interpersonal skills particularly in relation to effective communication, leadership, motivation, influence, negotiation and conflict management, and problem solving (PMI, 2004).

Project Success

The traditional three measures of project success are project completion time, project budget, and accomplished project scope. However another important characteristic of project success is customer satisfaction. Research by Poli and Shenhar (Poli, and Shenhar, 2003) stated that customer satisfaction is the most important measure of project success. Customer satisfaction and organizational impact need to be considered as measures of project success along with the traditional measures of time, cost, and performance (Hamidovic and Krajnovic, 2005). This modern definition for project success is well defined by Kerzner who stated that project success is composed of primary and secondary factors, where primary factors include being on time and within the desired quality, and secondary factors include acceptance by customers (Kerzner, 2004).

2.2 Software Development

Project management has seen the greatest adaptation and growth in the field of software development. Software engineering started in the 1950's at the same time as the development of the first commercial computers (Hashage, Keli-Slawik, and Norber, 2002). Software engineering, also referred to as software development, produces software as a product or a service. Software development is a systematic approach that typically consists of the following activities: design, development, operation, and maintenance of software. Each specific and unique arrangement of these activities represents a unique software process model (Pressman, 1997). The most widely used models and methods include: code and fix model, linear sequential model, also know as the Waterfall model, evolutionary models, and Agile methods. However, these models and methods continue to evolve and develop over time.

The code and fix model was the earliest software development model to be used in software development. Historically, software development was an afterthought to many projects, and a programmer would develop the software, install it, and fix it when needed by going back to the code and fixing it. However as software complexities increased the effectiveness of the code and fix model declined. This method is unable to detect software complexities until later stages in the project, which is not sufficient for larger-scale projects. However, this model continues to work well for small projects, as new methods have emerged to manage more complicated software development projects (Pressman, 1997; Grubb, and Takang, 2003).

The linear sequential model, also know as the "classic life cycle" or the "Waterfall model" was proposed by Winston Royce in the 1970's (Pressman, 1997). The

linear model includes sequential steps that progress through analysis, design, coding,

testing, and maintenance. The original model proposed by Royce included feedback

loops between stages to allow customer feedback and corrections. However more recent

versions of this model are simplified and thus do not include feedback loops (Taylor,

Greer, Sage, Coleman, McDaid, and Keenan, 2006). This linear sequential model,

without the feedback loops, is one of the most widely used models for software

engineering. Nevertheless this approach suffers from a few drawbacks, including:

projects rarely have a sequential flow; it requires customers to have patience; this method

requires customers to give exact requirements during the early stages on projects; there is

limited ability to change requirements through the lifetime of the project; and finally,

linear flow can cause bottlenecks, particularly among developers working on dependent

tasks (Pressman, 1997).

Evolutionary software development methods were created to overcome the

shortcomings of the code and fix model and the Waterfall model. These methods are

iterative and allow software engineers to increasingly produce more functional versions

of the software (Davis, Bersoff, and Comer, 1988). The incremental model and the spiral

model are both representatives of the evolutionary software development approach. The

incremental model focuses on first implementing the core functionality. Once the

customers review the core functionality and provide feedback the development of the

next increment occurs. The spiral model on the other hand develops software in a series

of incremental software releases. The spiral model has a number of activity regions

including, customer communication, planning, risk analysis, engineering, release, and

customer evaluation. The number of these activity regions through which the project

moves, varies based on the complexity of the project. In subsequent releases more complete versions of the software are released. However this evolutionary approach can cause problems if major problems are uncovered in later releases rather than in earlier ones because this often leads to project delays (Pressman, 1997).

Agile Software Development

The aforementioned models in software development all have limitations that have led organizations to look for more effective ways to manage the development of software. Agile software development methods emerged as a contemporary method for managing software development. Agile methods aim to align with the real world business processes by reducing the risks in software development and increase productivity and quality (Coram and Bohner, 2005). Risks are reduced by developing software in short iterations and capturing frequent customer feedback. Agile management is based on the Agile Manifesto which was created in 2001 by 17 people, including representatives from Extreme Programming, SCRUM, Feature-Driven Development, Pragmatic Programming, and others. Specifically the manifesto states:

> "We are uncovering better ways of developing software by doing it and
> helping others do it. Through this work we have come to value:
> Individuals and interactions over processes and tools; Working software
> over comprehensive documentation; Customer collaboration over contract
> negotiation; Responding to change over following a plan ..."[2]

Agile methods focus on frequent face-to-face communication between team members and customers, rather than spending time generating detailed project documents as other methods may. Time is dedicated to rapidly develop working software with iterative functionality, such that it can be shown to the customer to gain early feedback

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[2] Manifesto for Agile Software development. Retrieved March 30th, 2008, from
http://www.agilemanifesto.org

regarding whether the development is on track and going in the right direction (Anderson, 2003). There are several software development models that are part of Agile development methods, the most commonly used are: Extreme Programming, SCRUM, and Feature-Driven Development.

Extreme Programming, which is also called XP, conceived during a project at the Chrysler Corporation in the 1990s, is an Agile method that emphasizes the following phases to complete each iteration of development: paired programming, continuous integration, no analysis or design phase, and a user acceptances phase instead of a dedicated test phase (Anderson, 2003).

Scrum, named by the strategic rugby formation, originated in the Japanese manufacturing industry. It is a software management method that combines daily stand-up meetings to tackle issues interfering with productivity and Sprint cycles (development iterations that typically last less about 4 weeks). In the Scrum method software development projects are organized into three levels: sprints, releases, and products. Releases are collections of sprints and products are collections of releases. Sprints are based on backlogs which contain the features to be implemented during a given sprint cycle (Anderson, 2003).

Feature-Driven Development, (FDD) is considered by some to be less of an Agile method because it uses many established software development methods. This method is composed of planning, modeling, and design as opposed to an approach of direct software development with minimal documentation and planning steps. FDD consists of five steps: (1) shape modeling, which involves modeling business behaviors, investigating non-functional requirements, and developing an architecture for the system;

(2) feature list, which uses the models created from the first step to create a finer grained prioritized list of features to be developed; (3) plan by subject area, which categorizes features based on similarity, into Features Sets (FS) and Subject Areas (SA); (4) design by feature, which consists of detailed designing of features from the feature sets; (5) build by chief programmer work package, which is the actual implementation of the designs developed in the step 4 (Anderson, 2003).

Applying Agile methodology to software project management is beneficial particularly when project managers have teams that have a high level of skills, expertise, and strong communication skills (Coram and Bohner, 2005). Although many organizations are moving towards adopting Agile methods these methods are not ideal for every project. In particular organizations attempting to apply agile methods to distributed development should carefully asses their readiness to adopt this method beforehand (Nerur, Makapatra, and Mangalaraj, 2005).

2.3 Global Software Development

The recent growth in the global software development arena is a directly related to globalization. Globalization is challenging to define since various interpretations of it exist that are dependent on the particular historic context. One contemporary definition of globalization is that it is "the extension of worldwide interconnection of all social aspects of the modern world, including political, cultural, and economical" (Held, McGrew, Goldblatt, and Perraton, 1999). Merriam-Webster online dictionary (2008) defines globalization as "the development of an increasingly global market economy marked especially by free trade, free flow of capital, and the tapping of the cheaper foreign labor markets."

During the Cold War from the 1940's to the 1990's, U.S. organizations were restricted to markets that were not aligned with the USSR. With the end of the Soviet Union, U.S. organizations were able to utilize these markets (Gerstenfeld and Njoroge, 2004). This shift allowed organizations to offer their products and services to these new markets as well as gain access to a cheaper labor force. In addition, following the Cold War, global markets closer to the U.S. became available. The North American Free Trade Agreement (NAFTA) granted U.S. organizations the rights to run production facilities in Mexico where the cost of labor is far less expensive that in the U.S. Similarly, European companies utilize skilled labor in Eastern Europe.

With advances in telecommunication and technical infrastructure reducing the impact of geographic distance, organizations continue to expand and establish their presence in these new markets, by distributing business units throughout the world. Specifically, organizations grew to form and operate business units distributed in markets among different cultures, languages, time zones, and political and legal systems (Adya, 2006). This growth, driven by globalization, has enabled companies to benefit from increased access to talent, cost savings, 24/7 development, and the ability to be closer to the customer (Bass, Herbsleb, and Lescher, 2007). These diverse advantages of globalization drove software development projects to a global level, global software development (GSD), where organization units and the project members are no longer co-located in the same office (Damian and Moitra, 2006).

With globally distributed software teams implementing projects there are risks and challenges that traditionally did not affect the outcome of co-located team software development projects. One study stated "International engineering teams are notoriously

behind schedule" (Mar-Yohana, 2001). There are many possible reasons why project

delays occur with global engineering teams. In one study many of the cases investigated

discovered that issues, such as group communications, education and training differences,

availability of technology, language, different management styles, different work ethics,

and political and legal issues were not properly addressed in global projects (Mar-

Yohana, 2001). In GSD projects team members speak and think in different languages,

have diverse cultural values, and are very rarely able to have in-person meetings

(Barczak, McDonough, and Athanassiou, 2006). Companies have to make crucial

changes to their management techniques to be successful in the global market since

customers continue to expect lower costs, shorter engineering times, and prompt attention

to their needs (Kini, 2000). Some of these changes are related to a series of project

management characteristics that may be linked to project success including: culture and

language, communication tools and training, specific to work on global projects,

employee's experience, and the requirements of the project.

Project Management Characteristics related to the Success of GSD Projects

Culture and Language

Global projects are associated with challenges related to culture, language, and

temporal distance, which are not generally present in projects being managed and staffed

by a co-located team in a single office. Managing these challenges is key to the success

of global projects (Bass, Herbsleb, and Lescher, 2007). Differences in culture and

language can cause difficulty among globally distributed teams in creating a common

understanding (Holmstrom, Conchuir, and Agerfalk, 2006). The overall success or

failure of a project is a direct reflection of the project team members' abilities to manage

cultural differences (Henrie and Sousa-Poza, 2005). When leading global software

development teams it is very important to understand the culture and background of

remote team members (Mar-Yohana, 2001).

Communication, Tools, and Training

Co-located development relies heavily on frequent communication, shared

knowledge, and common history, something that is absent within globally distributed

projects (Herbsleb, 2007). A popular strategy in global software development to

overcome these shortcomings is to establish virtual teams, teams that span across

temporal distances and geographical locations, organizations and are linked by

communication technologies (Casey, and Richardson, 2006), which will require

established policies and procedures combined with additional training in order to achieve

effective communication (Casey and Richardson, 2006). The geographical distance

resists a strong team formation and investment in key infrastructure technology that is

essential to support the virtual team strategy. Even smaller efforts, such as websites with

photos and personal profiles of team members can bring a globally distributed team

closer to benefit their performance (Holmstrom, Conchuir, and Agerfalk, 2006).

However there is no single effective technology to overcome the geographical distance

and time separation. Even synchronous technologies for distributed groups are still

limited in their usability (Damian, Lanubile, and Mallardo, 2006). A portfolio of

technologies coupled with practices and methods are used to address these challenges

(DeLona, Espionsa, Lee, and Carmel, 2005). However, very little is understood about the

tradeoffs and the conditions of applicability for these technologies, practices, and

methods (Herbsleb, 2007). Some organizations mistakenly assume that development

processes, practices, or methods to support teams that are geographical separated will not benefit a project when in fact they could (Chiang and Mookerjee, 2004).

Experience

Talented team members are the most important aspect related to improving performance in software development (Blackburn, Scudder, and Van Wassenhove, 2000). For global projects this talent and experience moves beyond the usual scope related to technical skills and education and additionally encompasses the ability to manage individuals from culturally diverse backgrounds, who are geographically removed from where the project manager is located. Observations have shown that prior experience with global information system projects is an important factor in achieving rigor and agility (Lee, DeLone, and Espinosa, 2007). A team comprised of members with prior experience on global projects can reduce the amount of rework and in turn increase the timeliness and effectiveness of the project (Gopal, Mukhopadhyay, and Krishnan, 2002). To increase this experience among next generation of professionals, research has motivated some academic institutions to provide education in global collaboration for students (Adya, 2006).

Requirements

Requirement gathering is one of the most critical phases in software development. Any uncertainty about the actual desired functionality that clients request can significantly affect the percentage of project rework required, which ultimately impacts the final project success in terms of timeliness, requirements met, and customer satisfaction (Gopal, Mukhopadhyay, and Krishnan, 2002). In GSD this risk is elevated due to the cultural and language complexities that can occur when gathering requirements from

clients (Aranda, Cechich, Vizcaino, and Piattini, 2006). For GSD projects to scceed managers need to find ways to reduce project execution challenges and risks associated with scope and requirements that are related to cultural differences (Wallace and Keil, 2004).

2.4 Purpose of the Present Study

Agile software development methods have been gaining acceptability in organizations and have been used successfully with GSD projects (Taylor, Greer, Sage, Coleman, McDaid, and Leenan, 2006).   However, from an empirical perspective, very little is known about the effectiveness of these practices (Herbsleb, 2007). In addition, much of the previous research in this area is comprised of qualitative studies; despite the usefulness of this research it is unable to provide any predictive insight related to which project characteristics are associated with project success among GSD projects. Also, previous research considering project characteristics related to GSD projects success have not considered how these characteristics work in combination with each other. The present study is concerned with understanding more about the project management characteristics associated with global software development project success. Specifically how Agile and Non-Agile management methods coupled with aforementioned project management characteristics related to project success, were investigated. In turn the following research questions were examined in this study:

1. Do Agile software development methods in GSD projects achieve greater project success than Non-Agile software development methods?

2. How do project management characteristics of global Agile projects compare to project management characteristics of global Non-Agile projects?

3. Which project management characteristics in global software development

    projects are associated with greater project success?

4. In global software projects, is the relationship between project management

    characteristics and project success factors moderated by the type of software

    management method applied, specifically looking at Agile versus Non-Agile

    software management methods?

Chapter 3

Research Methodology

This work is a quantitative study utilizing cross-sectional survey data to explore the aforementioned research questions. This chapter describes the data collection process, the measures used, and the techniques used to analyze the data.

3.1 Research Design

Sample Recruitment

A convenience sampling technique was used to recruit individuals for this study. The individuals targeted for this study were working professionals in various industries with diverse experience working on GSD projects, including software development, project management, and software test/quality assurance. Specifically, potential study participants were contacted through professional organizations' online user groups and forums. In particular, five project management user groups, four software development user groups, and one software test user group was contacted. See appendix A for a full list of user groups that were contacted.

A total of 136 surveys were collected. Out of these, 85 survey responses met the eligibility criteria, which included having worked on global projects and having complete survey data on the dependent variable. Thirty one participants responded as never having worked on global software development projects. Thirteen participants did not finish the survey, and seven respondents did not answer the specific question related to customer satisfaction.

Data Collection

Data for this study was collected using an online survey. Online surveys have

several advantages: low financial and time cost of implementation, the ability to contact

potential participants throughout the world, and convenience for the respondents

(Creswell, 2003). In addition the collection of survey data was also simplified since it

was aggregated into a single database by the online survey software vendor, Survey

Monkey.

Survey instrument

The data collection instrument for this study was a web based survey that

consisted of 21 questions, including 15 multiple choice questions, two short answer

questions, and four mixed type of questions. The initial survey was first run among five

individuals to test for question clarity. Based on feedback from the pilot test the survey

was revised.   For a full list of survey questions see appendix B.

3.2 Research Model

Figure 3.1 illustrates the conceptual model used to examine the relationship

between the project independent variables and project success as it is moderated by the

type of management methods used on the GSD project.
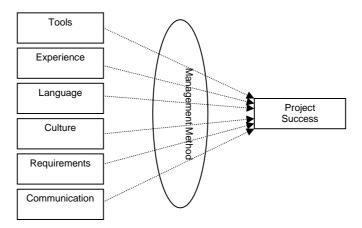
Figure 3-1: Research Model

3.3 Measures

To understand how software management methods impacted GSD project success, project management characteristics, including culture, language, communication, experience, tools, and requirements were treated as independent or predictor variables in this study. The dependent variable examined was project success. Interactions among management methods and the aforementioned independent variables were examined to understand how the management method moderated the relationship between project management characteristics and project success.

Independent Variables

Culture. Participants were asked "In what kinds of ways have cultural differences among team members who are located in other countries affected the global projects you have worked on?" in order to capture the impact of cultural differences on projects. The following response categories were utilized: highly negative = 1, slightly negative = 2, neither positive nor negative = 3, slightly positive = 4, and highly positive = 5.

Language. Participants were asked "How often does language make communication difficult between you and project team members in other countries?" in order to measure the impact of language difficulty on the projects. The following response categories were used: all the time = 1, more often than not = 2, sometimes = 3, hardly ever = 4, and never = 5.

Communication. Two aspects of communication were measured: local and remote communication. Specifically, participants were asked "How often do you interact with your local project team members (located in your office) when working on a global project?" in order to measure their frequency of engagement in local communication.

Regarding remote communication and the frequency of interaction between project members that are not located in the same physical office, participants were asked the following question, "How often do you have contact (does not have to be face-to-face) with remote project team members (located outside of your office) when working on a global project?" The following response categories were used for both questions: every day or more = 5, two to four times a week = 4, about once a week = 3, about once a month = 3, and never = 1.

   Experience. General experience and experience on global projects were measured. Specifically, to understand general work role experience participants were asked "How many years of experience do you have in your current role as described in question 4?" The following response categories were used: entry level, 0 – 2 years = 1, mid-level, 2 – 5 years = 2, senior level, 5 – 10 years = 3, middle management level, 10 – 20 years = 4, senior management level, 20 + years = 5. To understand how recent their experience on global projects was, participants were asked, "Have you worked on global projects (Global projects are projects that have team members in different countries working on them)?", and the response categories for it included: never worked on a global project = 0, worked on a global project over 10 years ago = 1, worked on a global project in the last 6 – 10 years = 2, worked on a global project in the last 3 – 5 years = 3, worked on a global project within the last 2 years = 4, and currently involved in the global project = 5.

   Tools. Participants were asked "Do you have the necessary tools to resolve any issues that might arise when working on global projects?" in order to measure if they thought that they have all the necessary tools to successfully accomplish their tasks. The

following response categories were used: totally disagree = 1, partially disagree = 2, neither agree nor disagree = 3, partially agree = 4, and totally agree = 5.

Requirements. Participants were asked "How often do the requirements for the tasks that you are responsible for change?" in order to capture the frequency of requirements changes in the participant's project. The following response categories were utilized: all the time = 1, more often than not = 2, sometimes = 3, hardly ever = 4, and never = 5.

Management method. Participants were asked "What type of management do you (or your manager) use?" to determine what type of management method their projects use. The following response categories were used: Agile method = 1 and Non-Agile method = 0.

Dependent Variable

Project success. A factor score was utilized to capture project success. This score was empirically determined by conducting a principal components analysis of three questions related to projects' timeliness, scope, and customer satisfaction. For project timeliness, participants were asked, "How many of the global projects that you have worked have met their planned project schedule?" Participants indicated their responses to this question such that 0% - 24% = 1, 25% - 49% = 2, 50% - 74% = 3, 75% - 99% = 4, and 100% = 5. For project scope, they were asked "How many of the global projects that you have worked have met their planned project deliverables?", and indicated one of the following as their response, 0% - 24% = 1, 25% - 49% = 2, 50% - 74% = 3, 75% - 99% = 4, and 100% = 5. Finally, regarding customer satisfaction participants were asked, "How satisfied are customers of the global projects you have worked on?", and indicated their

response as, don't know = 0, totally unsatisfied = 1, partially unsatisfied = 2, neither

satisfied or unsatisfied = 3, partially satisfied = 4, and totally satisfied = 5. In addition, a

reliability analysis was performed using Cronbach's alpha. Cronbach's alpha is a direct

function of the number of variables and their level of inter-correlation, and for

exploratory studies, an alpha greater than 0.7 is usually considered respectable (Martella,

Belson, and Marchand-Martella, 1999). The project success factor has a Cronbach's

alpha = 0.821 which was calculated SPSS, a statistical software package. For more detail

on Cronbach's alpha see appendix D.

Control Variable

Office Size. Participants were asked "How many employees work in your office?"

The following response categories were utilized: 50 or less = 1, 51 – 100 = 2, 101 – 200 =

3, 201 – 500 = 4, 501 – 1000 = 5, 1000 – more = 6.

3.4 Data Analyses

This study employed a quantitative approach. First, t-tests were conducted to

determine whether there were any statistical differences in the average level of project

success for participants who used Agile software development project management

methods and those who used Non-Agile software development management methods.

Second, a series of ordinary least squares (OLS) regression analyses were conducted to

analyze the relationships between project success and project characteristics; OLS

regression was utilized based upon the continuous, interval level of measurement of the

dependent variable, project success. An alpha level of 0.05 or less was considered

significant throughout these analyses. In the first step of the OLS regressions addressing

each of the four research questions, the dependent variable of project success was

regressed on the project management method, without any controls. In the second model, project success was regressed on project management method and the project management characteristics of interest. In the third model, project success was regressed onto the project management method, project management characteristics, with a control variable for size of office. In the fourth and final model, project success was regressed onto project management methods, project management characteristics, office size, interaction terms, which were created by interacting project management method with project management characteristics.

Chapter 4

Results

4.1 Descriptive Statistics

Local team geographical location. In this study 62.4% of the survey participants,

members of the local teams, were located in North America, 24.7% were located in Asia,

9.4% were located in Europe, 2.4% were located in Africa, 1.2% was located in South

American, and none were located in Australia. Table 4.1 illustrates this data. For a

breakdown by country see appendix E.

Continent	Percent of local team survey participants
N. America	62.4%
Asia	24.7%
Europe	9.4%
Africa	2.4%
S. America	1.2%
Australia	0%

Table 4.1: Local team geographical location

Remote team geographical location. The remote teams in this study, with whom the

survey participants collaborated on GSD projects, were located in the following

continents; 38.4% were located in the Europe, 36.8% were located in Asia, 19.5% were

located in North America, 2.6% were located in Australia, 2.1% were located in South

America, and 0.5% were located in Africa.

Continent	Percent of the time remote team located
Europe	38.4%
Asia	36.8%
N. America	19.5%
Australia	2.6%
S. America	2.1%
Africa	0.5%

Table 4.2: Remote team geographical location

Table 4.2 illustrates this data. For a complete breakdown by country see appendix F.

Type of software development wok. Out of the 85 survey responses 44.6% of the

respondents reported that they conduct engineering work, 33.7% performed project

management work, 13% conducted quality assurance, 5.4% conducted team management

activities, and 3.3% performed product management work. The data is illustrated in table

4.3.

Type of Work	Frequency	Percent
Engineering	35	44.6%
Project Management	31	33.7%
Quality Assurance	11	13%
Team Management	5	5.4%
Product Management	3	3.3%

Table 4.3: Survey participant type of work

Management method. Participants' responses for the question on the type of software

management method used indicated that 50.6% of the survey participants used Waterfall

model, 31.8% used Agile methods, 9.4% reported using both Agile and Waterfall model,

5.9% reported not using any method, and 2.4% reported using project management

software.

Management Method	Frequency	Percent
Waterfall	43	50.6%
Agile	27	31.8%
Waterfall and Agile	8	9.4%
None	5	5.9%
Software Application	2	2.4%

Table 4.4: Management methods

Office size. In this study 22.4% of the survey participants worked in an organization that

employed 50 or fewer people, 11.8% worked in an organization that employed 51 to 100

people, 16.5% worked in an organization that employed 101 – 200 people, 14.1% worked

in an organization that employed 201 – 500 people, 8.2% worked in an organization that

employed 501 – 1000 people, and 27.1% worked in an organization that employed 1000

ore more people. Table 4.5 illustrates this data.

Office Size	Frequency	Percent
50 or less	19	22.4%
51 - 100	10	11.8%
101 - 200	14	16.5%
201 - 500	12	14.1%
501 - 1000	7	8.2%
1000 - more	23	27.1%

Table 4.5: Office size

4.2 Agile and Non-Agile Software Development Project Management Methods: Project Management Characteristics and Overall Project Success

When participants who used Agile software development project management

methods were compared with participants who used Non-Agile methods on their ratings

of project management characteristics, there were no statistically significant differences

in the means. The values of the project management characteristics means of Agile vs.

Non-Agile methods are shown in the table 4.6 below.

The t-test comparing participants' experiences of project success based on

whether they used Agile or Non-Agile software development project management

methods, revealed no perceived significant difference in the mean levels of project

success. The project success factor mean for Agile method projects has a mean of 0.177

with a std. dev. of 0.895 and the project success factor mean for Non-Agile method

projects is -0.004 with a std. dev. of 1.048. Both means are within one standard deviation

of each other. Also see table 4.6 below. In the multivariate analyses, model one, which implemented additional independent and control variables, type of management method did not emerge as a significant predictor of project success (B = 0.181, β = 0.085, Std. Error = 0.234). Also see model one in table 4.7 below.

	Agile Methods	N	Mean	Std. Deviation
Project Success	0	58	-0.004	1.048
	1	27	0.177	0.895
Software Development Experience	0	58	3.086	1.031
	1	27	3.037	1.091
Global Project Experience	0	58	3.810	1.115
	1	27	3.889	1.251
Stability of Requirements	0	58	2.466	0.863
	1	27	2.259	0.594
Amount of Local Interaction	0	58	4.586	0.650
	1	27	4.704	0.609
Amount of Remote Interaction	0	58	3.552	1.202
	1	27	3.333	1.177
Lack of Language Barriers	0	58	3.172	1.172
	1	27	3.481	1.156
Availability of Necessary Tools	0	58	3.793	1.072
	1	27	3.630	1.043
Positive Influence of Culture	0	58	3.017	0.908
	1	27	3.148	0.989
Office Size	0	58	3.596	1.815
	1	27	3.444	2.136

Table 4.6: Means table of the independent and dependent variables.

4.3 Project Management Characteristics and Overall Project Success

Multivariate regression analyses indicated that certain project management characteristics were associated with project success. Specifically, in model two in which project success was regressed onto project management methods and the eight project management characteristics, stability of project requirements, availability of necessary

project tools, and positive influence of cultural factors emerged as significantly

associated with project success. Specifically, for every one unit of measure increase in

the stability of project requirement there was a 0.331 standard unit increase in project

success (p<.001); for every one unit of measure increase in the availability of project

tools there was a 0.227 standard unit increase in project success (p<0.01); for every one

unit of measure increase in the influence of positive cultural factors there was a 0.195

standard unit increase in project success (p<0.05). Also see model two in table 4.7

below.

In model three, when office size was added as a control variable the frequency of

project requirements changing and availability of necessary tools remained significant,

while cultural management characteristics dropped out as a significant predictor. In

particular for every one unit of measure increase in the stability of requirements, there

was a 0.324 standard unit increase in project success (p<0.01); and for every one unit of

measure increase in the availability of necessary tools there was a 0.224 standard unit

increase in project success (p<0.01). Also see model three in table 4.7 below.

Project Management Characteristics and Project Success

Adding interaction terms to the final regression model examined whether project

management method moderated the relationship between project management

characteristics and project success. In this final model stability of requirements,

availability or project tools, and positive influence of cultural factors (trend level)

emerged as significantly associated with project success; however none of the interaction

terms were significant. For every one unit increase in the stability of requirements the

project there was a 0.331 standard unit increase in project success (p<0.01); for every one

unit increase in the availability of project tools there was a 0.250 standard unit increase in

project success, and finally for every one unit increase in the positive influence of

cultural factors there was a 0.221 standard unit increase in project success (p<0.01). Also

see model four in table 4.7 below.

	Model 1		Model 2		Model 3		Model 4	
	B	β	B	β	B	B	B	β
	(Std. Error)		(Std. Error)		(Std. Error)		(Std. Error)	
Type of Project Management Method								
Agile methods	0.181	0.085	0.276	0.129	0.277	0.130	-2.676	-1.253
	0.234		0.204		0.202		2.852	
Project Management Characteristics								
Software Development Experience			0.102	0.106	0.112	0.117	0.079	0.082
			0.092		0.091		0.113	
Global Project Experience			-0.009	-0.010	0.016	0.018	-0.026	-0.030
			0.087		0.087		0.106	
Stability of Requirements			0.419	0.331***	0.410	0.324**	0.419	0.331**
			0.127		0.125		0.140	
Amount of Local Interaction			-0.160	-0.102	-0.109	-0.070	-0.269	-0.171
			0.150		0.152		0.182	
Amount of Remote Interaction			0.061	0.073	0.049	0.059	0.124	0.148
			0.080		0.080		0.100	
Lack of Language Barriers			0.119	0.139	0.129	0.150	0.135	0.157
			0.092		0.091		0.111	
Availability of Necessary Tools			0.214	0.227**	0.212	0.224**	0.236	0.250**
			0.093		0.092		0.108	
Positive Influence of Culture			0.209	0.195*	0.187	0.174	0.237	0.221+
			0.114		0.113		0.129	
Control Variable								
Office Size					0.085	0.162	0.099	0.190

					0.051		0.053	
Interaction Terms								
Agile x Software Development Experience							0.219	0.338
							0.209	
Agile x Global Project Experience							0.188	0.366
							0.211	
Agile x Stability of Requirements							0.039	0.043
							0.377	
Agile x Local Interaction							0.533	1.187
							0.344	
Agile x Remote Interaction							-0.269	-0.455
							0.179	
Agile x Language Barriers							-0.022	-0.038
							0.216	
Agile x Availability of Necessary Tools							0.032	0.058
							0.240	
Agile x Positive Influence of Culture							-0.046	-0.073
							0.308	

***, **, *, + Statistically significant at the .1%, 1%, 5%, 10% levels. Standard errors are in parentheses. Each model contains 85 observations.

Table 4.7: Regression model data

Chapter 5

Discussion

This study provides useful insight regarding project management characteristics and GSD project success. The results of this study indicate that GSD projects managed using Agile software development project management methods do not experience different levels of project success than GSD projects managed using Non-Agile software development project management methods. Also, this study did not find any difference in the measured means of project characteristics based on the type of management method applied in GSD projects. Coram and Bohner have highlighted that Agile methods are not appropriate for every project (Coram, and Bohner, 2005).   However, this study indicates three project management characteristics that are associated with higher levels of project success on GSD projects, regardless of the management methods used. The findings of this study show that less frequent changes of requirements on projects, providing appropriate project tools to project team members, and building cultural synergy among the globally distributed team positively affects the outcome of GSD projects, particularly in terms of time, scope, and customer satisfaction. Previous research highlighted similar findings with incomplete requirements being a major reason for software project failure (Hofman and Lehner, 2001). Also, culture is a major challenge for global projects and project managers to overcome (Barczak, McDonough, and Athanassiou, 2006). This study found culture to be associated with project success regardless of whether Agile ore Non-Agile methods were employed. Language challenges among project team members, frequency of team communication, and higher levels of experience on GSD projects did not seem to directly affect project success.

5.1 Implications for Practice

Managers of GSD undertakings should take steps to minimize project risk associated with changing requirements. Damian has highlighted several lessons learned from practice that help GSD projects better manage requirements during the project lifetime (Damian, 2007). GSD projects benefit when all stakeholders have a shared understanding of the client's needs and the technological abilities needed to address them, which can be achieved by implementing iterative knowledge acquisition and sharing processes. This enables effective communication of project information amongst all stakeholders. In addition, GSD projects benefit from iterative development processes which discover integration issues earlier in the lifecycle of a project, while project deliverables are still in the early stages of development and less complicated to fix. Waiting too long for initial integration of work produced by remote teams will cause delays.

To assist with iterative development cycles GSD projects need to encourage informal communication between remote teams. Communication tools, such as instant message clients, online knowledge sharing sites, and mailing lists help can assist in enabling informal communication between remote teams and also help bridge cultural and temporal barriers (Herbsleb, 2007). Also, collaboration tools used for versioning and issue tracking help maintain a central hub of project information which can be used by all project members. In addition, this grows the project knowledge base by tracking all of the work and issues performed on the project. These tools combined with automatic nightly build and test tools will assist with iterative development. Their immediate

discovery of integration issues will ensure that remote teams always have compatible project work components.

Cross-cultural software project teams can overcome project vulnerabilities when the relationship between team members' cultural values and their ideas about project decision-making processes are is better understood (Tan, Smith, Keil, IEEE Member, and Montealegre, 2003). In order to overcome such cultural risks in GSD projects managers will benefit if they complete cultural competency trainings and also provide training for their team members. These trainings empower members to effectively work together with culturally diverse remote teams and so enable the forming of a strong team. In addition, team members travelling to remote sites will also have positive effects on the project success by allowing members to establish relationships with face-to-face meetings (Holmstrom, Conchúir, Ågerfalk, and Fiztgerald, 2005). Once relationships and common project understandings have been established they create a foundation of equal vision on the project goals between the remote sites and also allow for better communication between the remote sites going forward.

5.2 Implications for Research

The positive association between stability of project requirements and project success is in accordance with previous research. Studies in the U.S. and Europe show that 50% of project failure is related to project requirements issues (Lamsweerde, 2000). This study provides evidence to suggest that regardless of whether GSD project teams use Agile or Non-Agile management methods, success of GSD projects will be enhanced by reducing the frequency of requirement changes throughout the life of a project. Frequent changes in requirements leads to project rework, which results in project team

members spending time implementing the modified requirements rather than moving

forward in implementing the initially planned work. This rework often leads to project

delays (Gopal, Mukhopadhyay, and Krishnan, 2002).

Ensuring that the appropriate project tools are available for project team members

is vital for GSD projects. Inadequate tools can impede various efforts of project team

members, delay projects, frustrate team member, all of which can negatively impact

project success. To facilitate the availability of necessary project tools, managers should

investigate the needs of the project by drawing on their own previous experience, current

research in the field, and feedback from project team members. Readily available tools

such as instant messaging clients, project knowledge web sites, and software version

control systems can improve communication and collaboration on global software

development projects (Herbsleb, 2007). As GSD teams are engaging in more

complicated projects there will continue to be increased demand for supporting tools and

infrastructure to match the growth in project complexity. This study did not capture

which tools enhance GSD project success; future studies of GSD project management

should explore this area further to distinguish the specific tools that may lead to greater

GSD project success.

Previous research has highlighted how different cultural communication styles

and work behaviors can affect overall project outcomes (Huang and Trauth, 2007). In the

present study, there were participants from 42 unique countries, indicating the number of

possible cultures within which GSD projects have been managed. Fostering cultural

synergy on GSD projects is challenging. Project managers need to develop unique skills

to effectively bring teams from different cultural backgrounds together to positively

impact project success. Specifically, managers of GSD projects should not only become familiar with the cultural backgrounds of their teams but also work to develop synergy among the various cultures throughout the life of the project. Understanding the cultural background of team members, and developing a level of cultural competence through trainings and workshops, will enable managers of GSD projects to utilize the diverse strengths of project team members to optimize team performance and in turn, overall project success.

5.3 Limitations

The generalizability of the results of this study are limited because a convenience sample rather than a random sample was used. Random selection was not feasible because complete lists of user groups and members of various user groups are not available to the public. A second limitation of this study is that the measure for utilization of Agile or Non-Agile software development project management methods was based on a one-item indicator, rather than a series of questions allowing for classification into either of these groups. A third limitation related to the survey is that it has not been validated; future researchers in this area should consider developing a validated instrument to further explore the concepts that emerged as important in this research. A final limitation of this research is that the various types of Agile management methods, including Extreme Programming, Scrum, and Feature-Drive Development, were not accounted for; investigating this in future research would be beneficial to the field. Despite the aforementioned limitations, this study offers valuable quantitative insight into project management characteristics associated with project success.

5.4 Future Research

In addition to utilizing a larger, more representative sample, validating the survey tool, and exploring various types of Agile software development project management methods, future research in this area should also consider the types of tools that are important for GSD project success. Also, the size of global project teams should be considered in future studies. Finally next steps in this area of research should focus on researching and discovering methods for fostering and understanding cultural synergy on GSD projects.

Chapter 6

Conclusion

This quantitative study investigated success of Agile management methods compared to Non-Agile management methods in GSD project, as well as the impact of a select group of project management characteristics on project success. It provides exploratory insight into understanding what aspects of project management methods and project management characteristics are associated with increased GSD project success. This study did not find that participants who indicated using Agile management methods on GSD projects experienced greater project success than participants who indicated using Non-Agile management methods. However, GSD projects with fewer changes in requirements, better availability of appropriate tools to project team members, and globally distributed teams who enjoyed positive cultural relationships, experienced greater project success. Project managers can reduce risks associated with requirement changes by ensuring that effective communication among all stakeholders is in place. Also, having proper project communication and collaboration tools available to project team members can mitigate risks associated with requirements changes and support remote team cooperation. Finally, GSD projects benefit when project managers and team members gain experience and training related to working with team members from diverse cultural backgrounds.

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Appendix A: Professional Online User Groups Contacted

User groups contacted
NovaJug Yahoo group (Norther Virgina Java User Group)
Agile testing Yahoo group
Google project management group
Google user group alt.comp.project-management
Agile Project Management Yahoo group
PM Hub Yahoo group
IT jobs India Yahoo group
Critical Chain Yahoo user group
Phoenix java Yahoo user group
San Diego java Yahoo user group

Appendix B: Survey Questions

1. What country is your office located in?
(ex. USA, India, Mexico, etc.)

- open text response

2. How many employees work in your office?

- 50 or less

- 51 - 100

- 101 - 200

- 201 - 500

- 501 - 1000

- 1000 - more

3. What industry do you work in?

- IT/Engineering

- Finance/Banking

- Health

- Biotech/Pharmaceutical

- Government

- Other (please specify)

4. What is the primary type of work you perform in your current job?

- Business Analytics

- Engineering

- Project management

- Team management

- Quality Assurance

- Other (please specify)

5. How many years of experience do you have in your current role as described in the question 4?

- 0 – 2 years

- 2 – 5 years

- 5 – 10 years

- 10 – 20 years

- 20 + years

6. Have you worked on global projects (Global projects are projects that have team members in different countries working on them)?

- I have never worked on a global project

- I am currently involved in a global project

- I worked on a global project within the last 2 years

- I worked on a global project in the last 3-5 years

- I worked on a global project in the last 6-10 years

- I worked on a global project over 10 years ago

7. In which countries are the other project team members located? (For example: India, Germany, Mexico, US) List all countries

- open text response

8. What type of management do you (or your manager) use?

- Agile management

- Waterfall (Go from Requirements->Design->Engineering->Test->Release)

- Do not know

- Other (please specify)

9. What is the primary way you get notified of the project tasks you are responsible for?

- by email

- by meeting

- by phone

- by informal discussion

- Other (please specify)

10. How often do the requirements for the tasks that you are responsible for change?

- All the time

- More often than not

- Sometimes

- Hardly ever

- Never

11. How often do you interact with your local project team members (located in your office) when working on a global project?

- Every day or more

- 2 – 4 times a week

- About Once a Week

- About Once a Month

- Never

12. How often do you have contact (does not have to be face-to-face) with

remote project team members (located outside of your office) when working on a global project?

- Every day or more
- 2 – 4 times a week
- About Once a Week
- About Once a Month
- Never

13. How often does language make communication difficult between you and project team members in other countries?

- All the time
- More often than not
- Sometimes
- Hardly ever
- Never

14. Do you have the necessary tools to resolve any issues that might arise when working on global projects?

- Totally agree
- Partially agree
- Neither agree or disagree
- Partially disagree
- Totally disagree

15. In comparison to non-global projects, do you find that global projects are typically:

- Totally Overstaffed

- Partially Overstaffed

- Neither Overstaffed or Understaffed

- Partially Understaffed

- Totally Understaffed

16. Do you think it would be beneficial to receive training on how to work on global projects?

- Totally Agree

- Partially Agree

- Neither Agree or Disagree

- Partially Disagree

- Totally Disagree

17. Previous working experience on global projects contributes positively to my ability to work on the next global project?

- Totally agree

- Partially agree

- Neither agree or disagree

- Partially disagree

- Totally disagree

18. In what kinds of ways have cultural differences among teams members who are located in other countries affected the global projects you have worked on?

- Highly positive

- Slightly positive

- Neither positive or negative

- Slightly negative

- Highly negative

19. How many of the global projects that you have worked have met their planned project SCHEDULE?

- 100%

- 75% - 99%

- 50% - 74%

- 25% - 49%

- 0% - 24%

20. How many of the global projects that you have worked have met their planned project DELIVERABLES?

- 100%

- 75% - 99%

- 50% - 74%

- 25% - 49%

- 0% - 24%

21. How satisfied are customers of the global projects you have worked on?

- Totally Satisfied

- Partially Satisfied

- Neither Satisfied or Unsatisfied

- Partially Unsatisfied

- Totally Unsatisfied

- Don't know

Appendix C: Survey Participation Invitation Email

The following introduction email has been used when contacting online groups and

forums:

"Hello XXX members,

I am doing a Masters thesis in Engineering Management at Northeastern University, Boston, MA. My thesis examines how global software development projects operate. In turn I am conducting a brief survey related to this.

http://www.surveymonkey.com/s.aspx?sm=TPmVEY3RvZ%2bXggSwUPE37A%3d%3d

I would very much appreciate if you could help me by taking my survey.

Many thanks,
Rajko Ilincic

Appendix D: Cronbach's Alpha

Cronbach's alpha is a measure of reliability used to evaluate factor's internal consistency. According to Martella, Nelson, and Marchand-Martella, " Internal consistency establishes how unified the items are in a measurement device. In other words it provides a measure of the degree to which items on the measurement device are functioning in a homogenous fashion," (1999, p. 68). It is a common measure of reliability that assesses the internal consistency reliability of several items or scores that get added together to get a summary score. Alpha is based on the correlation matrix and values greater than .70 provide acceptable backing for internal consistency reliability. The formula for coefficient alpha is:

$$\alpha = \frac{N}{N-1} * \left(\frac{\sigma^2 - \sum_{i=1}^{N} \sigma_i^2}{\sigma^2} \right)$$

N = Number of items in the instrument

σ^2 = Variance of the total observed test scores

σ_i^2 = Variance of the individual test score

Appendix E: Country List of Survey Participants

Complete list of countries from which the survey participant's local team office have

been based out of.

Country	Number of survey participants
USA	49
India	17
UK	4
Canada	3
Philippines	2
Argentina	1
Belgium	1
Bulgaria	1
Ghana	1
Iran	1
Italia	1
Kenya	1
Mexico	1
Russia	1
Singapore	1

Appendix F: Country List of Remote Team Member Locations

Complete list of countries from which the survey participant's remote teams have been

based out of.

Country	Number of times been the remote team host country
India	37
USA	32
England	21
Germany	12
China	11
France	7
Russia	7
Israel	5
Australia	4
Canada	4
Europe	3
Hong Kong	3
Japan	3
Switzerland	3
Singapore	3
Ukraine	3
Demark	2
Netherlands	2
Spain	2
Ireland	2
Poland	2
Asia	1
Belgium	1
Brazil	1
Chile	1
New Zealand	1
Pakistan	1
South Africa	1
Sweden	1
Indonesia	1
Italy	1
Malaysia	1
Norway	1
Slovenia	1
Sudan	1

Philippines	1
South Korea	1
Argentina	1
Mexico	1
Venezuela	1
Vietnam	1
Austria	1
Croatia	1