QUALITY MODEL EFFECTIVENESS FOR IMPROVING PROJECT SUCCESS: A LOGLINEAR STUDY

by

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Abstract

This quantitative study investigated the connection between quality models and project management's success rates. The project managers that made up the sample covered a wide variety of industries and were 18 years of age or older. The research design of this study was non-experimental and used loglinear analysis to examine a sample of project managers. The study was performed through the use of a newly created survey that has been reviewed by subject matter experts for validity and reliability. Data was gathered by a professional data collection service. There were three questions asked. Each of the three question was the same except that it referenced one of the three quality models examined, Six Sigma, Lean, and, Lean Six Sigma. The question asked was if each specific quality model could be used to increase a project's success rate. Each quality model was determined to be useful and was more beneficial as additional amounts of the quality model was used. The results had an effect size of 0.3 and showed that there is a positive connection between the use of quality models and project management's success rate. In addition, it was shown that the more of a quality model that is used the greater the increase in the project management success rate.

Dedication

This work is dedicated to my wonderful wife. She has allowed me to spend countless hours working on the completion of my Bachelor's degree, MBA, and now my PhD. There have been rough times and there has been good times. During all this time she has always been there to support me and my goals.

Acknowledgments

My mentor, Dr. Gottwald, efforts has been profound. I have been hard at work for many years now working on this educational journey. His efforts have tried to keep me headed in the correct direction even when it took multiple tries to keep me going in the proper direction.

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CHAPTER 1. INTRODUCTION

Project management became a recognized discipline during the Manhattan Project, the development of the atomic bomb (Maguad, 2006). Quality models, various tools that are used in an attempt to increase the quality output of any system, emerged in conjunction with the project management discipline following the end of World War II as Japan experienced a period of rebuilding.

Project managers use various methods to improve quality of service in both the manufacturing and service industries (Herbert, Curry, & Angel, 2003). Most useful project management tools include quality models to increase the project success rate (Martin & Tate, 1998). Six Sigma, Lean, and Lean Six Sigma are common quality models (Martin, 2007). As a quality model, six Sigma has shown great promise raising project success rates, specifically in the manufacturing industry. (Zhang & Xu, 2008). Six Sigma is also being applied to the service industry with good results (Herbert et al., 2003). Lean is another model that has been used to affect quality (Martin, 2007). Lean is used to reduce waste in a project, which may lead to an improvement in project success rate (Martin, 2007). The combination of Six Sigma and Lean, has been used in the business world, but little research has focused on the benefits of combining the two models (Hill, Zhang, & Gilbreath, 2011).

Existing scholarly literature demonstrates a need for research that will investigate the connection between quality models and project success rates. Results from such studies may lead to practical applications that are useful to the field of project management (Kerzner, 2009). The present study investigated how quality models and project management are related. If it can be shown that there is a connection between the use of quality models and the outcome of projects, project managers may be able to make better-informed decisions about which quality models to integrate into their projects

Background of the Study

The CHAOS Report shows that project management success rates in information systems have been increasing; over an 18-year period the success rate increased from 16% to 37% (The Standish Group, 1994, 2012). It should be noted that project success rates and success rates are the same. This information implies that progress has been made to improve project success rates with some of the progress coming from the areas of project management office and project risk management (Zhang & Xu, 2008). In addition, quality models have been used to improve quality, productivity, and cost (Martin, 2007). *The Chaos Report* and Zhang and Xu’s work both measure project success by how well projects maintained cost and schedule parameters (Hill et al., 2011). Research indicates that there is a desire to improve the understanding and usage of quality models and project management (Martin, 2007; Hill et al., 2011). Other industries also show success rates that are less than 100%. For example, new project development within the technology industry shows that the success rate for projects is between 50% and 60% (Rungi, 2010).

Statement of the Problem

Historically, information systems' project success rates have been lower than desired (The Standish Group, 2012). *The Standish Group* measures the success rate of information systems’ projects which shows the increase in project success rates from 16% to 37% over an 18-year period of time (The Standish Group, 1994, 2012). This data from *The Standish Group* points to a problem with how IT projects are managed due to their low success rate. There are many theories for this behavior that include the IT industry and many others.

One theory of why projects fail is based on the multidimensionality of project success (Winch, Usmani, & Edkins, 1998). Project success can be both positive and negative at the same time depending on the perspective that is being looked through (Kuo, 2009). For example, a project manager can fulfill all the project specifications and still have a customer that is not happy with the end result of the project. In this case, the project manager believes that the project was a success but the customer thinks that the project was a failure (Winch et al., 1998). Another theory of project failure is based on communications (Ebert, 2007). Communication needs to be clear between all involved parties including the project manager, stakeholders, and customers (Ebert, 2007). Another project management failure theory is that all projects can be treated as the same type of project (Shenhar, Tishler, Dvir, Lipovetsky, & Lechler, 2002). An example of this is that innovative projects and non-innovative projects need to be handled differently based on that innovative projects have a higher degree of flexibility than non-innovative projects, which can be highly structured (Besner & Hobbs, 2008). An innovative project is "a project that produces a new product or that involves a new concept and a new technology" (Besner & Hobbs, 2008). Quality models may have the ability to handle these issues. According to Martin and Tate (1998), business's found that process improvement could increase business efficiency which is what Six Sigma and lean are designed to accomplish. The same connection has been used to cope with increasing time and cost pressures in new product development, through the use of Six Sigma and Lean processes (Nepal, Yadav, & Solanki, 2011). Not enough is known about how quality models might improve project success.

Purpose of the Study

The present research will study the connection between quality models and project success rates. The study will specifically examine the use of the quality models Six Sigma, Lean, and Lean Six Sigma in connection with project success. The results describe relationships that exist between the use of quality models and project success rates Zhang and Xu (2008). The present study adds to the literature, and its goal is to find ways to increase project success with the aid of Six Sigma, Lean, and Lean Six Sigma.

The correlation between project management and quality models has been researched but not to the extent that it could be (Zhang & Xu, 2008; Hill et al., 2011). The purpose of this research is to provide additional insight into how various quality models may affect project success potential. Having the knowledge and tools to increase project success benefit both scholars and practitioners in that scholars have an expanded body of knowledge to examine and practitioners have additional evidence to employ to increase project success rates.

Quality models are an important issue in the attempt to provide a quality service as literature suggests that the selection of the best quality model can impact project success rates (Martin, 2007). Work by Martin described some of the popular quality models but left unanswered the question of which one might produce the best results. Thus, the need to know more about quality models and how they can be used to improve project success provides the rationale to further explore the use of commonly used quality models. This research study will examine project managers' use of Six Sigma, Lean, and Lean Six Sigma to determine if there is an association between the use of these approaches and improved project success.

Authors who have done work in this area are Zhang and Xu (2008) and Ravichandran and Rai (2000). Ravichandran and Rai developed the R&R model, which describes how quality influences project management in software development. The quality influence is in large part obtained through continuous improvement (Hill et al., 2011). Zhang and Xu revised the R&R model to include Six Sigma. Zhang and Xu (2008) and Ravichandran and Rai (2000) both made recommendations that future study extend into more complex issues related to project success. However, before this is done, the method used by Ravichandran and Rai and Zhang and Xu should include the most effective quality model possible. The present study will add to the possible quality models that can be used, and then the method can be updated to include the most effective quality models.

Research Questions

The research questions that will be examined by this study are:

ResQ 1 What is the association between Six Sigma and project outcomes?

ResQ 2 What is the association between Lean and project outcomes?

ResQ 3 What is the association between Lean Six Sigma and project outcomes?

The following hypotheses will be tested:

$H_0$1: There is no statistically significant difference between the use of Six Sigma and the project success rate.

Ha1: There is a statistically significant difference between the use of Six Sigma and the project success rate.

H02: There is no statistically significant difference between the use of Lean and the project success rate.

Ha2: There is a statistically significant difference between the use of Lean and the project success rate.

H03: There is no statistically significant difference between the use of Lean Six Sigma and the project success rate.

Ha3: There is a statistically significant difference between the use of Lean Six Sigma and the project success rate.

Significance of the Study

The present research describes the importance of quality models in the determination of project success. This has a practical application in that the use of a specific quality model may cause the project success rate to change. The goal for practitioners is to choose the quality model that increases the project success rate to the largest degree. Findings from this research may aid project managers in determining whether to use specific quality models. The body of knowledge is expanded by the ability to better define the connection between project success and quality models. In addition, a quantitative examination will be added to the body of knowledge in regard to the use of Six Sigma, Lean, and Lean Six Sigma.

Definition of Terms

Many common terms will be used in this study. To avoid confusion, they will be defined as they are related to this study:

Green belt six sigma. A certification that consists of the completion of an exam and 3 years of proven professional experience.

Lean. A collection of tools that decreases the amount of waste in any process.

Lean Six Sigma. A quality model that combines the best parts of Six Sigma and Lean.

Project management. Management of projects from conception to completion, typically temporary work that is important to the organization.

Project Management Institute (PMI). A non-profit group that encourages the practice of project management.

Project management office (PMO). A structural element of a company that is in place to ensure projects are executed effectively and in line with company goals.

Project management professional (PMP). A certification issued by PMI that requires the successful completion of a comprehensive exam and proven professional experience in the field.

Project success rate. A measure of how well projects have fulfilled their original plans in regard to time and cost.

Quality models. Various methods that are used in an attempt to increase the quality output of any system.

Six Sigma. A quality model that relies on quantitative measures and focuses on the reduction of variation.

Total Quality Management (TQM). A model to improve quality using continuous quality improvement as a primary tool.

Assumptions and Limitations

A key assumption of this study is that all projects can be viewed interchangeably. It is possible that different types of projects may need to be treated differently to achieve the same results (Shenhar et al., 2002). Quality standards vary based on the type of industry they are used in. Six Sigma was developed specifically for manufacturing, but it has been adapted to the service industry with mixed results (Herbert et al., 2003). Another assumption is that meeting expectations about project time schedules, costs, and resources is the best measure of project success (Basten, Joosten, & Mellis, 2011). In addition, Six Sigma can and will be considered as a quality model for this study even though it can be used as more than just a quality model. For example, Six Sigma can also be used as a business strategy.

The sampling technique that was employed in this study presents a limitation to the research. Participants were sampled through a self-selection process. The self-selection process allows participants to determine if they are included in the sample. Another limitation is that the data may not support the assumptions present within the research design. If the data does not support the assumptions, then proper procedures will be used to modify the data or the calculations so that the results can be validated. These limitations can reduce the generalizability of the results.

Nature of the Study

This study looked at how quality models affect project management success rates. The process is non-experimental and uses Loglinear Analysis to explore the data. The participants are project managers who are members of SurveyMonkey's expert's panel which is called SurveyMonkey Audience Service. The independent variable is the use of a specific type of quality model. In general, Quality models are systems that are well defined to increase quality and produce measurable results (Zhang & Xu, 2008). There are a large number of quality models designed to improve management outcomes (Martin, 2007). The present study used Six Sigma, Lean, and Lean Six Sigma as the quality models of interest.

Use of a quality model serves as the independent variable. Each quality model will be identified by two measures, which quality model and how much of the quality model. First, it is necessary to identify that the quality model was used. Second, it must be determined how much of the quality model was used. Participants will indicate which quality model was used, and the extent to which a model was used, and was measured through the use of a Likert scale.

The dependent variable is the success rate of project management. The success rate of project management can be defined as how closely the project fulfills the plan according to measures of time, cost, and performance (Kerzner, 2009). Projects are easily measured in regard to their success or failure based on their nature of being a temporary process (Martin & Tate, 1998). A temporary process should have an overall plan, which can be compared to the final outcome (Martin & Tate, 1998). Participants were asked to indicate whether or not they considered their project to be a success.

Conceptually, this study will involve three quality models. Each model will be further classified as to how much of the quality model is used. The success rate will be examined through each of the quality models and the amount of each quality model used.

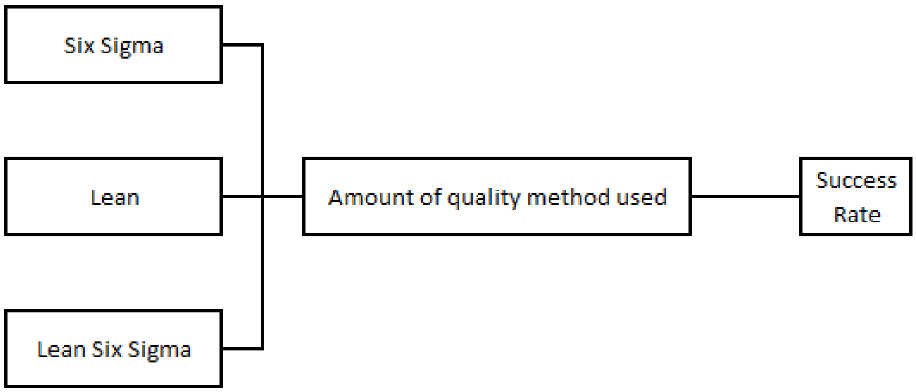

Figure 1. Conceptual framework of the study

The participants were protected from harm. All contact with the participants was done through a professional data collection service, and the researcher developed the survey to not offend the participants.

Organization of the Remainder of the Study

Chapter 2 contains a review of the literature related to quality models and the effects of quality models on project success. Chapter 3 describes the methodology and design approach that was used in this study. Chapter 4 presents the analysis and findings from the survey data. Chapter 5 summarizes the findings and poses recommendations and conclusions based on the data analysis.

CHAPTER 2. LITERATURE REVIEW

The literature reviewed for this study investigates scholarly work on general management, quality models, project management, construction management, information technology management, and healthcare management. The literature review begins by looking at project management, both its history and its current practices. Project management success rates will be the next topic looked at. The review continues by examination of how the construct of quality was developed and how quality is defined today. Quality models are then reviewed in detail. Finally, project management's use of the quality models Six Sigma, Lean, and Lean Six Sigma is explored.

Project Management

According to Nicholas and Steyn (2008), while the concept of project management has been important for centuries, it has become an accepted discipline and an area of scholarly interest starting in the mid-20th century. A type of project management was employed by the ancient Egyptians during the building of the great pyramids. This ancient task covered a 20 year time period, involved well over 100,000 workers, used 2.3 million stones that totaled a weight of well over 5 million tons; the building site covered 13 acres, and the pyramids have stood for centuries (Nicholas & Steyn, 2008). Nicholas and Steyn (2008) argued that this amount of work could not have been achieved without a planning effort which today would be called project management.

As an evolving discipline, modern project management is more clearly characterized and delineated than it's seminal roots. A project can be defined as a temporary endeavor that has a specified ending point and deals with constraints in time, cost, and resources (Shenhar & Dvir, 2007). Project management includes the administrative activities involved in taking a project from beginning to completion (Shenhar & Dvir, 2007). PMI (2013a) provides a more complete definition, "Project management is the application of knowledge, skills and techniques to execute projects effectively and efficiently. It's a strategic competency for organizations, enabling them to tie project results to business goals — and thus, better compete in their markets." (para. 6)

Another definition of project management is:

Have a specific objective to be completed within certain specifications.

Have defined start and end dates.

Have funding limits (if applicable).

Consume human and nonhuman resources (i.e., money, people, and equipment).

Are multifunctional (i.e., cut across several function lines). (Kerzner, 2009, p. 2)

According to Nicholas and Steyn (2008), project management is a single person (project manager) who is responsible for the delivery of a project by working with various functional units to bring the needed resources to the project and allow other function units to perform any duties that are needed for the project. Project management can also be thought of as "a management practice that helps an organization achieve its business results" (Patanakul, Iewwongcharoen, & Milosevic, 2010. p. 41). Project management may also be thought of this way "Clients expect to pay what they had originally agreed to pay; the building to function as they want it to function; and for it to be ready when they need it" (Winch et al., 1998, p. 193) and they go on to say that a "surprised client is a dissatisfied client" (Winch et al., 1998, p. 193). The definitions vary in depth of detail and completeness. The main consensus is that project management deals with a temporary project which has resource limitations and a completion goal.

Project management as a separate discipline began with the Manhattan Project, the development of the atomic bomb, during the 1940's (Lenfle & Loch, 2010). The Manhattan Project was designed to develop new technological performance using a trial-and-error approach (Lenfle & Loch, 2010). In the 1950's another project was modeled after the Manhattan Project, this was the Atlas project which followed the Manhattan Project's concurrency by also developing the Titan Rocket as a back-up to the Atlas Rocket (Lenfle & Loch, 2010). Then, in 1958, the Polaris Project introduced the Program Evaluation and Review Technique (PERT) to the field of project management (Kerzner, 2009). One of PERT's contribution is it allows control of the time constraint for a project (Kerzner, 2009). PERT's time control is based on its weighted averaging of most likely time, optimistic time, and pessimistic time to produce the time to completion that is expected (Milosevic, 2003). The 1950's theory of project management involved multiple trials, flexible trial-and-error approaches, and time constrains (Lenfle & Loch, 2010). These are atypical of today's project management approach. Project management was quantitative in nature and a part of operational research until the 1960's (Cicmil & Hodgson, 2006).

As the discipline evolved, project management has grown into a more formalized process than demonstrated by its seminal roots (Lenfle & Loch, 2010). It is interesting that early project management work violates later doctrine within the discipline related to a phased project life cycle (Lenfle & Loch, 2010). In the 1960's the phased project life cycle approach was adopted by the Department of Defense and NASA in an attempt to reduce costs (Lenfle & Loch, 2010). This new approach has had its share of disappointments. One example of such a disappointment was when the Denver airport project was completed at over 300% of its initial cost estimate and four extensions of the project completion date (Cicmil & Hodgson, 2006). The Apollo project is an example of a success. Apollo was the quest to have a man walk on the moon. The new phased approach was used and the project was a success even with the new technology that had to be developed and the size of the endeavor (Lenfle & Loch, 2010).

Project management is a challenging endeavor based on today's market pressure to develop ideas into final products in an ever decreasing amount of time and with minimal use of resources (Kuo, 2009; Ebert, 2007). In addition, project management encompasses a variety of duties including those related to project finance, project performance, procurement of materials, and monitoring project scope (Ahsan, 2012). Many different tools are available to today project managers. According to Besner and Hobbs (2002) there are 91 well-known tools. Shenhar (2001) developed a contingent approach to project management that says the larger the project the more planning is required to deal with the larger size of the project and the amount of uncertainty. Dealing with so many different duties involves a large amount of training. Training in project management is offered from various sources, with PMI offering one of the most recognized programs and certification for all levels of Project Managers from beginning project manager to experienced project managers (PMI, 2013b).

Project management is used in many different industries including, healthcare, construction, software development, information technology, aerospace, defense, and automotive (Davis, Mahanna, Joly, Zelek, Riley, Verma, & Fisher, 2014; Hughes, Tippett, & Thomas, 2004; Pan, Pan, & Newman, 2007; Nepal et al., 2011; Laureani, Antony & Douglas, 2010; Lenfle & Loch, 2010). This widespread usage has made project management common; however, many organizations continue to have failed projects (Pan et al., 2007). As Yamada and Kawahara (2009) said "if we can improve the quality of software development process based on project management technologies, software development productivity and product quality can be also improved" (p. 435). It appears that quality models are being incorporated into the field of systems development, specifically TQM (Ravichandran & Rai, 2000) but failures are still common. One of the major issues of failed projects is how project success is measured.

Project Management Success Rates

Project management is the planning and direction of temporary objectives, the efficiency of these objectives is measured by a project's success rate (Kerzner, 2009). The success rate can be difficult be measure, one definition is:

> If the project meets the technical performance specifications and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among key people in the parent organization, key people in the client organization, key people on the project team, and key users or clientele of the project effort, the project is considered an overall success. (Baker, Murphy, and Fisher, 1974 as cited by Hughes et al., 2004, p. 32)

This passage shows the difficulty of using customer satisfaction to measure project management's success rate.

Another way of stating the difficulty of using customer satisfaction as a measure of success is:

> Success means different thing to different people. An architect may consider success in terms of aesthetic appearance, an engineer in terms of technical competence, an accountant in terms of dollars spent under budget, a human resources manager in terms of employee satisfaction. Chief executive officers rate their success in the stock market. (Freeman & Beale, 1992, p. 8)

This study will use project management success rate to mean how well the project accomplished meeting its planned specifications.

The Standish Group's annual Chaos Report is a widely quoted industry publication reporting IT project success rates (Jørgensen, & Moløkken-Østvold, 2006). The CHAOS Report, a yearly IT publication put out by the Standish Group, shows that project success rates have been increasing; over a 16-year period IT project success rates increased from 16% to 37% (The Standish Group, 1994, 2012). However, despite the fact that The CHAOS Report is widely cited, the significance of the report has been debated among scholars and practitioners. There is an opinion that the number of projects that have been successfully completed demonstrates that project management in the field is sufficient to consider that the CHAOS Report numbers are of adequate significance (Glass, 2006). This logic, having an adequate number of successes, has been questioned by others based on a company's desire is to have their projects succeed 100% of the time (McNally, Akdeniz, & Calantone, 2011). In the construction industry, the project success rate is between 71% and 76%, and in new project development within the technology industry, the success rate for projects is between 50% and 60% (Rungi, 2010). As the above figures show, project success rates are not always as high as desired. These success rate failure raise the question of why do project fail?

Projects fail for a number of reasons including customers that are not satisfied, late delivery, cost overruns, project members who are uninterested in the project, and projects that never seem to be completed (Martin & Tate, 1998). Customers that are not satisfied may be based on that they were surprised by the output of the project because they were not involved in the process (Winch et al., 1998). Late delivery is a main concern for any project due to its importance to completion of the project according to original specifications (Jha & Iyer, 2006). Cost overruns are also critical to the completion of a project according to original specifications (Jha & Iyer, 2006). Project members who are uninterested in the project do not allow the project to proceed as quickly as it could, they need to buy-in to the process to allow the project to meet customer's expectations (Martin & Tate, 1998). Projects that never seem to be completed are normally the victim of scope creep, continuously changing project requirements (Kerzner, 2009). Scope creep is a sign that the project was not adequately managed (Kerzner, 2009). Customer satisfaction involves all of the above issues that should combine to create a successful project and a satisfied client. One quote about project success is "Trying to pin down what success means in the project context is akin to gaining consensus from a group of people on the definition of 'good art'" (Jugdev & Muller, 2005, p. 19). One way to improve a project's success rate is to ensure that the scope of the project is well defined before the project is started and that the scope of the project is fairly stable (Jugdev & Muller, 2005). One example is a project that was executed in Trinidad in 2000 **(**Lenfle & Loch, 2010). The project was considered both a failure and success based on a project failure, due to a lack of proper risk management, then the project team was changed and the project was a success (Lenfle & Loch, 2010). A significant factor in project success is related to the quality of the project's process or product.

Quality

Before the seminal roots of quality models are examined, establishing a definition of quality is necessary. Quality has been defined differently in different settings. The literature states that quality has been an issue since man began his existence (Nicholas & Steyn, 2008). The first quality standard was in the area of food (Maguad, 2006). In this case each individual decided when food was of the appropriate quality to be consumed (Maguad, 2006). The notion of quality has progressed from these humble beginnings to systems that can be very complex (Maguad, 2006). The construction industry has historically based their project management on the competitive bidding process which stresses time and cost so quality was overlooked (Rwelamila & Hall, 1995). Quality should have a higher priority but how quality is determined is a key consideration even though it has been very subjective.

Oliver, Schab, and Holweg (2007) have described quality as how an end customer perceives the value of a product. Customers also could describe quality as value for their money (Rwelamila & Hall, 1995). Defining quality in this manner leaves the issue of quality up to the customer's opinion of the product (Oliver et al., 2007). Quality can also be defined through predetermined, specific measurements; how well each of one these measurements is achieved determines the level of quality (Lam, Chan, & Chan, 2008). A traditional definition of quality, especially quality as related to project management is a determination of whether the project was completed on time and within budget (Jha & Iyer, 2006; Rwelamila & Hall, 1995). This definition of quality will be used for this study.

Quality can be used in many different applications. Public agencies have used quality improvement practices to improve their agencies culture (), health care uses multiple quality models to improve their bottom-line results (Craven, Clark, Cramer, Corwin, & Cooper, 2006), and call centers have used quality models to reduce their manpower needs and to increase their customer satisfaction (Hughes et al., 2004). Quality can be considered to be as old as mankind but can also have begun with Frederick Taylor's 1912 work on scientific management which laid the foundation for the post-war quality movement (Freeman, 1996). Taylor's theory was designed to reduce waste in the form of making a company's manpower more efficient and accountable (Taneja, Pryor, & Toombs, 2011). Even though Taylor's theory is similar to today's view of quality, it was designed as a management technique as can be derived by its name Scientific Management (Blake & Moseley, 2011). Quality models such as TQM and Lean drew on Taylor's theories about quality. TQM is similar to Scientific Management based on that they are both concerned with management (Freeman, 1996). Lean is also similar to Scientific Management based on that they both strive to reduce waste through standardization (Taneja et al., 2011). Some scholars typically consider quality to have started right after World War II ended (Freeman, 1996).

After World War II, Deming (1953) explored how to increase quality. Deming was one of the American pioneers who assisted Japan in the rebuilding of their industry following World War II (Naslund, 2008). Deming's (1953) work was based on the idea that statistical control of processes would ensure quality. Statistical control reduces the cost of production by minimizing variation, and it results in a reduction in the percentage of product that has to be reworked in order for it to be of the quality desired (Deming, 1953). For example, statistical control charts have increased production without expanding the manufacturing plant and in another case has reduced fuel costs by 29% (Deming, 1953). These improvements were the result of statistical control over the manufacturing process. Juran (1951) was another quality model pioneer in the 1950s. Juran's Trilogy, quality improvement, quality planning, and quality control, shared similarities with Demming's work in that quality was defined as meeting specifications through the minimization of variation (Kerzner, 2009). However, Juran's (1951) work went beyond just meeting specifications, his ultimate goal was to ensure that the customer was happy with the end product. Quality has been changing and improving based on various ideas over the last 100 years. At the start of this period, each individual was responsible for the quality of their work, next an increase in the amount of quality work was focused on, then quality moved towards how the customer perceived the product, and today all of these ideas are used to form the idea of quality (Kerzner, 2009).

Scientific Management can be considered to be a starting point for many quality models (Freeman, 1996). Scientific Management was the work of Frederick Taylor, and Taylor's theories were published in 1911, as *The Principles of Scientific Management.* Taylor's approach was that each job can be broken down into individual tasks, and each task must be made as efficient as possible (Freeman, 1996). In order to do this, each task is broken down into it's separate components, any unneeded components are disregarded, and the remaining components are simplified into their most essential efforts; the result is a streamlined process (Drucker, 1999). Several different quality models arose from the body of scholarly work on quality. These include TQM, CQI, Six Sigma, Lean, and Lean Six Sigma. Of these models, this review will specifically examine Six Sigma, Lean, and Lean Six Sigma.

TQM is a quality model along with tools that are aimed at improving the quality and effectiveness of a company (Nicholas, & Steyn, 2008). TQM strives for less variability and reduced waste (Kerzner, 2009). Another quality model is CQI which means whatever the current status of a company or process is, the quest is to improve upon it for the next day (Nicholas, & Steyn, 2008). Continuous Quality Improvement (CQI) is important based on that it keeps the company moving forward in its quest of becoming more efficient (Kerzner, 2009). Taylor's theory has similarities with quality theories that will be developed, such as Total Quality Management and Lean (Taneja et al., 2011).

Various quality models use similar approaches. Lean Six Sigma is a quality model that stresses reduction of waste and reduction of variance. TQM is the management of quality. Even though they sound different Lean Six Sigma and TQM are similar approaches (Nicholas, & Steyn, 2008). Both Lean Six Sigma and TQM strive to reduce both waste and variability (Kerzner, 2009). Six Sigma is the model that will be of primary concern in this study based on it being the most resent and commonly used model. In addition to quality models that are similar to each other, sometimes multiple quality models can be combined to form another quality model. This is the case in that Lean and Six Sigma combine to form Lean Six Sigma (Kerzner, 2009). Lean can be defined as a reduction waste (Martin, 2007) and Six Sigma can be defined as reduction of variable. This combination method is based on a reduction of waste and the reduction of variance.

In addition to the methods mentioned above, there are methods that use some of the same tools. One such tool is the Quality Improvement Map (QIM), which uses a series of logical steps to identify issues with a project and determine potential causes and solutions (Milosevic, 2003). QIM consists of five stages, problem definition, cause analysis, corrective actions, results, and standardization (Milosevic, 2003). QIM's main focus is the use of facts instead of opinions (Milosevic, 2003). Another tool is Quality Circles, which consist of a small group of project members that meet to determine and develop possible solutions to quality issues (Kerzner, 2009). Quality circles allow issues to be addressed in a quick and efficient manner. Quality Function Deployment is another tool that leverages customer input to ensure that a completed project will be acceptable to the customer; this is done by including the customer in the requirements of the project (Milosevic, 2003). These tools are not directly used in this research study but can used in the quality models that are being studied. Continuous quality improvement will result in quality of the future being higher than it is today. Maguad (2006) anticipates that quality of the future will see quality being important in manufacturing and have an even more important part in service and other areas of business such as billing and customer support. Quality must be applied to all areas of business to satisfy the customer of the future as they will demand high quality product and services along with all support services that a company supplies (Maguad, 2006).

Six Sigma

Six Sigma is a quality model that aims to reduce variability. There are similarities between Six Sigma and both Taylor's work and TQM. The main concern of Taylor's work was to standardize functions resulting in higher product uniformity while reducing the amount of effort required (Drucker, 1999). TQM is a model to improve quality using continuous quality improvement as a primary tool. Six Sigma and other quality models are different in that Six Sigma creates specialized positions to execute its projects whereas other quality models add additional work to current positions to execute their projects, these positions include Master Black Belts, Black Belts, Yellow Belts (Gutiérrez, Bustinza, & Molina, 2010). A short definition of Six Sigma is a method that provides organizations tools to improve the capability of their business processes. (American Society of Quality, 2013a).

Six Sigma was conceptualized by Motorola to reduce the rate of product defects incurred in the manufacturing process (Kerzner, 2009). Six Sigma was designed to reduce defects which has the result of reducing costs (Shah, Chandrasekaran, & Linderman, 2008). The increase in performance and decrease in process variation lead to defect reduction and improvement in profits, employee morale, and quality of products or services. Six Sigma quality is a term generally used to indicate a process is well controlled (within process limits ±3s from the center line in a control chart, and requirements/tolerance limits ±6s from the center line) (American Society of Quality, 2013a). Six Sigma utilizes a variety of quality tools to solve manufacturing problems and reduce variability to desired levels (Maguad, 2006). The desired variability level of Six Sigma is six standard deviations or 3.4 issues in one million opportunities (Martin, 2007).

This level of variability was chosen based on the desire to have nearly zero defects; it was calculated that any defects (variability's) at nearly a level of zero is when there is no noticeable variability within six deviations or six sigma (Maguad, 2006). Currently the financial industry typically operates at less than a 3.5 sigma which indicates that improvement is possible (Heckl, Moormann, & Rosemann). Having the ability to look at the sigma number and quickly determining if there may be increases in quality show how simple it can be to see improvement even if the improvement itself can be a very complex task.

Six Sigma uses statistical methods to improve quality. These methods include control charts, statistical process control, and regression analyses (Gutierrez et al., 2010; Kerzner, 2009; Shah et al., 2008). A control chart is used to see how a process changes over time (Milosevic, 2003), statistical process control is the process of using statistics to control variance (Maguad, 2006), and regression analyses which is a linear model where one variable can predict another variable (Field, 2009). These methods allow the determination as to when a process is in control (running efficiently) or out of control (not running at optimal efficiency and may be improved upon). The Six Sigma process is detailed and time consuming to execute. As a result, it is also expansive. Therefore, only processes that have the ability to save a large amount of time and money are good candidates for this quality model (Martin, 2007). Expenses related to Six Sigma are also driven by the extra manpower needed to administrate the six sigma process (Shah et al, 2008). Despite these expenses, however, significant savings can be recognized through process improvement. General Electric invested in Six Sigma, and in its 1997 annual report, the savings were $300,000 (Kerzner, 2009).

These savings were created in different areas of the business:

Medical Systems described how Six Sigma designs have produced a 10-fold increase in the life of CT scanner x-ray tubes — increasing the "uptime" of these machines and the profitability and level of patient care given by hospitals and other health care providers. Superabrasives — our industrial diamond business — described how Six Sigma quadrupled its return on investment and, by improving yields, is giving it a full decade's worth of capacity despite growing volume — without spending a nickel on plant and equipment capacity.

Our railcar leasing business described a 62% reduction in turnaround time at its repair shops: an enormous productivity gain for our railroad and shipper customers and for a business that's now two to three times faster than its nearest rival because of Six Sigma improvements. In the next phase, spread across the entire shop network, Black Belts and Green Belts, working with their teams, redesigned the overhaul process, resulting in a 50% further reduction in cycle time.

The plastics business, through rigorous Six Sigma process work, added 300 million pounds of new capacity (equivalent to a "free plant"), saved $400 million in investment and will save another $400 million by 2000. (General Electric, 1998)

The large investment that General Electric made in Six Sigma has returned more then was put into the program and more than it was ever believed to return (General Electric, 1998).

Six Sigma is considered a data-driven process based on the use of various data tools: statistical process control, quality improvement map, and the quantification of defects per million opportunities (Shah et al., 2008; Milosevic, 2003; Naslund, 2008). Statistical process control is the process of using statistics to control variance (Maguad, 2006). Quality improvement map is used to structure the approach used in quality improvement projects (Milosevic, 2003).

Quantification of defects per million is the number of rejections per million opportunities. Six Sigma is also customer-centered based in that the goal is to keep customers happy and not just to make efficient processes that result in products customers do not want or need (de Mast, 2006).

To perform Six Sigma, a 5-step process called DMAIC is used. The five steps of DMAIC are (a) define the issue, (b) measure the issue, (c) analyze the issue, (d) improve the issue, and (e) control the issue (Maguad, 2006; de Mast 2006). This is similar to QIM in that logic is used to determine where problems exist. Two different quality models can use similar tools. Such is the case with Six Sigma and TQM. They use DMAIC and QIM, respectively. DMAIC will be the focus here. DMAIC was first used in process improvement projects, but it has also been applied in other areas such as software development and healthcare (Zhang & Xu, 2008; Martin, 2007). Typically Black Belts, as defined later, lead the DMAIC process to encourage a continuous improvement atmosphere (Shah et al., 2008). One of the benefits of DMAIC is that it provides a roadmap of how to proceed in the quest for improvement (Wang & Chen, 2012). This roadmap is important but any Six Sigma project must be first qualified to ensure that the possible benefits are greater than the cost of the program (Martin, 2007).

One of Six Sigma's main goals is to improve the success rate of improvement projects (Linderman, Schroeder, & Choo, 2006). Six Sigma's approach uses trained personnel at various levels who specialize in particular skills (Kerzner, 2009).

Six Sigma uses a belt-level system to distinguish between personnel at various levels:

Black Belt: Leads problem-solving projects. Trains and coaches project teams.

Green Belt: Assists with data collection and analysis for Black Belt projects. Leads Green Belt projects or teams.

Master Black Belt: Trains and coaches Black Belts and Green Belts. Functions more at the Six Sigma program level by developing key metrics and the strategic direction. Acts as an organization's Six Sigma technologist and internal consultant.

Yellow Belt: Participates as a project team member. Reviews process improvements that support the project.

White Belt: Can work on local problem-solving teams that support overall projects, but may not be part of a Six Sigma project team. Understands basic Six Sigma concepts from an awareness perspective. (American Society of Quality, 2013a)

These various levels of personal use the DMAIC process to reduce variation within the process being examined (Zhang & Xu, 2008). The overall concept of the Six Sigma quality process is to reduce variation to six deviations, which is 3.4 issues per one million opportunities (Martin, 2007). These steps are only initiated when the issue has been determined to be significant in both quality and cost (Martin, 2007).

Six Sigma can be applied to any industry or problem area, but it may have to be slightly modified to work in an effective manor (Craven et al., 2006). Both financial and healthcare services have modified the Six Sigma process to improve customer service (Heckl et al., 2010). In service settings Six Sigma may place less emphasis on measurements as service data is less specific than manufacturing data, and process flow is not used in the service industry as often at it is used in manufacturing (Antony, 2004). Despite these changes, improvements that can be achieved using Six Sigma in service industries include improved teamwork, increased employee morale, shorter delivery times, reduced costs, and greater efficiency throughout the organization (Antony, 2004).

New York-Presbyterian Hospital is an example of an organization that experienced great success using Six Sigma. In 2004, New York-Presbyterian Hospital spent 8 million dollars to initiate a Six Sigma program, which resulted in a 47 million dollar savings (Craven et al., 2006). The hospital trained 40 Six Sigma Black Belts and 160 Six Sigma Green Belt in the first year of the program (Craven et al., 2006). This enabled the hospital to start over 130 Six Sigma projects in a single year (Craven et al., 2006). One of the many successful projects involved patient room turnaround time, the time it takes for a room to be available after a patient has been discharged (Craven et al., 2006). A Six Sigma Black Belt took on this project and was able to lower the turnaround time from 101 minutes to 50 minutes by changing communications and scheduling. The resulting time savings yielded an annual cost savings of more than $700,000 (Craven et al., 2006). The changes were simple in that the personnel who actually did the work had no standardized communications and there was a standard scheduling where the entire staff was off for lunch and breaks at the same time. The solution was to issue pagers to all personnel so that there was a single method on how to contact them and to stagger the non-working times so that there would always be personnel available when needed.

The Ford motor company also implemented Six Sigma company-wide to improve results. In the maintenance department, Ford evaluated their environmental chambers using Six Sigma, and as a result, the company saved $60,000 and increased customer satisfaction (Holtz & Campbell, 2004). This was achieved through the adoption of a preventative maintenance program which allowed for better use of the maintenance department’s environmental chambers and additional uptime of the equipment (Holtz & Campbell, 2004). Communications with other departments also allowed for scheduling the downtown of the chambers when they were not in use instead of having to delay any testing that was to be performed (Holtz & Campbell, 2004).

The theoretical background of Six Sigma involves the use of teamwork to reduce variation in the end product and increase customer satisfaction (Gutierrez et al., 2010). Six Sigma can be difficult to use effectively based on the lack of availability of comprehensive data about issues being investigated, this is more common in service processes then manufacturing processes (Heckl et al., 2010). Top managements support of Six Sigma is also a crucial factor for success (Naslund, 2013). Top management support allows the resources that are required for successful completion to be available. New York-Presbyterian Hospital learned that Six Sigma can be used to great affect but that it is not the appropriate tool for all issues based on its expense, an issue must have enough potential savings to be a worthy Six Sigma project (Craven et al., 2006).

The major weakness of Six Sigma is its expense. Having to train the Master Black Belts, Black Belts, and Green Belts takes a significant amount of time, and this is an important cost consideration (Craven et al., 2006). The training involves various requirements for each different belt being obtained. To achieve Green Belt Certification, an individual must complete 115 hours of course work, attend a 3-day seminar, and meet several prerequisites. These prerequisites include knowledge of college level algebra, proficiency with basis statistics, experience with teams, leadership experience, and oversight of a project with of the potential to save between $10,000 and $50,000 that has been approved by the attendee's management (American Society of Quality, 2013a). The Black Belt Certification has similar requirements except that the course length is 170 hours, and the project must represent savings potential of at least $100,000 (American Society of Quality, 2013a). To achieve Master Black Belt Certification, individuals must pass an exam and portfolio review of either 5 years of work experience as a Six Sigma Black Belt or the completion of 10 Six Sigma Black Belt Projects (American Society of Quality, 2013a).

Lean

The second quality model that will be examined during the course of this study is called Lean. Lean is one of the leading approaches in manufacturing management but Lean can be difficult to implement successfully (Boyle, Scherrer-Rathje, & Stuart, 2011). Lean attempts to reduce waste while adding value to the process (Martin, 2007).

A comprehensive definition is:

> Lean is a system of techniques and activities for running a manufacturing or service operation. The techniques and activities differ according to the application at hand but they have the same underlying principle: the elimination of all non-value-adding activities and waste from the business. (American Society of Quality, 2013a)

A simpler definition is Lean is the elimination of waste (Gershon & Rajashekharaiah, 2011). Lean was initially developed by Toyota (Kerzner, 2009); but Ford also successfully applied Lean to its manufacturing processes (Martin, 2007). Toyota studied how cars were built in North America and combined techniques from various industries to create a system that worked well in the Japanese culture; this system was called Lean Production (Alves, Dinis-Carvalho, & Sousa, 2012). Lean uses many tools including Just In Time inventory (JIT), standardization, simplified information flow, education, coordination, continuous improvement, and supplier relationships (St John & Heriot, 1993: Nepal et al, 2011).

JIT is:

> A process that continuously stresses waste reduction by optimizing the processes and procedures necessary to maintain a manufacturing operation. Part of the process is JIT

purchasing or inventory where the materials needed appear just in time for use, thus eliminating costs associated with material handling, storage, paperwork, and even inspection. (Kerzner, 2009, p. 917)

Standardization is used where the work is the same or similar in nature so that each time it is performed, the work is done according to an accepted standard (Nepal et al., 2011). Simplified information flow is a clear flow of information that is exchanged in a simple and consistent format (Nepal et al., 2011). Education is the process of workers and leaders working together to create the best possible solutions by having the workers take responsibility for their work and the leaders facilitating the workers opportunities to solve problem issues (Nepal et al., 2011), Coordination is various personnel and departments being able to work together and efficiently to solve issues (Nepal et al., 2011). Continuous improvement is the desire to always be better today than yesterday. This is achieved through standardization, simplified information flow, education, and coordination (Nepal et al., 2011). Supplier relationships are the same between the company and any of it suppliers. Supplier relationships are each specific as to how much is to be supplied, at what cost they will be supplied, and when they will be supplied (Nepal et al., 2011).

There are specific tools that can be used, but the main premise of Lean is the reduction of waste and the promotion of efficiency (Kerzner, 2009). Waste reduction can be achieved by reducing the space requirements of needed inventory. This is accomplished by purchasing in smaller quantities and building stronger relationships with a fewer number of vendors (Kerzner, 2009). This strategy has benefits and disadvantages. Some of the benefits include a reduced amount of space needed to store inventory and vendors that are more familiar with the items needed (Danese, Romano, & Bortolotti, 2012). A number of the disadvantages are fewer suppliers and larger volume orders (St John & Heriot, 1993). Fewer suppliers and larger volume orders may be considered a disadvantage but they can also be an advantage. Fewer suppliers means that each of this smaller number of suppliers can be aware of what the purchaser needs instead of supplying what they have available. This allows for the supplied material to be exactly what the purchaser needs. Larger volumes allows for a process to be set up to produce an item instead of the more ad hoc nature of filling small orders (St John & Heriot, 1993). For example, Xerox reduced their number of suppliers from 5,000 to 300; this required the remaining suppliers to handle a higher volume of goods. One of the main tools used in Lean is JIT. JIT allows for a minimum of inventory to be used. Needed parts arrive just as they are needed, and only what the customer has already ordered is built (Naslund, 2008). The result is that organizations carry less inventory (Maguad, 2006). Excess inventory represents a waste when there is no immediate need (Maguad, 2006). Maintaining a minimum inventory reduces the space needed to store inventory and reduces the manpower needed to properly manage the inventory (Oliver et al., 2007).

Toyota has used the Lean Principles to reduce the amount of work-in-progress inventory (Nepal et al., 2011). This reduction of waste is achieved through the use of various tools including: standardization, simplified information flow, education, coordination, continuous improvement, and supplier relationships (St John & Heriot, 1993). The tool of standardization is designing a process so that it is accomplished in a specific manner the same way every time (Craven et al., 2006). The tool of simplified information flow requires each process to be documented in the same manner so that all the information is easily exchangeable between processes (Nepal et al., 2011). The tool of education is a critical element in Lean because Lean focuses on change, and the ability to make changes is a learned behavior (Naslund, 2013). The tool of coordination refers to how well the company communicates its needs both internally and externally to vendors (Naslund, 2008). This can be achieved partially through the use of value stream mapping where the mapping of all value through a process shows possible waste that then can be removed (Naslund, 2008). Tool of continuous improvement is, as its name suggests, continual improvement of a process until perfection is achieved (Oliver et al., 2007). The tool of supplier relationships is critical in that suppliers are responsible for supplying a quality product, and often documentation is required to prove that supply quality is at the desired level (St John & Heriot, 1993).

Lean is able to handle almost any situation where improvements can be made, this is in part because of the many different tools that can be used with the quality model (Kerzner, 2009). This flexibility allows Lean to be applied in many different industries, for example healthcare and the automotive industry (Martin, 2007). In addition to utilizing JIT, Lean aims to remove as much waste as possible. For example, New York-Presbyterian Hospital used Lean principles to better manage their medicine management system (Craven et al., 2006). This was executed by the removal of expired medicine in various places in the supply chain including when medicines were delivered to a facility and removal of expired medicine for the stocking shelves of each stocking location (Craven et al., 2006). The improvement process resulted in a uniform inventory management system, a standardized inventory system for quantities to be on hand, and stock that was used in a manner that provided for the oldest inventory to be used first (Craven et al., 2006).

Lean tries to reduce waste to an absolute minimum using continuous improvement and other tools (Maguad, 2006). There are many ways to achieve this. One way is to eliminate as many issues as possible that do not add value to the item (Martin, 2007). Suppliers need to be held responsible for the quality of material being delivered. When suppliers can demonstrate the quality of their product they are then qualified to provide large quantities of product to a company that uses JIT purchasing (St John & Heriot, 1993). Standardization provides for a company to reduce its inventory and development costs by using one item in multiple products (Kerzner, 2009). In addition to minimizing inventory, waste reduction is an important issue. Waste reduction is the responsibility of workers at all levels ranging from the manual worker to top management (Naslund, 2008).

Training for Lean can be obtained through many different organizations. One of the leading training programs for the quality model is offered by the Lean Enterprise Institute.

They offer a 2-day course (16 hours) described as follows:

> The course is structured as repetitive cycles of *Learn-See-Do*. First we will teach a principle, then you will see how this principle is put into practice in three sectors; manufacturing, office and services, and healthcare. After that the class will participate in implementing the principle at Whishmaker, Inc. (a generic company created to illustrate the application of principles to a business) fulfilling the "do" cycle.
>
> We will repeat these *Learn-See-Do* cycles until each element is covered and then examine how the pieces work together to support a problem-solving culture typical of a mature lean organization. (Lean Enterprise Institute, para 4)

Lean, when applied correctly, is an efficient system, but it can be difficult to implement correctly due to the communication that is required to maintain system level optimization instead of just the optimization of small pockets within the system (Oliver et al., 2007). When the system level is optimized with no thought of the end product, then the system may end up with an output that is not desirable (Oliver et al., 2007). For example, if a switch is deemed acceptable to be used in multiple products but the end user does not like this particular type of switch in one of the products then the attempt at lean is not successful for the one product but may be for the other products.

Lean's weakness is that extensive resources are required to properly implement the system. Both the leaders and the workers within an organization must accept the Lean philosophy (Craven et al., 2006). The Lean philosophy, while simple, can be difficult to implement (Boyle, et al., 2011), and critical success factors include employees that are willing to change, management that focuses on the systems instead of schedules, and Lean becoming an integral part of operations instead of being a separate operation (Sawhney & Chason, 2005). The human element is the most important part to a successful Lean implementation due to the pressures put upon employees to adapt to the new system of Lean (Sawhney & Chason, 2005). Long time employees may resist the change more than newer employees and this is amplified when top management is not supportive of the new Lean system (Sawhney & Chason, 2005). Implementation of any new system, including Lean, takes proper planning, execution, and support of top management. When Lean is introduced to a company in a positive and complete manner so that the workers can have an overall idea of what is going on and can present solutions instead of just doing what they are told, then results can then be realized (Alves et al., 2012).

Lean Six Sigma

Lean Six Sigma is a very flexible quality model, which makes the definition of Lean Six Sigma difficult to completely define (Hill et al., 2011). One definition is that Lean Six Sigma is simply the combination of Lean and Six Sigma (Wang & Chen, 2012; Kerzner, 2009).

A more complete definition is:

> Lean-Six Sigma is a fact-based, data-driven philosophy of improvement that values defect prevention over defect detection. It drives customer satisfaction and bottom-line results by reducing variation, waste, and cycle time, while promoting the use of work standardization and flow, thereby creating a competitive advantage. It applies anywhere variation and waste exist, and every employee should be involved. (American Society of Quality, 2013b, para 1)

The differences in definitions reflect the flexibility of the Lean Six Sigma to handle many different situations.

> Lean Six Sigma is perceived to be:
>
> It is a condensed and less costly version of Six Sigma.
>
> It is Six Sigma on a fast track (less completion time)
>
> It is Six Sigma combined with lean tools for better results (Gershon & Rajashekharaiah, 2011, p. 27).

Lean Six Sigma can be seen from five separate viewpoints which are:

> The metric view (sigma number).
>
> The tool view (statistical analysis tools).
>
> The project view (project management tools).
>
> The program view (project management office's idea of control over multiple projects).
>
> The philosophy view (system level thinking). (Hill et al., 2011, p. 50)

All five of these viewpoints must be used together to produce the desired results (Hill et al., 2011). Lean Six Sigma can be considered as the combination of Lean and Six Sigma capitalizing on the benefits of both systems (Gershon & Rajashekharaiah, 2011). Lean can be considered to emphasize speed and efficiency while Six Sigma enhances precision and accuracy

(Laureani et al., 2010); Lean strives to apply the correct resources to the proper activities while Six Sigma strives for the process to be completed correctly the first time (Laureani et al., 2010). Lean Six Sigma uses the tools of each quality model to reduce of waste and decrease variability (Laureani & Antony, 2012). Lean Six Sigma has many different tools that can be used. Some of these tools are statistical process control, DMAIC, value stream mapping, and JIT (Naslund, 2008). The tools come from Lean and Six Sigma, but most can be used concurrently (Shah et al., 2008). Statistical process control is the process of using statistics to control variance (Maguad, 2006). DMAIC is a roadmap to solve issues. This is achieved based on that DMAIC is an acronym for Define the issue, Measure the issue, Analyze the issue, Improve the issue, and Control the issue (Maguad, 2006; de Mast 2006). Value stream mapping is where the mapping of all value through a process shows possible waste that then can be removed (Naslund, 2008). JIT is the reduction of waste through the minimization of inventory via supplies that provide good quality goods when they are needed which is called a pull system (Kerzner, 2009). These tools are compatible because each quality model is designed for a different purpose, Six Sigma's main purpose is to reduce defects while Lean's main purpose is the reduction of waste (Wang & Chen, 2012). As a result, Lean Six Sigma strives to reduce defects and waste concurrently.

The benefits of Lean Six Sigma include:

Ensuring services or products conform to what the customer needs (voice of the customer).

Removing non-value adding activities (waste).

Reducing the incidence of defective products or transactions.

Shortening cycle time.

Delivering the correct product or service at the right time in the right place. (Laureani et al., 2010, p. 758)

Like Six Sigma and Lean, Lean Six Sigma can handle almost any situation where improvement can be made (Hill et al., 2011). Lean Six Sigma is a collection of tools from both Lean and Six Sigma that work together to create an efficient system (Shah et al, 2008).

The only major weakness of Lean Six Sigma is cost (Craven et al., 2006). Cost is primarily associated with personnel training (Kerzner, 2009). Training personnel for Lean Six Sigma can be time intensive. Training Lean Six Sigma Black Belts and Lean Six Sigma Green Belts takes a significant amount of time, and this is a cost consideration (Craven et al., 2006). The training involves various requirements for each different belt being obtained. Like Six Sigma, the Lean Six Sigma Green Belt certification involves 115 hours of course work, a 3-day seminar, and several prerequisites. These prerequisites include knowledge of college level algebra, familiarity with basis statistics, experience with teams, leadership experience, and oversight of a project with of the potential to save between $10,000 and $50,000 that has been approved by the attendee's management (American Society of Quality, 2013a). The Lean Six Sigma Black Belt Certification has similar requirements except that the course length is 170 hours, and the project must represent savings potential of at least $100,000 (American Society of Quality, 2013a). The costs may be high, but the benefits can make the investment worthwhile. Motorola saved 16 billion dollars between 1986 and 2001 due to their Lean Six Sigma program (Hill et al., 2011). This savings used statistical tools to reduce costs, increase customer satisfaction, and decrease project times (Kerzner, 2009).

Lean and Six Sigma's combination into Lean Six Sigma can be confusing based on that the techniques of Lean and Six Sigma are very similar but they do have their differences (Shah et al., 2008). Both Lean and Six Sigma desire to have a quality output with Lean stressing efficiency and Six Sigma stressing the reduction of defects (Shat et al., 2008). This combination of Lean's waste reduction and Six Sigma's reduction of variation results in a flexible and effective quality model (Hill et al., 2011). By combining both methods, the results can surpass the individual models alone. Studies have shown manufacturing companies increasingly use Lean Six Sigma (Wang & Chen, 2012). Service industries are also using Lean Six Sigma. The healthcare industry has used Lean Six Sigma to improve their customer service, financial bottom line, and employee moral (Craven et al., 2006). Research has shown there are 10 areas that are critical to a Lean Six Sigma program:

1. Lean Six Sigma is customized to the specific implementation.
2. The organizational structure must compliment Lean Six Sigma's structure.
3. Lean Six Sigma develops leaders.
4. Staffing of Lean Six Sigma projects has to follow human resources practices.
5. Use Lean Six Sigma to innovate new product design.
6. Lean Six Sigma and strategic objectives must align.
7. Lean Six Sigma follows a project management structure.
8. Lean Six Sigma uses both Lean and Six Sigma techniques.
9. Supply chain partners need to be involved in Lean Six Sigma activities.
10. Document benefits (Hill et al., 2011).

A European call center that received 10,000 calls a month decided to use Lean Six Sigma in an attempt to increase its number of first-call resolutions (Laureani et al., 2010). The process included Six Sigma's DMAIC and Lean's value stream mapping. The result was a 3% increase in the first-call resolution, which corresponded with a $200,000 savings each year (Laureani et al., 2010).

Lean Six Sigma has the same weakness as both Lean and Six Sigma, cost of training. In addition, however, Lean Six Sigma has no standards for certification (Laureani & Antony, 2012). Certifications in Lean Six Sigma are normally done by larger companies that deploy Lean Six Sigma such as Motorola, DuPont, and Mircrosoft (Laureani & Antony, 2012). Motorola and Microsoft require that an exam be passed to be certified, but DuPont does not (Laureani & Antony, 2012).

Quality models and project management

An examination of the combination of quality models and project management is the purpose of this study. The two fields have not been extensively studied in combination as of yet (Julian, 2008; Jha & Iyer, 2006; Kuo, 2009; Nepal et al., 2011). As Yamada and Kawahara (2009) said "if we can improve the quality of software development process based on project management technologies, software development productivity and product quality can be also improved" (p. 435). More recently a study was performed that investigated the relationship between high performance work practices in PMO's (Wickramasinghe & Llyanage, 2013). The literature suggests that improvement is achieved at a quicker pace when multiple changes are made at one time (Davis et al., 2014). There is a gap in the literature as to which selection of practices would be the most beneficial (Wickramasinghe & Llyanage, 2013). Ravichandran and Rai (2000) stated that quality models are an important consideration for information systems management and TQM can be an effective approach. Zhang and Xu (2008) extended Ravichandran and Rai's work (R & R Model) to include Six Sigma. The R & R model presented a 'quality-orientated organizational system for software development quality performance"

(Zhang & Xu, 2008, p. 60). The inclusion of Six Sigma to the R & R model allows additional understanding of how Six Sigma can be used in a project management environment (Zhang & Xu, 2008). This collection of practices can be called a quality model, and in this case the model applies to project management, specifically PMO's.

PMOs represent a newer concept in the field of project management, and PMOs generally oversee the application of quality models (Julian, 2008). A PMO is tasked with overseeing or having direct supervision of project managers, and this is where quality models may be appropriately monitored (Aubry, Richer, Lavoie-Tremblay, & Cyr, 2011). The ability of the PMO to monitor project manager performance also allows for quality models to measure the performance of the projects through the use of statistics measuring cost and schedule estimate accuracy (Project Management, 2013). Previous studies have shown that software projects fail a good deal of the time (The Standish Group, 2004; Haponava & Al-Jibouri, 2010); however, proper management may improve project success rates (Collins & Baccarini, 2004; Julian, 2008). Use of a quality model allows for a framework to be in place so that proper management is more likely (Julian, 2008). This applies to many industries that include healthcare (Davis et al., 2014), manufacturing (Wang & Chen, 2012), and call centers (Laureani et al., 2010). How project success is measured is a key factor in the determination of whether a project is a success or not (Basten et al., 2011; Collins & Baccarini, 2004; Jugdev & Muller, 2005; Patanakul et al., 2010; Rwelamila & Hall, 1995). Project management defines project success in different ways (Jugdev & Muller, 2005). In the present study, project success was defined as how near the scheduled time, cost, and resources a finished project was completed compared with the original expectations (Patanakul et al., 2010; Jugdev & Muller, 2005; Mishra, Dangayach, & Mittal, 2011).

CHAPTER 3. METHODOLOGY

The research design of this study was non-experimental and used loglinear analysis to examine a sample of project managers. The study was performed through the use of a newly created survey that has been reviewed by subject matter experts for validity and reliability. Data was gathered by a professional data collection service. The participants of the survey were protected from harm through the application of the Belmont Principles.

This study looked at the association between project success rates and the use of quality models. The quality models being investigated are Six Sigma, Lean, and Lean Six Sigma. Loglinear Analysis was used to examine the relationship between quality models and project success rates. The results add to the scholarly literature and provide additional material that practitioners can use. The specific area of the additional information is in how project management's success rate may be improved.

The remainder of this chapter will cover research design, sample, data collection, and data analysis. The chapter will continue with validity and reliability which includes field test and pilot test. The chapter will conclude with ethical considerations.

Research Design

A non-experimental correlational approach to the research was taken using loglinear analysis. Loglinear analysis was used because it allows the relationship between categorical variables to be seen (Field, 2009). The study design is non-experimental and based on a self-administered questionnaire. This design allows the relationship between the independent (IV) and dependent (DV) variables to be examined. The IV is what is being looked at to see what change it makes to the DV (Creswell, 2009). In the past, project management researchers have used non-experimental surveys with a quantitative approach (Besner & Hobbs, 2008; Ali, Anbari, & Money, 2008; Basten et al., 2011).

Any self-administered survey assumes that the responses are truthful. This assumption of truthfulness is common to any type of survey, and it is accepted practice among scholarly researchers (Barrett, 1972). The quantitative approach was chosen based on the current minimal amount of empirical data that is available on this subject. The non-experimental, survey-based design was chosen based on the logistics required for full implementation. The author is not connected with any organization that deals with this topic, nor with the research be funded by any outside entity. Any costs associated with the research will be funded by the researcher.

Sample

The population consists of project managers. The target population is also project managers. The participants were selected from the first responses from SurveyMonkey Audience. The sample size needed according to G*Power 3.0.10 when using an effect size of 0.3, an error probability of 0.05, and a power of 0.8, is 181 participants. Using an effect size of 0.3 accounts for 9% of the total variance and is considered as a medium effect (Field, 2009). A 0.05 error probability will ensure that the mean of the data is contained in the data and a 0.05 error probability is the value that is the commonly used value for research (Field, 2009). A power of 0.8 results in an 80% chance of detecting an effect if one truly exists (Field, 2009). Using these values to select a sample size enhances the sample's relationship to the general population. The sample was self-selected from the population of project managers that have worked on projects of various types.

Instrumentation

The instrument used in this research was created for the study. The instrument was used to measure what project managers think of the use of quality models to improve project management's success rate. The survey consists of general questions about the participant's project management experience and a series of questions using a five-point Likert scale. The general questions allow the instrument to see how the participants are divided according to their demographics. Each question, using a Likert scale, is designed to have the participant give their opinion regarding how a specific quality model affects a project's outcome. This information allows the determination of how quality model effects the outcome of the project. The instrument was field tested by three experts in the field and three issues were noted. The issues were minor and the changes were made to the instrumentation. The answers to the questions will provide the data for the data analysis. The limitation of the participants to project managers exists to prevent non-project managers from responding to the survey with answers that do not have any relevancy. Limiting the study to project managers enhances both validity and reliability. Addition enhancements for validity and reliability are that a field test and pilot test were performed to ensure that the instrument is reliable and that the data represents what was intended. The survey instrument was reviewed by three subject matter experts with the result being that four issues were raised. Each issue was considered, and changes were made as needed. A pilot study was performed before the study data was collected. Both the pilot study and study data was acquired through a professional data collection service, SurveyMonkey Audience Service. The informed consent and survey questions were provided to the professional data collection service who then provided the survey to its project management members and returned the raw data to the researcher. The raw data only included completed surveys. The number of completed surveys were the requested number and the number of surveys that were started and not completed was also provided. In addition to these numbers, the typical demographic data was included which consisted of gender, age range, education level, annual household income, and location.

Data Collection

Data collection was performed via a professional data collection service, SurveyMonkey Audience Service. The instrument and informed consent were provided to the professional data collection service. The survey was administered via Survey Monkey's Audience Service which allowed the study to be executed in an efficient and timely manner. The data was then transferred to SPSS for analysis where it was verified for completeness and reliability. 181 surveys were requested to be completed with informed consent information being included as a part of the survey that was required to be accepted before the remainder of the survey could be completed. If the informed consent was not agreed to, then survey could not be completed and it would not be included in the data used for the survey.

Validity is important to any study. The current study increased validity by limiting the study to project managers. Limited the study to project managers increased the validity by using only participants that are professionals. Addition enhancements for validity are that a field test and pilot test were performed to ensure that the instrument is both reliable and valid. The survey instrument was reviewed by three subject matter experts with the result being that four issues were raised. Each issue was considered, and changes were made as needed.

Data Analysis

The data consisted of categorical variables. The analysis of categorical variables can be done with Pearson's chi-square test but this method is limited to only two categorical variables.

To extend the Pearson's chi-square test to handle additional categorical variables, loglinear analysis is used. A study using three categorical variables could use either of these two analysis models. Pearson's chi-square test would require multiple calculation with each calculation using only two of the variables. Loglinear analysis allows for a single calculation to be done to achieve the same results (Field, 2009). Loglinear analysis was chosen for this study to provide a direct result instead of making multiple calculations and then comparing the multiple results.

Validity and Reliability

There are many threats to validity, and each one must be minimized to ensure results that can be generalized to larger populations. Validity is how accurate the results are compared to what was intended to be measured (Swanson & Holton, 2005). . Reliability refers to how repeatable participant responses can be measured using Cronbach's Alpha. The desired level of Cronbach's Alpha is determined to be 0.70 or above (Vogt, 2007). Reliability also can be defined to be "The ability of a measure to produce consistent results when the same entities are measured under different conditions" (Field, 2009, p. 793). The limitation of the participants to project managers exists to prevent non-project managers from responding to the survey with answers that do not have any relevancy. Limiting the study to project managers enhances both validity and reliability. Addition enhancements for validity and reliability are that a field test and pilot test were performed to ensure that the instrument is reliable and that the data represents what was intended. The survey instrument was reviewed by three subject matter experts with the result being that four issues were raised. Each issue was considered, and changes were made as needed.

A pilot study was performed before the study data was collected. Both the pilot study and study data was acquired through a professional data collection service, SurveyMonkey

Audience Service. The informed consent and survey questions were provided to the professional data collection service who then provided the survey to its project management members and returned the raw data to the researcher. The raw data only included completed surveys. The number of completed surveys were the requested number and the number of surveys that were started and not completed was also provided. In addition to these numbers, the typical demographic data was included which consisted of gender, age range, education level, annual household income, and location. The time frame for the data collection is 2 weeks. After the data collection was complete the data analysis began. The pilot study used 37 participants and resulted in a Cronbach's alpha being calculated to be greater than 0.91. The study also revealed that the participants took an average of 5 minutes and 15 seconds to complete the survey and that minimal difficulties were encountered during the pilot study. The difficulties mentioned were that the main terms were not defined. These terms are industry terms and were intended to be defined by each participant. The results indicate that the main study may proceed.

Ethical Considerations

The Belmont principles include respect for persons, beneficence, and justice and equity. This study abided by these concerns. A large consideration to any study is how the data is to be collected. One way to enhance the Belmont principles is through the use of a third party to collect data. The data for this study was collected through a professional data collection service which enhances respect for persons by isolating the participants from the researcher, enhances beneficence by isolating the participants from the researcher, and enhances justice and equity by providing the same survey to each participant. The participants will either be working in or have worked in a project management capacity. This implies that the participants are of age and are able to make their own decisions. This also eliminates the probability of using a vulnerable population. Another potential concern is conflict of interest. This is not an issue based on the fact that there is no connection between the researcher and any outside firm that could taint the results.

The electronic data will be stored on the hard drive of a laptop computer while the study is being performed, and a backup copy of the data will be stored on a thumb drive both during and after the research is completed. After 7 years, the collected data will be destroyed along with both the computer and thumb drive. During the 7 years, the data will be secured physically within the building they are located in, the computer and thumb drive will not leave the premises, and the hard drive will be password protected.

CHAPTER 4. RESULTS

This chapter presents the results of the study, the data collected, and the data analysis. The purpose of this study was to investigate the correlation between project management and the use of quality models, specifically Six Sigma, Lean, and Lean Six Sigma. The results show that each of the three quality models improved the project success rate. Additionally, as more of a quality model was used the greater the improvement of the project success rate. Data analysis was executed through the use of descriptive statistics and a loglinear analysis.

The project management literature shows that project management is a complex task which involves the interaction of many different stakeholders. Each stakeholder may have a different idea of what a successful project is. This differing of opinion is what makes project management a challenge. One way to alleviate the issue is the purpose of this study, can quality models be used to improve the project management success rate. Work by de Mast, Martin, and Naslund have provided background that assisted in the determination of the possibilities of project management and how it could possibly be improved upon. The methodology uses a research design of a non-experimental study that used loglinear analysis to examine a sample of project managers. The results show that this sample of project managers believe that the use of Six Sigma, Lean, or Lean Six Sigma can increase a project's success rate.

Data Collection

Data was needed to test the hypotheses. The data was obtained from a population that consisted of project managers. This criteria was supplied to the professional data collection company that was used, SurveyMonkey Audience Service in addition to the survey that was created for the study. SurveyMonkey Audience Service returned the results that included data from 157 different project managers. This resulted in a cross-section of project managers responding to the survey. The raw data showed a good number of responses that indicated that quality models can increase project management's success rate. The data will be analyzed to either confirm or deny this preliminary result.

Data Analysis

Once the data collection had been completed the data was entered into SPSS, and the data was reviewed for completeness and accuracy. Any data records that were incomplete or that are obviously in error were removed from the data pool. Incomplete records include any responses with data missing. Records that are in error would include data that contradicts itself. The use of a professional data collection service should eliminate both incomplete records and data that is in error. Correct data is achieved by only using completed surveys being used and supplied to the researcher, and data that is in error should be avoided by the design of the questions. The questions are a simple design to avoid contradictions. Once the data has been verified a loglinear analysis was performed on the data. The results were analyzed using the values for the Likelihood ratio and Pearson. These are the goodness-of-fit test statistics. The final values should be less than 0.05.

One hundred and fifty seven valid responses were received from the study. The data was analyzed using IBM's SPSS software, version 22. Descriptive statistics were run to verify the data and loglinear analysis was used to verify and test the hypotheses. Both the descriptive statistics and loglinear analysis determine that the null hypothesis are invalid which results in supporting the hypothesis. The studies participants represent a good cross-section of project managers. To confirm this, the demographics were compared to PMI's demographics. PMI is a large and prestigious group for project managers. The studies participant included PMI certified project managers but this was not a requirement for their participation. The 157 project managers included in the study covered most the United States with 46 of the states having participants, Wyoming, North Dakota, South Dakota, and Maine were the four states that had no participants in the survey. The count values for gender are contained in Table 1 which shows the count values for the survey participant's ages and the count values for members of PMI ages. Table 1 shows how ages of the survey participants compare to PMI's population.

Table 1
Gender comparison

Gender	Survey Participants	PMI Members[a]
Male	36%	63%
Female	64%	37%

[a] Information was obtained from PMI's 2013 "Project Management Salary Survey – Eighth Edition" by PMI, p. 269. Copyright 2013 by PMI.

Gender was divided as 64% female and 36% male for the survey participants and 63% male and 37% female for PMI's responses to a Project Management Salary Survey in 2013. The difference may be due to the PMI Members completing a survey about their salary themselves and having their assistants fill out other surveys. Their assistants may have a larger number of females working as assistants to project managers.

Age had the majority of participants being higher in the number of years lived. Table 2 shows the details of age for survey participants.

Even though age and years of work experience are different there is a relationship between the two. Assuming that most project manager start working around 20 to 25 years old then that is the differential between the two sets of values. One important issue is that years of work experience can only go up once it is stared and age works in the same manner but is limited by the United States mandatory retirement age which has varied over the years. Both sets of values show an increasing number as the number of years of age or experience increase. The decrease in the 60 and over age category may be based on the mandatory retirement age imposed by the United States Government. Table 3 shows the number of years worked for PMI members that filled out the Project Management Salary Survey (2013).

Table 2
Age

Age	Survey Participants
18 to 29 years old	11%
30 to 44 years old	28%
45 to 60 years old	44%
Over 60 years old	17%

Table 3
Years Worked

Years of work experience	PMI members[a]
Less than 3 years of work experience	1%
3 to 5 years of work experience	1%
5 to 10 years of work experience	9%
10 to 15 years of work experience	15%
15 to 20 years of work experience	18%
Greater than 20 years of work experience	57%

[a] Information was obtained from PMI's 2013 "Project Management Salary Survey – Eighth Edition" by PMI, p. 269. Copyright 2013 by PMI.

Education is similar to age and years of work experience in that the higher percentages were at the higher levels. See Table 4 for complete details. Table 4 shows that project managers have a tendency to have a high level of education with both Survey Participants and PMI members having only 1% of the respondents having not finished high school. This 1% value was listed in the Survey Participant results and is the only remaining value unaccounted for in the PMI member numbers. The values for Survey Participant and PMI member are the same at the 4 year degree level and skewed to the higher level in the other values for the PMI member. Both the Survey Participants and PMI members are working in the profession but PMI members may be more involved bases on their participation in a professional organization that PMI is. The Survey Participants may be members of PMI but only 32% were PMI certified. This also shows that the PMI members may be more involved in the profession which may show that they are more willing to advance their education to better serve their profession.

Table 4
Education Levels

Education Level	Survey Participant	PMI member[a]
High School Graduate	3%	1%
Some college work	22%	8%
4 year college degree	42%	42%
Graduate degree	32%	48%

[a] Information was obtained from PMI's 2013 "Project Management Salary Survey – Eighth Edition" by PMI, p. 269. Copyright 2013 by PMI.

The project managers, included in the survey, cover a wide cross section of experience, age, and types of projects that have executed. The sample covered most the United States including both genders and covered a wide age range. Education also covered a wide range, from project managers that have not graduated from high school to project managers with graduate degrees. Age and education were similar in that both areas contained higher percentages of participants from the higher levels. The sample size needed according to G*Power 3.0.10 when using an effect size of 0.3, an error probability of 0.05, and a power of 0.8, is 181 participants. Using these values to select a sample size will enhance the sample's relationship to the general population. The sample will be self-selected from the target population of project managers that have worked on projects of various types. The sample had a 26% drop out rate which is considered normal.

Data Analysis Results

The loglinear analysis output includes frequency tables for each element that was considered in the analysis. Table 5 shows the frequency table for the full implementation of Six Sigma. The results are similar in all other cases which include Six Sigma, Lean, and Lean Six Sigma. Each one of these quality models has three frequency tables, one for full implementation, one for partial implementation, and one for minimal implementation.

Table 5
Full Implementation of Six Sigma

Survey response	Frequency	Percent	Valid Percent	Cumulative Percent
Absolutely	19	12.1	12.1	12.1
To a large degree	37	23.6	23.6	35.7
To a small degree	19	12.1	12.1	47.8
No difference	40	25.5	25.5	73.2
More time with some benefit	20	12.7	12.7	86.0
More time with little benefit	12	7.6	7.6	93.6
More time with no benefit	10	6.4	6.4	100.0
Total	157	100.0	100.0	

Table 5 shows how many participants believe in the element being asked about. For example, in this full implementation of Six Sigma, the element of Absolutely was selected 19 times. The Percent and Valid Percent are the same values and are the Frequency divided by the total number of participants. The Percent and Valid Percent are the same based on that there is no missing data. There is no data missing due to the data collection being done by a professional data collection service with all question being required to be answered. This results in any response that was incomplete to be considered an incomplete response which was excluded from the data. The Cumulative Percent is the summation of all Frequency values from any given element and all the values that are above it in Table 5. After the summation, the value is divided by the total number of participants.

The results for Six Sigma, Lean, and Lean Six Sigma each have similar numbers to the sample shown in Table 6. The exact numbers very for each different case but in each case the majority of the values are in the upper half of the table. This can be seen by adding the Frequency or Percent for any of the nine cases, the top three values (Absolutely, To a large degree, and To a small degree) always result in a large value then the summation of More time with some benefit, More time with little benefit, and More time with no benefit. The numbers can be seen in Table 6.

Table 6
Case Values of Frequency Tables

Case	Count of Absolutely, To a large degree, and To a small degree	Count of More time with some benefit, More time with little benefit, and More time with no benefit
Full implementation of Six Sigma	75	42
Partial implementation of Six Sigma	77	34
Minimal implementation of Six Sigma	64	29
Full implementation of Lean	81	34
Partial implementation of Lean	81	27
Minimal implementation of Lean	72	24
Full implementation of Lean Six Sigma	78	37
Partial implementation of Lean Six Sigma	80	29
Minimal implementation of Lean Six Sigma	70	27

The concept is that the more responses that were received for beneficial use points to an advantage of using this quality model. If there were less responses, then the quality model may not be the best quality model to use. The same concept is used with the Percent and Valid Percent columns. The Cumulative Percent is interpreted differently. For a quality model to have any advantage while being used the table would show a larger increase in the top half of the table then it does in the lower half of the table. This would be shown be a Cumulative Percent in the To a small degree row to be near or above 50% and the No difference row to be significantly greater than 50%.

Another table to be considered contains cell counts and residuals. This table is a result from the loglinear analysis. A small section of one such table is shown in Table 7.

Table 7 shows a small section of the cell counts and residuals table for Six Sigma that resulted from the loglinear analysis. The table is divided into three sections. The first section shows the quality model used, Six Sigma in this case, and the amount of the quality model used. The second section shows the Count and Percentage of the responses. The Observed Count is the actual number of cases that match with the criteria for any given row. The Observed Percentage is the number of participants that gave this particular answer divided by the number of participants. The Expected Count and Percentage are the same as the Observed Count and Percentage except that they are based on the model used to execute the calculations. When the Expected values are near the Observed values, the data is not significantly different from the model which means the model is a good fit with the data (Field, 2009). The third section of the Table 7 shows the residuals and the deviance. The residual is the collection of values based on the difference between the observed and expected values. The residual is an indicator of how well the data fits the model used. The standardized residual is the residual, or unstandardized residual, divided by an approximation of the standard deviation which results in a better indicator of fit then the residual. The adjusted residual is the residual value with that particular case removed. The value of this metric is that the difference it makes to the rest of the data is quantified. This means that the data is calculated with all data and with all the data except one case. The adjusted residual shows the difference when that case is in data and when it is not included. This shows how well an individual case lines up with the rest of the data. Deviance is the amount of difference that exists between the observed and expected frequency, frequency is a term that includes both count and percentage (Field, 2009).

Table 7
Cell Counts and Residuals

Full implementation of Six Sigma	Partial implementation of Six Sigma	Minimal implementation of Six Sigma	Observed Count	Observed Percentage	Expected Count	Expected Percentage	Residual	Standardized Residual	Adjusted Residual	Deviance
Absolutely	Absolutely	Absolutely	5.500	1.7%	5.500	1.7%	.000	.000	.000	.000
		To a large degree	2.500	0.8%	2.500	0.8%	.000	.000	.000	.000
		To a small degree	1.500	0.5%	1.500	0.5%	.000	.000	.000	.000

Six Sigma, Lean, and Lean Six Sigma all showed results that were grouped in the beneficial range. The beneficial range would include the responses of Absolutely, To a large degree, To a small degree, and No difference. The loglinear analysis for Six Sigma shows that 29 out of 49 cases, where the expected count was greater than one, resulted from Six Sigma either assisting or not effecting the project success rate. Loglinear analysis assumes that expected counts will be greater than one and that counts greater than five are desirable. Counts that were of a value of 5 or greater showed 9 out of 10 cases were Six Sigma was rated as either being used or not effecting the project success rate. The loglinear analysis for Lean shows that 27 out of 45 cases, where the expected count was greater than one, resulted from Lean either assisting or not effecting the project success rate. Loglinear analysis assumes that expected counts will be greater than one and that counts greater than five are desirable. Counts that were of a value of 5 or greater showed 7 out of 8 cases were Lean was rated as either being used or not effecting the project success rate. The loglinear analysis shows that 10 out of 45 cases, where the expected count was greater than one, resulted from Lean Six Sigma either assisting or not effecting the project success rate. Loglinear analysis assumes that expected counts will be greater than one and that counts greater than five are desirable. Counts that were of a value of 5 or greater showed 8 out of 9 cases were Lean Six Sigma was rated as either being used or not effecting the project success rate.

Goodness-of-fit tests shows weather the data is significantly different. A Lower value means that the data is not significantly different. The lower the value the better the goodness-of-fit and the data and model are not significantly different. Table 8 shows the results for Lean Six Sigma with Six Sigma and Lean having the same results.

Table 8

Goodness-of-Fit Tests

Goodness-of-Fit Tests	Value	df	Sig.
Likelihood Ratio	.000	0	.
Pearson Chi-Square	.000	0	.

Table 7 shows two rows, Likelihood Ratio and Pearson Chi-Square. Likelihood Ratio is the preferred metric for smaller sample sizes while either test works well with larger sample sizes. The Value column shows the result of a mathematical equation. Likelihood Ration uses an equation that the value squared is equal to twice the summation of the result of the observed value multiplied by the natural log of the observed value divided by the model value. Pearson Chi-Square uses an equation that has the square of the value being a summation of the result of the square of the difference of the observed value and model value which is then divided by the model value. The df column is the number of degrees of freedom. The final column is significance. The larger the significance value is the less the data and the model are significant to each other. A value larger than 0.05 indicates that the model may not have been the correct choice to use with this data. A significance value represented as "." Means that the data and model are a perfect fit for each other (Field, 2009). All three quality models, Six Sigma, Lean, and Lean Six Sigma, have the value of.000 for both Likelihood Ratio and Person Chi-Square, df of 0, and significance of ".".

Research Questions, Hypothesis, and Statistical Test Performed

The study consisted of three research questions which are:

ResQ 1 What is the association between Six Sigma and project outcomes?

ResQ 2 What is the association between Lean and project outcomes?

ResQ 3 What is the association between Lean Six Sigma and project outcomes?

These three question lead to the hypotheses of:

$H_0$1: There is no statistically significant difference between the use of Six Sigma and the project success rate.

Ha1: There is a statistically significant difference between the use of Six Sigma and the project success rate.

H02: There is no statistically significant difference between the use of Lean and the project success rate.

Ha2: There is a statistically significant difference between the use of Lean and the project success rate.

H03: There is no statistically significant difference between the use of Lean Six Sigma and the project success rate.

Ha3: There is a statistically significant difference between the use of Lean Six Sigma and the project success rate.

These research questions and hypotheses should result in determining if a quality model can be used to increase the project management success rate.

Hypothesis 1 states there is a statistically significant difference between the use of Six Sigma and the project success rate. This is shown to be a valid statement through the increasing breath of the standard deviation as the amount of Six Sigma is increased. The statement is also shown to be valid based on the results of the loglinear analysis. Loglinear analysis was used based on its ability to handle multiple categorical variables. The loglinear analysis showed that cases with a count of 5 or greater showed 9 out of 10 cases where Six Sigma was rated as either being used or not effecting the project success rate. The null is rejected based on the figures mentioned above in regard to more cases showing that Six Sigma can assist in improving the project success rate along with a minimal amount of causing additional work with no gain.

Hypothesis 2 states there is a statistically significant difference between the use of Lean and the project success rate. This statement is valid based on the increasing value of the standard deviation as the amount of Lean is increased. Loglinear analysis was used based on its ability to handle multiple categorical variables. Results of the loglinear analysis that contained counts with a value of 5 or greater showed 7 out of 8 cases where Lean was rated as either being used or not effecting the project success rate. The null is rejected based on the figures mentioned above in regard to more cases showing that Lean can assist in improving the project success rate along with a minimal amount of causing additional work with no gain.

Hypothesis 3 states there is a statistically significant difference between the use of Lean Six Sigma and the project success rate. This statement is shown to be true by an increase in the standard deviation as the amount of Lean Six Sigma is applied. Loglinear analysis was used based on its ability to handle multiple categorical variables. The loglinear analysis results showed cased that had counts with a value of 5 or greater showed 8 out of 9 cases where Lean Six Sigma was rated as either being used or not effecting the project success rate. The null is rejected based on the figures mentioned above in regard to more cases showing that Lean Six Sigma can assist in improving the project success rate along with a minimal amount of causing additional work with no gain.

The three null hypothesis have been rejected based on the number of cases that show either an improvement or no harm to the project success rate. The three hypotheses stated that each quality model, Six Sigma, Lean, and, Lean Six Sigma, can improve a project's success rate. The survey's responses have shown that there are more project managers in the sample that believe of Six Sigma, Lean, or, Lean Six Sigma can result in a benefit to a project's success rate.

Summary of Data Analysis Results

This study proposed that quality models could be used to increase the project management success rate. A survey was designed and 157 project managers completed the survey in its entirety. Descriptive statistics and loglinear analysis was used to determine that the three null hypothesis have been rejected based on the number of cases that show either an improvement or no harm to the project success rate. The three hypotheses stated that each quality model, Six Sigma, Lean, and, Lean Six Sigma, can improve a project's success rate. The survey's responses have shown that there are more project managers in the sample that believe of Six Sigma, Lean, or, Lean Six Sigma can result in a benefit to a project's success rate. The next chapter will look at these results in more detail and present possible conclusions about how the results can be used.

CHAPTER 5. DISCUSSION, IMPLICATIONS, RECOMMENDATIONS

This chapter recapitulates the purpose of the research study, provides a summary and discussion of the results, explains the study's significance, the methodology used, and summarizes the study's findings. It also presents the implications of the study in relationship to the body of literature reviewed and identifies the limitations of the study. Finally, it provides recommendations for future research and conclusions of this research study.

The purpose of this study was to investigate if three specific quality models, Six Sigma, Lean, and, Lean Six Sigma can effect a project's success rate. The results show that each of the three quality models improved the project success rate. Additionally, as more of a quality model was used the greater the improvement of the project success rate. The study was non-experimental and used loglinear analysis to examine the data.

Problem Restatement

Historically, information systems' project success rates have been lower than desired (The Standish Group, 2012). *The Standish Group* measures the success rate of information systems' projects which shows the increase in project success rates from 16% to 37% over an 18-year period of time (The Standish Group, 1994, 2012). This data from *The Standish Group* points to a problem with how IT projects are managed due to their low success rate. There are many theories for this behavior that include the IT industry and many others.

One theory of why projects fail is based on the multidimensionality of project success (Winch et al., 1998). Project success can be both positive and negative at the same time depending on the perspective that is being looked through (Kuo, 2009). For example, a project manager can fulfill all the project specifications and still have a customer that is not happy with the end result of the project. In this case, the project manager believes that the project was a success but the customer thinks that the project was a failure (Winch et al., 1998). Another theory of project failure is based on communications (Ebert, 2007). Communication needs to be clear between all involved parties including the project manager, stakeholders, and customers (Ebert, 2007). Another project management failure theory is that all projects can be treated as the same type of project (Shenhar et al., 2002). An example of this is that innovative projects and non-innovative projects need to be handled differently based on that innovative projects have a higher degree of flexibility than non-innovative projects, which can be highly structured (Besner & Hobbs, 2008). An innovative project is "a project that produces a new product or that involves a new concept and a new technology" (Besner & Hobbs, 2008). Quality models may have the ability to handle these issues. According to Martin and Tate (1998), business's found that process improvement could increase business efficiency which is what Six Sigma and lean are designed to accomplish. The same connection has been used to cope with increasing time and cost pressures in new product development, through the use of Six Sigma and Lean processes (Nepal et al., 2011). Not enough is known about how quality models might improve project success.

Summary of Data Analysis and Findings

The relationship between quality models and project management's success rate was the focus of this study. The results show that quality models have a positive effect on project management's success rate. The following section covers a summary of the data analysis and finding of the study.

Summary of Data Analysis

Data analysis started by determination of the sample size needed. According to G*Power 3.0.10 when using an effect size of 0.3, an error probability of 0.05, and a power of 0.8, is 181 participants. Using an effect size of 0.3 accounts for 9% of the total variance and is considered as a medium effect (Field, 2009). A 0.05 error probability will ensure that the mean of the data is contained in the data and a 0.05 error probability is the value that is the commonly used value for research (Field, 2009). A power of 0.8 results in an 80% chance of detecting an effect if one truly exists (Field, 2009). Using these values to select a sample size will enhance the sample's relationship to the general population. The sample will be self-selected from the target population of project managers that have worked on projects of various types. The sample had a 26% dropout rate which is considered normal. Even though the dropout rate was normal, it resulted in the participants dropping to 157 from the desired 181. The difference will lower the strength of the study to a small degree. The original number of desired participants was based on using a power of 0.80. Research studies commonly use a value of 0.70 to ensure that the strength of a study is sufficient (Field, 2009). This difference in the value of the power factor nullifies the sample size difference. Based on this information the decision was made to proceed with the study using the received number of responses.

After the data was collected, descriptive statistics and loglinear analysis were used to determine if the hypotheses were valid. The three null hypotheses were rejected which gives support to the hypotheses.

Summary of Findings

The findings show that quality models can be used to improve project management's success rate. These findings were achieved by descriptive statistics that show an increasing likelihood of project management's success rate when quality models are applied and project management's success rate increases at a greater rate when more of a quality model is applied. These findings were confirmed by the loglinear analysis which also showed the as quality models were applied the project management success rate increased and increased to a greater degree when more of a particular quality model was applied.

Discussion of Findings

The study's results will allow both scholars and practitioners better determine if the use of Six Sigma, Lean, or Lean Six Sigma may be valuable to their needs. The literature that was reviewed for the study includes work by de Mast, Martin, and Naslund. These works provided background that assisted in the determination of the possibilities of project management and how it could possibly be improved upon. The methodology uses a research design of a non-experimental study that used loglinear analysis to examine a sample of project managers. The results show that this sample of project managers believe that the use of Six Sigma, Lean, or Lean Six Sigma can increase a project's success rate.

This study was designed to provide both scholars and practitioners of project management with more data about quality models and project's success rates. The results have answered each of the three questions that were posed:

ResQ 1 What is the association between Six Sigma and project outcomes?

ResQ 2 What is the association between Lean and project outcomes?

ResQ 3 What is the association between Lean Six Sigma and project outcomes?

Each of the three questions was answered by asking a wide variety of project managers weather each of the three stated quality models could improve a project's success rate. Both the descriptive statistics and loglinear analysis showed that the more of a quality model that is applied the larger the amount of the project managers think that the project success rate have a positive effect.

Hypothesis 1 states there is a statistically significant difference between the use of Six Sigma and the project success rate. This is shown to be a valid statement through the increasing breath of the standard deviation as the amount of Six Sigma is increased. The statement is also shown to be valid based on the results of the loglinear analysis. The loglinear analysis shows that 29 out of 49 cases, where the expected count was greater than one, resulted from Six Sigma either assisting or not effecting the project success rate. Loglinear analysis assumes that expected counts will be greater than one and that counts greater than five are desirable. Counts that were of a value of 5 or greater showed 9 out of 10 cases were Six Sigma was rated as either being used or not effecting the project success rate. Loglinear analysis was used based on its ability to handle multiple categorical variables. The null is rejected based on the figures mentioned above in regard to more cases showing that Six Sigma can assist in improving the project success rate along with a minimal amount of causing additional work with no gain.

Hypothesis 2 states there is a statistically significant difference between the use of Lean and the project success rate. This statement is valid based on the increasing value of the standard deviation as the amount of Lean is increased. The statement is also shown to be valid based on the results of the loglinear analysis. The loglinear analysis shows that 27 out of 45 cases, where the expected count was greater than one, resulted from Lean either assisting or not effecting the project success rate. Loglinear analysis assumes that expected counts will be greater than one and that counts greater than five are desirable. Counts that were of a value of 5 or greater showed 7 out of 8 cases were Lean was rated as either being used or not effecting the project success rate. Loglinear analysis was used based on its ability to handle multiple categorical variables. The null is rejected based on the figures mentioned above in regard to more cases showing that Lean can assist in improving the project success rate along with a minimal amount of causing additional work with no gain.

Hypothesis 3 states there is a statistically significant difference between the use of Lean Six Sigma and the project success rate. This statement is shown to be true by an increase in the standard deviation as the amount of Lean Six Sigma is applied. The statement is also shown to be valid based on the results of the loglinear analysis. The loglinear analysis shows that 10 out of 45 cases, where the expected count was greater than one, resulted from Lean Six Sigma either assisting or not effecting the project success rate. Loglinear analysis assumes that expected counts will be greater than one and that counts greater than five are desirable. Counts that were of a value of 5 or greater showed 8 out of 9 cases were Lean Six Sigma was rated as either being used or not effecting the project success rate. Loglinear analysis was used based on its ability to handle multiple categorical variables. The null is rejected based on the figures mentioned above in regard to more cases showing that Lean Six Sigma can assist in improving the project success rate along with a minimal amount of causing additional work with no gain.

Having seen that quality models can be beneficial for project management allows scholars to research the topic in more detail and for practitioners to verify that quality models can be effectively used with project management. This study was very broad in nature so it is limited by being at a high level. The study could have been stronger by either having more participants or by manipulating the data to provide more powerful results.

Implications of Findings

This study's results can be considered to be a link between de Mast (2006) work and Shenhar and Dvir (2007) work. De Mast's work with Six Sigma dealing with possibilities for improvement and Shenhar and Dvir (2007) work in project management research are being bridged by this study by examining project management and Six Sigma. The results describe that a situation exists where additional research could provide detailed information about how quality models can be used to effect a project's success rate. This detailed information could provide for increased in project management success rate figures in the future.

The study results show that quality models can be beneficial project management. The results indicate that the more of a quality model that is used the more benefit it can have. The implication is that as project managers adopt the use of quality models and apply more of the model they decide is best for a given project, the higher the project success rate will become. This has the possibility to save millions of dollars through the reduction of failed projects and can increase the quality of projects that are completed. The same result can be seen in Table 2 by there being more responses indicating that quality models increase project management's results more times than they hurt the results. The implication here is that the use of a quality model will improve project success but even more important is that the more any quality model is used, the less negative impact it will have on the project. When taking away any negative effect, there can be additional positive effect. Either way, the end result is a project that is of a higher quality at the end of the project.

The work of de Mast (2006) dealt with Six Sigma and competitive advantage. The current study brings support to the use of Six Sigma with de Mast's work showing how Six Sigma can create advantages for a company. These benefits are focused on reducing the cost of poor quality and continuous improvement of operational efficiency and effectiveness. The current study has the same goal but is focused on showing that quality models have a legitimate use for project management. One of the points that de Mast (2006) makes is that quality improvement is not always translated into increased customer satisfaction or even increasing the bottom line numbers of a company. This is a limitation of the study and will be discussed in the next section.

The work of Shenhar and Dvir (2007) investigates how project management is researched in an attempt to discover how to improve project management's success rate. Shenhar and Dvir (2007) show a less than optimal project management success rate even though they indicate that there is a rich and helpful. Even with this helpful information the project management success rate is at a level that can be improved upon. The current study proposes a way to improve the project management success rate and increase the depth of the current body of knowledge. Expanding the current body of knowledge has been achieved by this study with even additional expansion that can come by following some of the ideas for future research, potential future research ideas will be presented shortly, and ideas that may come out of the ideas for future research as presented. Shenhar and Dvir (2007) state in their conclusion:

> Project management research is still evolving, it has not yet established its role … Perhaps, as claimed, the reason is the lack of a strong theoretical basis and a guiding set of concepts. The authors hope that the ideas presented here will prompt additional theoretical development and further discussion. (p. 97)

The current study is involved in the evolving and expansion of project management research. It also is a potential guiding set of concepts that may result in a significant increase in the project management success rate. In addition to expansion of the existing body of knowledge it also follows in the desires of Shenhar and Dvir's in that additional discussion has been started in part due to their work. Shenhar and Dvir (2007) go on to state that one theory will be unable to cover all of project management but the current study should enable for some improvement and may also uncover additional areas that need to be addressed. Shenhar and Dvir (2007) also said that project management is a growing field and is rich with challenges. This points to additional research being performed that may be beneficial to the scholars and practitioners. Scholars benefit through the opportunity to do additional research and the practitioners benefit through additional information that they can use to improve their projects.

Maguad (2006) worked in quality and suggests that quality has only been around for a few decades and that it will take many more decades before quality becomes extremely effective. This goes along with the work of Shenhar and Dvir in that their respective fields have not fully matured and will require addition time and research to perform at their best levels possible. The current study adds to the body of knowledge so that additional work, discussion, and research can be done to further expand the efficiency of the discipline. Martin (2007) investigated how to select the best quality model to produce the best results. The implication is that it is not only if quality models are used but that the correct one should produce the best results. The current study shows that quality models can have the result of a better project management success rate and indicates that there is a preference to Lean Six Sigma.

One area that has not been covered by this study is which quality to use in specific industries. Naslund (2013) mentioned that each quality model may not be the best model to be used for any given industry or individual project. Innovative and non-innovative projects require different approaches to project management, especially in the area of risk management. The current study only deals with quality models and project management. To see the implications at a deeper level additional studies would have to be performed. It is interesting to note that early project management was very innovative in it application, specifically the Manhattan Project, while current project management is better suited to non-innovative projects. Winch, Usmani, and Edkins (1998) stated that in the construction management there is a weakness in their project success rate and that no alternative has been proposed. Even though their paper was published in 1998, no additional work was found to suggest the use of quality models to increase their project success rate. The current study allows for one alternative that can be studied to determine how well it can work in their specific industry, construction.

Lenfle and Lock (2010) cover a similar topic in their paper as did Naslund. This topic was how project management that involve innovative and non-innovative projects require different approaches. The current study treats each quality model across various industries so that the results only show weather each quality model may be useful. Lenfle and Lock (2010) worked on the innovation verses non-innovative issue. The current study could be combined with Lenfle and Lock's work in an attempt to better understand how, where, and when any specific quality model may be used in a beneficial manner. The study by Jugdev and Muller (2005) shows that a good deal of work has been done on improving project management in the last 40 years. Most of this work has been on better understanding project management but little has had any effect on the project management success rate. Understanding what project management is and how it works is important to the future improvement of project management. The knowledge gained in the last 40 years has the field moving to a more holistic approach. This in combination with the use of quality models may be the answer to improving the project management success rate that has not been increasing as quickly as companies would like.

The work of Zhang and

Xu (2008) expanded an earlier theoretical model to include the use of Six Sigma. Their results points to Six Sigma being a useful addition to the qualities that can be used in the space of IS project management. This is complimentary to the result found in the current study in that quality models can be useful to project management to increase the project management success rate. Zhang and Xu (2008) go on to say that their study is in the early stages of Six Sigma and additional research will be required to further examine the potential benefits of the application of Six Sigma on project management. The current study applies the same thought in that additional research into the area would be beneficial to fully explore the potential gains that the use of quality models can have on project management's success rate. Julian (2008) identifies that continuous improvement is important to project management. Continuous improvement is a portion of Six Sigma which is critical to the long term success of Six Sigma as a quality model. This continuous improvement allows a company to improve it project management success rate in an increasing manner. When continuous improvement is ineffective because of company politics then the result is that improvements will not be made. This is a similar situation to quality models. When company politics do not allow for quality models to be used then a PMO may be the level that the quality models need to be applied by. This creates a situation where continuous improvement can exist throughout a project which is an important aspect of Six Sigma.

Limitations of the Study

This study was performed at a high level to determine the possibility of quality models use to increase project managements success rate. Having completed the study at a high level leaves many details open for interpretation. These details include experience level of the project managers, are some industries better suited for the use of quality models, which quality models can produce better results, are there additional options to use to increase project management's success rate, and so on. One issue that came up during the study was during the loglinear analysis, the results were not as powerful as originally intended. The desired amount of participants being 181 and the actual sample used was 157. The difference will lower the strength of the study to a small degree. The original number of desired participants was based on using a power of 0.80. Research studies commonly use a value of 0.70 ensure that the strength of a study is sufficient (Field, 2009). This difference in the value of the power factor nullifies the sample size difference. Based on this information the decision was made to proceed with the study using the received number of responses. Another important limitation of this study is that the use of a quality model may increase costs with little to no benefit for a company. This limitation is important in that even is a quality model is shown to be beneficial it must also be used in a manner that will produce results for a company. This limitation is well beyond the scope of this study but is a possible topic for further research. Another limitation to this study is in the determination of which quality model to use for any industry or any given project. This is a large topic to be cover and would best be broken up into many smaller studies, possibly with each one looking at only one quality model and one industry. An important limitation of the study is that the participants answered truthfully. Using participants that are only qualified to be part of the general population would result in a major limitation for a study. The current study used participants that were professionals in the field, this greatly decreases the possibility of untrue answers to the survey. One final limitation of the study is that different quality models are applied in different manners by different project managers. The importance of this limitation is that quality models must be applied as they are designed to be used or they are of little used. Some project managers may use bits and pieces of a quality model and consider that they are using a full quality model when they are in actuality using only a small portion of the quality model.

Recommendations for Future Research

This study was executed at a high level so there are various opportunities for further research. Some of these opportunities of future research are increasing the quantity of quality models researched, limiting the industries that are included in the study, discovering if there are regional differences, determining if project manager gender is significant, and the determination of which quality model works best in specific industries. As mentioned in the previous section even if a quality model can improve the project management success rate, it is important to determine if that will improve a company's business. Future research could also be done to determine if the cost of implementing a quality model is worth the time and effort.

Conclusion

This study has shown that there is a connection with quality models and project's success rates. The project managers that made up the sample, has shown that quality models can be beneficial to project management. There were three questions asked. Each of the three question was the same except that it referenced one of the three quality models examined, Six Sigma, Lean, and, Lean Six Sigma. The question asked was if each specific quality model could be used to increase a project's success rate. Each quality model was determined to be useful and was more beneficial as additional amounts of the quality model was used.

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APPENDIX A. STATEMENT OF ORIGINAL WORK

Academic Honesty Policy

Capella University's Academic Honesty Policy (3.01.01) holds learners accountable for the integrity of work they submit, which includes but is not limited to discussion postings, assignments, comprehensive exams, and the dissertation or capstone project.

Established in the Policy are the expectations for original work, rationale for the policy, definition of terms that pertain to academic honesty and original work, and disciplinary consequences of academic dishonesty. Also stated in the Policy is the expectation that learners will follow APA rules for citing another person's ideas or works.

The following standards for original work and definition of *plagiarism* are discussed in the Policy:

> Learners are expected to be the sole authors of their work and to acknowledge the authorship of others' work through proper citation and reference. Use of another person's ideas, including another learner's, without proper reference or citation constitutes plagiarism and academic dishonesty and is prohibited conduct. (p. 1)
>
> Plagiarism is one example of academic dishonesty. Plagiarism is presenting someone else's ideas or work as your own. Plagiarism also includes copying verbatim or rephrasing ideas without properly acknowledging the source by author, date, and publication medium. (p. 2)

Capella University's Research Misconduct Policy (3.03.06) holds learners accountable for research integrity. What constitutes research misconduct is discussed in the Policy:

> Research misconduct includes but is not limited to falsification, fabrication, plagiarism, misappropriation, or other practices that seriously deviate from those that are commonly accepted within the academic community for proposing, conducting, or reviewing research, or in reporting research results. (p. 1)

Learners failing to abide by these policies are subject to consequences, including but not limited to dismissal or revocation of the degree.

Statement of Original Work and Signature

I have read, understood, and abided by Capella University's Academic Honesty Policy (3.01.01) and Research Misconduct Policy (3.03.06), including the Policy Statements, Rationale, and Definitions.

I attest that this dissertation or capstone project is my own work. Where I have used the ideas or words of others, I have paraphrased, summarized, or used direct quotes following the guidelines set forth in the APA *Publication Manual*.

Learner ID and e-mail	Bryan Whited 10/8/14
Mentor name and school	Dr. Werner Gottwald, School of Business and Technology
Learner signature and date	