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When Does Six Sigma Reduce Defects and Increase Efficiencies?

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This is to certify that the doctoral dissertation by

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Abstract

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Abstract

A field research-based statistical study was used to investigate successes and failures of Six Sigma methodologies based projects. Six Sigma methodologies require that projects be designed, planned, and implemented using techniques specifically designed to achieve desired benefits that are based on the method's key drivers for project success. This study addressed an identified gap in the literature that Six Sigma projects do not fail because of Six Sigma methodologies, but that the projects can fail because of deficient support processes. Six Sigma projects that do not achieve the desired benefits are often labeled as "fads." Research questions related to management support processes for Six Sigma projects addressed whether the project was properly scoped and if Six Sigma projects were conducted with the appropriate methodological framework. Field research data were collected using a 5-point, Likert self-administered survey, which was provided to a sample of 206 Six Sigma Black Belt practitioners and project participants. The survey data were analyzed using descriptive and inferential statistics to identify probable significance of the results. The general data results concluded that Six Sigma projects do not fail solely because of Six Sigma methodology; instead, failure was attributed to other unexamined reasons and factors. Successful Six Sigma projects, which are deployed to increase claims processing accuracy throughput for insurance companies and the Centers for Medicare & Medicaid Services, can trigger positive social change. Increased efficiencies should lead to improved cash flow for doctors and hospitals that will positively affect services offered, utilization processes, and their employees.

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Dedication

I dedicate this dissertation to my two beautiful daughters, Brooke and Samantha, and my loving fiancée, Laura.

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Chapter 1: Introduction to the Study

Background of the Study

To achieve higher operational effectiveness in business and organizational performance, new approaches have emerged that aim to improve operational performance, boost profitability, and enhance competitiveness. As a structured methodology emerged from quality management (De Feo & Juran, 2010), Six Sigma programs have received considerable attention in these processes of improvement (Ansari, Lockwood, Thies, Modarress, & Nino, 2011; Prashar, 2014). The Six Sigma methodology plays a major role in determining the quality of a management approach despite its dependence on using tools that some researchers regard as traditional tools of quality management (Inozu, 2012; Prasad, Subbaiah, & Padmavathi, 2012). The fundamental pillars of the Six Sigma approach are effective, although some researchers regard them as traditional (Cournoyer et al., 2011; Kohn, Corrigan, & Donaldson, 2000; McClusky, 2000; Mehrjerdi, 2011; Miltenburg, 2011; Montgomery, 2012). The define, measure, analyze, improve, and control (DMAIC) projects that are the hallmark of Six Sigma increased efficiency and reduced defect results are key reasons why the Six Sigma methodology continues to be used as a business process.

Six Sigma is a business strategy that provides new knowledge and capabilities to employees so that these employees can better organize business processes, solve business problems, and make better decisions (Angel & Pritchard, 2008; Abid, Rehman, & Anees, 2010). The development and effective deployment of the Six Sigma approach depends on employees' understanding and application for Six Sigma to work (Chiarini, 2011a, 2011b; McClusky, 2000). For this reason, applying Six Sigma methodology to a corporation requires a Six Sigma Black Belt to lead DMAIC projects and to help employees to succeed (Taghizadegan, 2014). Training on subjects such as statistical methods enhances the success of an organization that is applying the Six Sigma approach in its management (Chiarini, 2011a, 2011b; Antony, Krishan, Cullen, & Kumar, 2012; Pacheco, Lacerda, Neto, Jung, & Antunes, 2014; Peteros & Maleyeff, 2013; Pinto & Brunese, 2011; Revere & Black, 2011).

Using Six Sigma has become a common approach to addressing business problems and removing waste, resulting in significant profitability improvements (Angel & Pritchard, 2008). In addition to improving profitability, Six Sigma improves both customer and employee satisfaction. The Six Sigma approach has developed into an efficient system of management (Gupta, Acharya, & Patwardhan, 2013; McClusky, 2000). Its success is attributed to not only enhancing management, but also to producing results (Starbird & Cavanagh, 2011). Practitioners can use the Six Sigma to organize systems of operations and streamline them toward achievement of the organizational goals (DALBAR, 2012).

The Six Sigma process measurement and management system may also enable employees and companies to enjoy an organized view of the entire business (AlSagheer, 2011). By using the various concepts embedded in Six Sigma, practitioners can identify key processes, prioritize outputs of these processes, determine capabilities, and make necessary improvements so that executives can implement a management structure to ensure the ongoing success of the business (DALBAR, 2013). The efficiency of Six

Sigma methodology provides a stable, consistent, statistical-based platform for management of demanding fields such as information technology (IT) (Inozu, 2012). Six Sigma is an effective tool for coordinating and aligning processes toward achievement of the common goal (Ismyrlis & Moschidis, 2013). Quality and innovation are aspects of an organization that thrive based on the management structure in place (Büyüközkan & Öztürkcan, 2010). Innovation enhances quality while working toward achieving quality, and it complements and introduces the innovative aspect to an organization (Charles et al., 2014; Martin, 2014). As such, management systems are often required to facilitate an environment that allows these aspects to thrive for the good of the organization (Cronholm, 2013).

Problem Statement

Some business leaders have perceived Six Sigma methodologies as “fads” that do not work (AlSagheer, 2011; Burge, 2008; McManus, 2008). Some workers in departments receiving Six Sigma benefits have refused to participate as directed, even though the benefits of successful Six Sigma implementations have been documented (Burge, 2008). Burge (2008) remarked that such projects could fail due to a lack of communication and proper guidance. Successful Six Sigma projects positively affect the corporate bottom line. Company leaders must use Six Sigma if they are seeking a competitive edge in the markets (Baril, Yacout, & Clément, 2011). Applying Six Sigma facilitates a competitive edge, which enhances and fortifies operation efficiency (Cheng & Chang, 2012). The Six Sigma solution is best suited for organizations that have the necessary resources to deploy Six Sigma DMAIC projects properly (Levine, Gitlow, &

Melynck, 2015). Despite the consensus regarding the effectiveness of the Six Sigma approach, literature includes reports of several factors that cause Six Sigma projects to fail.

Data Integrity

Six Sigma projects are statistically and data-driven to draw hypotheses from collected data and quantify and reduce defects per million opportunities (DPMO). Deming and Orsini (2013) focused on the processes being in or out of control, which also holds true for the data required for a Six Sigma project. Six Sigma is based on the standard deviation of a normal bell-shaped distribution pattern, the implication of which is a goal of reducing the number of defects to less than 3.4 defects per occurrences (Revere & Black, 2011). Antony (2012) explained that Six Sigma is a customer-based approach to management of the production efforts of an organization. Aspects of Six Sigma, such as innovativeness and quality, elevate the customer experience to a different level (Charles et al., 2014). According to Liker and Convis (2011), Six Sigma is a management strategy that marked the beginning of a revolution for managing corporations worldwide. With the effectiveness achieved through its administration, Six Sigma is widely regarded as the necessary breakthrough in management (Cima et al., 2010; Harry & Schroeder, 2014). The success rate of the Six Sigma approach has cemented the reputation of this quality improvement strategy (Fraser & Fraser, 2011; Jit Singh & Bakshi, 2014).

As with all data-driven projects, quality and consistency are key factors for a successful Six Sigma project. Process improvement would be difficult if the current steps in the process systematically produced faulty data (Aggarwal, Kumar, Khatter, & Aggarwal, 2012). The team needed to have confidence in the numbers on which it was going to base its findings and recommendations. By examining representative samples of data in detail, the team was able to confirm that the actual sales transaction data were relatively stable and reliable, even though various reports presented the information in different formats (Desai, 2010). Data outputs established the metric on which the project was based and against which the metric was then measured. Data inputs drove the entire project with required sample sizes to sustain statistical validity. Therefore, consistent accurate data inputs and outputs were key factors.

Organizational Support

Continuous improvement programs, such as Total Quality Management (TQM) and just-in-time management, are prevalent in organizations large and small (de Mast, Kemper, Does, Mandjes, & van der Bijl, 2011). Six Sigma Black Belt practitioners work as change agents to quantify defects and to recommend and implement an approved strategy (Ganguly, 2012). Black Belt practitioners cannot make change without assistance; such change requires full organizational support, especially within the segment(s) where the change will have the greatest effect. The singular action of a chief executive officer (CEO) issuing a directive will not entice process owners to embrace change (DelliFraine, Langabeer, & Nembhard, 2010). Although data quantification provides direction for the Six Sigma objective, the employees involved make it happen. For Six Sigma methodology to work, management at all levels of an organization must be actively involved (Eckes, 2001). Being involved at multiple levels of the project requires project members and their leaders to attain a certain level of understanding Six Sigma. Company executives must take the time to learn about Six Sigma and fully support it; otherwise, the Six Sigma DMAIC project leaders will fail (Duffy et al., 2012; Lunau & Staudter, 2013).

Executives must coordinate efforts and channel the resources of a company toward earning a profit. Incorporating the Six Sigma approach into management can help company leaders achieve and ensure the efforts are part of a sustainable strategy. This foundation of coordination highlights why leaders of many different organizations and businesses across the globe appreciate the strategy. Two challenges to organizations are the element of technical difficulties and the effects of political environments. A negative leadership (political) environment can affect the results of Six Sigma DMAIC potential, given the importance of leadership involvement. Apart from negative leadership, technical difficulties may hamper the flow of the processes of production, thereby affecting the success of the approach.

Project Scope

Six Sigma DMAIC projects focus on improving an existing process by reducing defects, increasing quality, and increasing throughput (Teichgräber & du Bucourt, 2012). Although the Six Sigma methodology is a powerful technique for solving problems, those individuals selecting the project must be cautious and adhere carefully to the Six Sigma construct (Drohomeretski, Gouvea da Costa, Pinheiro de Lima, & Andrea da Rosa Garbuio, 2014; Meredith & Mantel, 2010). Selection of the right projects in a Six Sigma program is a major factor in the early success and long-term acceptance of Six Sigma within any organization. If company leaders do not exercise a rigorous and disciplined approach to selecting projects, there is a high probability that project efforts will flounder (Pacheco, Pergher, Vaccaro, Jung, & ten Caten, 2015).

Six Sigma projects typically have executive-level visibility; leaders expect these projects to deliver a high return on investments. Six Sigma projects are also highly data driven, link directly to corporate strategy, and focus on a single defect or process implemented with a sense of urgency. The Six Sigma strategy of management is often effective for organizations, unless the aspects of individual workload and stress set in. Such factors often bring into perspective the element of organizational commitment.

Ultimately, barring corrective action, the strategy fails when employees lack the right frame of mind and commitment (Dieterich, 2014). Use of the Six Sigma approach in small- and medium-sized enterprises can be successful. Six Sigma tasks and processes are coordinated in a way that allows the system to be self-sufficient and self-sustaining. Leaders who use the Six Sigma approach in small- and medium-sized enterprises may find the process easier than those in large organizations because the workforce is manageable (Nonaka, 1995).

Purpose of the Study

The purpose of this study was to use empirical research to determine which drivers can cause Six Sigma DMAIC projects to not succeed. Few quantitative researchers have attempted to isolate and understand conclusively the specific drivers that cause Six Sigma DMAIC projects to fail. While several authors have discussed Six Sigma failures (Angel & Pritchard, 2008; Clifford, 2001; Dalgeish, 2003; Harbola, 2010;

James, 2010; McManus, 2008; Miller, 2010; Mullavey, 2006), none have specifically concluded their findings based on empirical research. For this study, I collected and examined data to determine the relationship between failed Six Sigma DMAIC projects and the key drivers that cause these projects to not succeed. Information gathered from the research can assist Six Sigma practitioners from repeating such behaviors.

Nature of the Study

Organizational behavior mainly involves designing an effective project structure. In other words, organizational behavior addresses the human aspects of project management. It is for this reason that organizations often employ Six Sigma.

Different combinations of work practices emerge periodically as new, continuous improvement programs (Cole, 1999). Six Sigma is one such continuous improvement program that has captured the interest of several organizations (Linderman, Schroeder, Zaheer, & Choo, 2003). The nature of this study was a large-sample, quantitative study based on a survey to prove quantitatively which drivers cause Six Sigma DMAIC projects to fail (Erturk & Ondategui-Parra, 2012). The current literature has focused primarily on associating project failures with Six Sigma as a whole, but not the drivers that cause the projects to fail (Angel & Pritchard, 2008; Clifford, 2001; Dalgeish, 2003; Hallencreutz & Turner, 2011; Harbola, 2010; James, 2010; McManus, 2008; Miller, 2010; Mullavey, 2006). This study examined how Six Sigma DMAIC project drivers affected the success or failure of the Six Sigma DMAIC project outcomes. The purpose of this research was to study the rationale of Six Sigma DMAIC project drivers. The next three chapters address questions about what organizational and process improvement practices constituted Six Sigma programs and how these practices resulted in improvements or failures in process-and-organization performance.

Research Questions and Hypotheses

Research questions for this study were as follows:

1. Is the lack of management support the driver for Six Sigma project failures?
2. Did the project fail occur because the practitioners did not scope the Six Sigma project in accordance with Six Sigma methodology framework?
3. Is Six Sigma methodology the driver for Six Sigma project failures?

The researcher developed a hypothesis based on existing literature indicating that Six Sigma DMAIC projects fail due to reasons other than Six Sigma methodology (Angel & Pritchard, 2008; Clifford, 2001; Dalgeish, 2003; Goldstein, 2011; Harbola, 2010; Harry et al., 2011; James, 2010; McManus, 2008; Miller, 2010; Mullavey, 2006).

Following are the study hypothesis (H_0) and null hypothesis (H_a).

H_o = Six Sigma projects do not fail because of Six Sigma methodology.

H_a = Six Sigma projects fail because of Six Sigma methodology.

Theoretical Base

Six Sigma requires total company commitment and requires time, money, and resources to implement the changed processes correctly. Researchers (Gorman, Donnell, & Mack, 2011; Hasenkamp, 2010; Nonaka, 1994) deployed knowledge creation framework and applied it to explore new product development. Project goal statements not requiring the rigor, financial investment, and timelines of the Six Sigma methodology incorrectly define project scoping (Köksal, Batmaz, & Testik, 2011). The heart of Six

Sigma embraces change to yield a positive customer experience (Burge, 2008; Q. Zhang, Vonderembse, & Lim, 2011). Companies whose leaders resist change face a precarious future because the alternative is stagnation. The challenge is to be willing to embrace change.

Change Management

Six Sigma is to change as "six" is to perfection on a bell curve. Kübler-Ross (1969), in *On Death and Dying*, identified three key stages describing nine states of emotion that involve dealing with change. Business leaders have adopted this analogy to describe driving staff through major transition (Hugos, 2011). Six Sigma DMAIC projects represent the search for perfection but typically settle on a set of accepted business metrics. As Burge (2008) noted, "Significantly, positive results are the main reason to perform a Six Sigma project" (p. 36). Six Sigma is a concept that promotes creativity because of the objectives in reducing defects and increasing efficiencies (Antony, 2011; de Mast et al., 2011; Köksal et al., 2011). This creativity exemplifies why practitioners apply the concept of Six Sigma to organizational theory and concepts. Deploying Six Sigma creates change in organizational processes and procedures. The efficiency of the Six Sigma design ensures that the systems and employees are well coordinated and organized (Kang, Kim, Hong, Jung, & Song, 2011; Kruskal, Reedy, Pascal, Rosen, & Boiselle, 2012; Lee & Peccei, 2011; M. A. Lewis, 2011; Maskell, Baggaley, & Grasso, 2011; Ministry of Finance, Malaysia, 2013). Six Sigma strategy has longevity because the design takes into account the needs and expectations of the customer (Hung, Ho, Jou, & Tai, 2011). It is for this reason that leaders of most organizations trust the Six Sigma strategy to be able to deliver for the customer and organization as well. Managers therefore embrace this approach as a results-oriented approach.

With change comes resistance from those individuals affected (Kohn et al., 2000; Kotter, 1998; Kuo, Borycki, Kushniruk, & Lee, 2011; McClusky, 2000). Successful change management requires deploying strategies to manage the culture to work through change and embrace it. Successful Six Sigma DMAIC projects can not only increase efficiencies and reduce defects, but also can save the company money by decreasing needed labor (Burge, 2008).

Transformation

Transformation is the act of moving from one way of doing business to another. Full transformation of business processes usually takes a long time (Eckes, 2001). Projects lose momentum if managers do not establish a sense of urgency early in the process and continue to promote the process throughout the project (Hung et al., 2011). Kotter (1998) remarked, “Without motivation, people won’t help and the effort goes nowhere” (p. 3). A dedicated core team must lead the transformation to ensure that all of the associated groups stay engaged and informed and complete their assigned tasks in a timely fashion (Jin, Janamanchi, & Feng, 2011). Six Sigma DMAIC project efforts that lack a sufficiently powerful guiding project team can make apparent progress for a short time, but the opposition eventually gathers itself together and stops the change (Kotter, 1998).

The success of Six Sigma comes down to the environment in which it operates. With the right resources and personnel in place, the strategy can be successful (Bhamu & Singh, 2014). When the infrastructure is not favorable, results are usually not forthcoming (Pande, Neuman, & Cavanagh, 2014). The aim of implementing Six Sigma is to improve business performance (Jankowski, 2011). These strategies are largely successful, and reports indicate Six Sigma approaches reduce defects in operations while measuring the average variation of a process in manufacturing or service industries (Kemmis, McTaggart, & Nixon, 2014; Levine, Gitlow, & Melnyck, 2015).

Vision is the guiding principle determining where the project needs to conclude and by when (Kotter, 1998). Leaders and the core team must share and promote the vision to keep the focus on the desired direction. Operational efficiency often determines organizational success because operational efficiency directly reflects the success of the organization and the quality of goods and services it offers (Schön, Bergquist, & Klefsj, 2010). Goods and services processing can be challenging when organizational operations are not streamlined and coordinated. Therefore, the process needs to active management and a strategy that is not only goal-oriented, but also customer-centric because of the result must be quality output. The vision must be clear and easy to understand by the individuals on the project team as well as employees affected by the new process and or procedures (Knight, Allen, & Tracy, 2010).

Learning Organizations

Leaders of learning organizations are forward thinking, looking to make the necessary changes to prevent businesses from becoming outdated and falling behind the competition (Kwak & Anbari, 2012). Organizations in which new and sprawling patterns of thinking are cultivated, communal ambitions are set free, people continually expand their capacity to create the results they truly desire, and people are persistently learning to grasp the whole together are the essence of a learning organization (Senge, 1990). Most companies will develop processes to support the business at given times. This practice can become outdated and prohibit the company from staying current or from being an industry leader (Jonny, 2012). Individuals working in a learning organization must be able to adapt to the changing environment and not be content with the status quo, which creates a slow-moving culture (Mehrabi, 2012). Learning organizations are a new concept with a new vision, values, and mental models. Prosperous corporations will be the organizations that can systematize ways to bring people together to develop the best possible mental models for facing any situation at hand (Kaushik & Khanduja, 2010; Senge, 1990).

Business strategies and methods are increasingly being adapted to the Six Sigma style of management (Martin, 2014). Having been in place for a number of years, the Six Sigma approach has accrued a reputation of experience that has made it relevant and more successful. The desired outcome of the process seeks to guarantee success for both short- and long-term benefits for a company. Six Sigma is easy to comprehend because it revolves around simple principles (Ramanan Lakshminarayanan, 2014). Business leaders must channel processes, tasks, procedures, and operations to achieve desired output (Douglas & Erwin, 2000). Therefore, Six Sigma involves coordinating input to ensure that the desired outputs are the result of all the elements of production.

Business leaders and employees should perceive change as good for the business and not as a threat to an employee's position or to the existence of the company in the marketplace (Larson & Carnell, n.d.; Liu & Kumar, 2011). Hence, developing a learning organization that embraces streamlined processes and ways of conducting business is important. Too often, Six Sigma professionals lack change management competency: the ability to manage the people side of change (de Mast & Lokkerbol, 2012; Larson & Carnell, n.d.).

Six Sigma Culture

Initial research on Six Sigma mainly addressed analysis of the technical aspects of Six Sigma with a specific focus on tools, methodologies, and techniques. Recent studies have shifted the attention to the contextual, psychological, and human aspects of Six Sigma. A shift in focus has given the Six Sigma approach a new perspective.

The Six Sigma culture revolves around threats and opportunities (Hutchins, 1995). What threats does the organization face (e.g., reduced customer base) in the short term and long term if practitioners do not correctly implement Six Sigma? What opportunities will be lost by not successfully implementing Six Sigma and what opportunities will be gained (e.g., increased profitability) by successfully implementing Six Sigma? Threats and opportunities indicate the need to deploy Six Sigma; threats are potential problems, and opportunities sustain the need for Six Sigma once the threat is mitigated. Thus, a balance of threats and opportunities is required if the need for Six Sigma is to be established (Eckes, 2001).

Establishing an authentic list of threats and opportunities for the organization will affect employee norms and behaviors (Harry & Schroeder, 2014; Manuj & Sahin, 2011). Therefore, it is important to streamline the list to ensure managers do not pick out threats to implement Six Sigma that are less serious and thus may require a lesser amount of effort to implement (Assarlind & Aaboen, 2014). Employee motivation leads to completing new projects and enabling the positive change to move forward. The methodology table (see Table 1) represents the high-level steps in the Six Sigma process, from hypothesis formulation through to report findings.

Definition of Terms

To understand the terms used in this study consistently, I present the following definitions:

DMAIC. A five-phase improvement cycle that has become common in Six Sigma projects (Eckes, 2001; Madlberger, 2011).

- Define. Define the team to work on improvement; define the customers of the process, their needs, and their requirements; and create a map of the process to be improved).
- Measure. Identify key measures of effectiveness and efficiency and translate them into the concept of sigma.

Table 1

Methodology Table

Formulate hypothesis	Method & design	Collect data	Analyze data & draw conclusion	Report findings
	Quantitative study:	Data collection:	Use Minitab 16	Research findings will be presented at the end of the research
H_o: Six Sigma projects do not fail because of Six Sigma methodology	Survey questions measured on 5-point Likert scale sample.	Survey with a minimum of 200 Six Sigma Black Belt practitioners	Conduct a two-sample *t* test. Two-tailed test and chi-square test	
H_a: Six Sigma projects fail because of Six Sigma methodology	The survey results must lead to hypotheses	Execute surveys via LinkedIn, UnitedHealth Group, & Kaiser	Accept or reject the null hypothesis	
Test for data normality between two data sets being directly compared to each other.	1-sample Wilcoxon test	Survey Questions 5 and 6.	Use Minitab 16 Conduct a 1-sample Wilcoxon test	Test results presented in Quantitative Data Collected section

- Analyze. Through analysis, determine the causes of the problem that needs improvement.
- Improve. The sum of activities that relate to generating, selecting, and implementing solutions.
- Control. Ensure that improvement is sustained.

Hypothesis: A hypothesis is a tentative answer to a research question or problem, expressed in the form of a relationship between independent and dependent variables (Arthur, 2001).

Lean Sigma: Lean manufacturing and lean principles are Companies following lean manufacturing have better flexibility and a good market share. Moreover, lean manufacturing produces an operational and cultural environment that is highly conducive to waste minimization. (Gupta & Jain, 2013; Mehrjerdi, 2011).

Null hypothesis: A null hypothesis is "[a] statement of no relationship between variables; the null hypothesis is rejected when an observed statistic appears unlikely under the null hypothesis" (Frankfort-Nachmias & Nachmias, 2008, p. 524).

Practitioner: A person who is engaged in the practice of a profession or occupation (Al-Zubi & Basha, 2010; Eckes, 2001).

Quality: A state in which value entitlement is realized for the customer and provider in every aspect of the business relationship (Harry & Schroeder, 2014; Zaman, Pattanayak, & Paul, 2013).

Six Sigma Black Belts: Highly trained and experienced individuals in Six Sigma methodologies (Barlow, 2008). Characteristics of Six Sigma Black Belts include:

- Being highly respected by supervisors, peers, and subordinates.
- Understanding the "big picture" of the business.
- Focusing on results and understand the importance of the bottom line.
- Speaking the language of management (e.g., money, time, organizational dynamics).
- Being committed to doing whatever it takes to excel.
- Being sponsored by vice president, director, or business unit manager.

- Being considered experts in their specific field.
- Possessing excellent communication skills, both written and verbal.
- Inspiring others to excel.
- Challenging others to be creative.
- Being capable of consulting, mentoring, and coachin.
- Driving change by challenging conventional wisdom, developing and applying new methodologies, and creating innovative strategies.
- Possessing a creative, critical, out-of-the-box intellect.
- Allowing room for failures and mistakes with a recovery plan.
- Accepting responsibility for choices.
- Viewing criticism as a motivator.

Six Sigma methodologies: A project method designed to reduce defects, increase quality, increase customer service and improve profit margins (Eckes, 2001; Rattan & Lal, 2012).

Six Sigma origins: Six Sigma originated at Motorola in 1979, when executive Art Sundry proclaimed that the real problem at Motorola is their quality was not at the standards required to compete in the market place. This began the formation of what is considered Six Sigma today (Inozu, 2012; D.-S. Kim, 2010; Nooramin, Ahouei, & Sayareh, 2011).

Six Sigma project team: A group of two or more individuals engaged in some joint action with a specific mission or goal. Motivating and driving forces that propel a team toward its goal or mission (Deming & Orsini, 2013).

Assumptions

The researcher in this study assumed that survey participants answered honestly and that the statistical scale accurately represented the demographic population located within the United States. Participants are or have been Six Sigma Black Belts practitioners running Six Sigma DMAIC projects and individuals (other than Six Sigma Black Belts), who have participated in Six Sigma DMAIC projects (Rahman, Sharif, & Esa, 2013; Suresh, 2011).

Limitations

Study participants were not segregated by age, race, gender, or years of experience. Bias from the Six Sigma Black Belt practitioners could influence their responses, as is true for Six Sigma DMAIC project participants. This study did not solicit survey input from Six Sigma Green Belts or Six Sigma Yellow Belts. Six Sigma Black Belts can receive their "Black Belt" designation from various institutions according to their own criteria. Six Sigma includes a wide range of tools that practitioners can deploy in each phase of the Six Sigma DMAIC project. Black Belts leading various projects choose these tools, which could reveal a different experience between the project participants in each phase. Broader global generalizations may not be valid because this survey was limited to the United States.

Delimitations

Correctly dispersing the survey questions to the appropriate Six Sigma Black Belts and Six Sigma DMAIC project participants was an important aspect of the survey. I utilized the process of synthesizing the survey data and deriving the conclusion to retain or reject the null hypothesis accurately based on the two-sample *t* test and chi-square test results to formulate the quantitative conclusions. A statistical test cannot prove if the null hypothesis is true or false if the statistical hypothesis testing does not directly measure the entire population (Frankfort-Nachmias & Nachmias, 2008). A Type I or Type II error occurs if the researcher incorrectly retains or rejects the null hypothesis (Kaltenbach, 2012).

Significance of the Study

Defect reduction and increased quality in the medical billing and claims processes can help us recognize positive social change. Defects lead to incorrect claim processing, which then financially affects the providers (e.g., doctors and hospitals). Successfully completed Six Sigma DMAIC projects may reduce defects for both medical billing and claims processing, thereby leading to correct billing to the payers (e.g., insurance companies and the Centers for Medicare & Medicaid Services; Gowen, McFadden & Settaluri, 2012). Timely and accurately paid claims lead to consistent cash flow for providers. This positive financial benefit then filters to the individuals employed by the provider (Hutchins, 1995; Pamfilie, Petcu, & Draghici, 2012).

Six Sigma practitioners will benefit from the key information derived from survey results. These practitioners can apply the information to their Six Sigma DMAIC projects. Health care providers can use these lessons to improve health care insurance billing and claims processes, which will benefit both insurance companies and the people they serve.

Summary

The purpose of this study was to use empirical research to examine the implications of drivers on the failure of Six Sigma projects. This study explored and tested various environmental elements that are contributing factors to Six Sigma project failures and benchmarked testing against actual Six Sigma practitioners who have conducted Six Sigma projects that have both failed and succeeded. The researcher then quantified these data to draw conclusions as to why Six Sigma projects fail. Chapter 2 presents a review of scholarly literature that examined Six Sigma. In this review, the researcher also examined the complexities of the elements affecting Six Sigma that might lead to business leaders considering the project a success or failure. Chapter 3 presents the quantitative methodology used in this study, content analysis, constant comparison processes, data collection procedures, methodology justification, and the significance of the problem statement. Chapter 4 outlines the research results. Chapter 5 discusses directions for future research and defines the benefits. It concludes with a summary of the social benefits of the research.

Chapter 2: Literature Review

Literature Outline

Having been developed from quality management philosophy, Six Sigma has attracted academic research in recent years (Raisinghani, Ette, Pierce, Cannon, & Daripaly, 2005; Schroeder, Linderman, Liedtke, & Choo, 2008; Sparrow & Otaye-Ebede, 2014). There has been no comprehensive study based on a cross-section of interviewing Six Sigma practitioners and the associated project teams to demonstrate the link between Six Sigma project failures and the associated drivers. Six Sigma employs a project-based methodology to solve a specific performance problem recognized by an organization (Hammer, 2002). The focus of Six Sigma is on the customer rather than the product (Douglas & Erwin, 2000). This study addressed the key drivers that cause Six Sigma DMAIC projects to fail to achieve desired project outcomes. I researched the following databases to explore published articles pertaining to the topic: (a) ProQuest, (b) WorldCat, (c) SAGE, (d) EBSCO, (e) American Society for Quality (ASQ), and (f) Barnes and Noble. I used the following search terms: (a) *Six Sigma*, (b) *DMAIC*, (c) *Six Sigma Lean*, (d) *General Electric* (*GE*), (e) *Motorola*, and (f) *Six Sigma Black Belts*.

History of Six Sigma

Six Sigma represents a commitment to managing through process, not function, and making decisions based on fact and data rather than the inherent skills managers believe make them great executives (Eckes, 2001). Understanding a problem using this philosophy requires exploring why the problem exists, where it originated, and how to fix the problem in a way to prevent it from reappearing (Lunau & Staudter, 2013). Formal research provides the structure to gather the facts to draw the proper conclusions to mitigate further occurrences (Assarlind & Aaboen, 2014; Clifford, 2001; L. Pinto & Tenera, 2013). Six Sigma is a success catalyst that relies on the efficiency of implementation. The need for the focus on development of this theory is because customer satisfaction is the ultimate goal for any organization (Y. Kim, Kim, & Change, 2010; Schroeder et al., 2008).

The quest to achieve Six Sigma originated at Motorola in 1979, when executive Art Sundry proclaimed that the real problem at Motorola was that its quality was not at the standards required to compete in the market place (Harry & Schroeder, 2014; Pepper & Spedding, 2010). Sundry sparked a new era within Motorola and led to the discovery of the crucial correlation between higher quality and lower development costs in manufacturing products of all kinds. Between 1986 and 2001, based on implementation of the Six Sigma methodology, Motorola reported $16 billion in cost savings, positioning Motorola as one of the pioneers and greatest beneficiaries of Six Sigma methodology ("The History of Six Sigma," n.d.). Despite the success of Six Sigma at Motorola, this philosophy became well known only after Jack Welch, then-chairman and chief executive officer of General Electric, made it a central focus of his business strategy in 1995 (Angel & Pritchard, 2008; Pettersson & Segerstedt, 2013). The Six Sigma approach brings out the innovative aspects of an organization because this approach strives to elicit better performance if provided with the necessary environment (McManus, 2013). Creativity and innovation are demonstrated when the working environment is conducive for and favorable to employees.

Six Sigma Black Belt

The Six Sigma strategy to mitigate defects, increase quality, and increase throughputs is carried out by individuals, so these individuals must be capable and trained correctly in the field of effecting change (Jirasukprasert, Garza-Reyes, Kumar, & Lim, 2014; Knowles, Whicker, Femant, & Del Campo Canales, 2005). The term *Black Belt* is often associated with individuals who reach a certain level of expertise in Karate. Six Sigma Black Belts become change agents as they develop practical real-life leadership skills as they hone their respective analytical skills working with organizations on Six Sigma DMAIC projects. The Six Sigma Black Belt also requires advanced levels of training in statistical problem solving and implementing projects based on the Six Sigma project methodology.

Six Sigma Black Belts find solutions to quality problems when others are bewildered. They are proficient at analyzing data and deploying advanced problem-solving techniques; they are also accomplished in project management; are astute with team dynamics; and act as leaders, teachers, and mentors (Rahman et al., 2013). Six Sigma Black Belts require mental discipline and systematic advanced training, as well as the mental capacity to process and successfully deploy multiple projects (Pryor, Alexander, Taneja, Tirumalasetty, & Chadalavada, 2015). Company leaders strive to make a profit through the processes and the strategies implemented. The philosophy of Six Sigma acknowledges a direct correlation among factors such as wasted operating costs, defects, and levels of customer satisfaction (Razaki & Aydin, 2011). This correlation is why the reciprocal strategy for implementing the Six Sigma approach is profitability and organizational success.

Six Sigma Methodology

The core of the Six Sigma methodology is statistical analysis, which is one of the key differences from other project methodologies, such as TQM, those advocated by the Project Management Institute, and management by objective, to name a few (Cole, 1999; Ramasubramanian, 2012). Six Sigma programs maintain a strong focus on specifying measurable and quantifiable goals (Linderman et al., 2003; Ranjan & Vora, 2014). Another key component to Six Sigma methodology is its focus on a problem that is measureable and actionable. The objective with Six Sigma methodology is to solve the question of why a product is not performing rather than terminating the ill-performing products (Lunau & Staudter, 2013).

Too often, business leaders believe the Six Sigma methodology is a fix-all method of solving multiple issues in one project rather than separating the issues into multiple projects (Cudney & Furterer, 2012). The more accurately a problem is defined, the more precise the target, and the better the chances for meeting performance targets. Business leaders should deploy the Six Sigma methodology to achieve the goal communicated by the voice of the customer (VOC). Managers and statisticians can work on improving the capability gaps with Six Sigma methodology along with identifying incapable processes (Lucian, Liviu, & Ioana, 2010).

Martin (2014) and Reosekar and Pohekar (2013) postulated a model that can enhance the application of Six Sigma methodologies in the supply chain business. They proposed a framework involving DMAIC, which focuses on the processes of design, measure, analyze, improve, and control, to support specificity and a purpose-driven strategy. The Six Sigma approach is a key ingredient for the performance of an organization (Paladino, 2011). Company leaders witness drastic improvement in performances when they adopt Six Sigma because its principles enhance the ability of the organization to perform. As such, Six Sigma is able to mirror the performance of the company. Because Six Sigma reflects the success of the company, company leaders use this strategy as a metric to measure performance.

Success of organizations or their projects relies on the timely identification and framing of the objectives. In this case, *timely* refers to the identification of these items in the early stages of project selection and development. Objectives and goals developed early and on time allow team leaders to develop the right methods and representative results to reflect the final goal. Sperl, Ptack, and Trewn (2013) focused on the application of Six Sigma and Lean strategies to improve the patient care and safety in hospitals. They concluded that the methodologies of Six Sigma and lean improve the operations in hospitals by addressing efficiency, problem solving and continuous improvement. The shift of operations toward adopting and using Six Sigma and Lean methodologies means individuals can perform these activities much more easily and quickly (Bhat, Gijo, & Jnanesh, 2014).

Six Sigma Success

Six Sigma is a set of tools that can be deployed where needed (Angel & Pritchard, 2008; Rever, 2010). Business leaders who want Six Sigma to be effective must allow practitioners to deploy and use the tools correctly. Data analysis and application can have a powerful effect on the target objective in either direction. Not fully understanding the VOC and the inputs into a Six Sigma project can have a disastrous effect on the target area (Brook & Brook, 2010). For this reason, Six Sigma practitioners must be properly trained, educated, and understand the subject (Cronemyr & Witell, 2010). Six Sigma approaches improve the efficiency and promptness of service delivery. Company leaders must consider the need to focus on customer satisfaction and the requisite components that will aid in achieving this objective. The Six Sigma approach focuses on customer satisfaction rather than product design and development (Douglas & Erwin, 2000). The approach represents an ideology that the organization achieves its goals when it satisfies the customer.

Most estimates of effective training suggest that individuals can improve their skills by only a small margin. This limitation means that if people are assigned to the wrong positions, they cannot be trained to become top performers. They can improve their weaker skills to levels that are not as weak as they were before. Training is too expensive to waste on the wrong people. Proven success and a record of accomplishments are solid indicators that the Six Sigma practitioner understands and knows what to do with the methodology (Dalgeish, 2003). As Six Sigma practitioners navigate along the Six Sigma project continuum, it is important for them also to educate the project champions and participants on what Six Sigma is and what it is not, as well as what tools will be applied where and why (Project Management Institute, 2014; Sehwail & DeYong, 2011; Snee, 2010; Taner, Sezen, & Antony, 2011).

Two of the needs and factors highlighted in the Six Sigma approach are the identification and positioning of a well-outlined goal for the project (Pande et al., 2014). The Six Sigma approach thrives in environments in which well-identified goals are the backbone. Achievement of well-identified goals is the key determinant in the outcome of the performance of the Six Sigma approach. Development and improvement of the Six Sigma approach are based on turning purpose-driven goals into methodologies and models that are both executable and results oriented (Linderman et al., 2003). This goal should be a key consideration in implementing the Six Sigma approach. Industry leaders have used Six Sigma concepts to accelerate growth (Raisinghani et al., 2005). These concepts allow companies to achieve accelerated growth because their application enhances efficiency.

Six Sigma is a set of process tools that should only be part of a more holistic process improvement strategy. Six Sigma empowers people to create process stability and a culture of continuous improvement (Angel & Pritchard, 2008). The leader of Toyota made lean enterprise a well-known approach, as embodied in the Toyota production system (Qu, Ma, & Zhang, 2011). Ohno (1988), creator of the Toyota production system, summarized the system as follows: “All we’re trying to do is shorten the time line . . . from order receipt to collecting the cash for the goods and services provided” (p. 36).

Use of Six Sigma tools and methods is instrumental in shaping the performance and ultimate success of an organization (Linderman et al., 2003). A firm will improve, which leaders prefer over stagnation, when the firm that has the right methodology and tools in place to implement the Six Sigma approach. Leaders who ignore this requirement face catastrophic results for the firm (Martínez-Jurado, Moyano-Fuentes, & Jerez-Gómez, 2014). The Six Sigma implementation process has two parts: the people perspective, which addresses behavior, and the process perspective, which addresses the methods used in implementation (Inozu, 2012). Six Sigma approach development and consideration is not only restricted to improvement management of the organization, but also can be a tool to enhance organizational learning . Organizational learning improves and reinforces the impact of implementing the Six Sigma approach in an organization (Sanders & Karr, 2015; Selden, 2012).

In all cases, cultural influence contributes to whether Six Sigma quality management programs succeed or fail. Six Sigma is a highly disciplined process that focuses on consistently developing and delivering near-perfect products and services (Angel & Pritchard, 2008). Six Sigma and lean enterprise focus heavily on satisfying customers. Six Sigma makes customers the primary focus in all aspects of the project to deliver products and services that match the VOC.

Six Sigma DMAIC project leaders must understand that the Six Sigma DMAIC methodology is not a one-size-fits-all framework. Business leaders must choose projects accordingly. If not, this project methodology could fail to attain a lasting place in the organization, as have other lesser programs, such as TQM, over the years (Deming & Orsini, 2013). Six Sigma projects initiate creativity and innovation (Parast, 2011). Therefore, Six Sigma is a great catalyst of the performance of an organization. Organizations whose leaders have adopted and implemented the Six Sigma project approach have been able to enhance growth and productivity, which gives them a competing edge.

Six Sigma Failures

At a conceptual level, Six Sigma projects address tasks, processes and operations. The best use of Six Sigma is to improve task processes (Levine et al., 2015). Researchers have begun to examine the outside factors that can affect successful application of the Six Sigma methodology. Eckes (2001) suggested that four issues in an organization could affect the ultimate success of a Six Sigma project: technical difficulties, political environment, individual workload and stress, and organizational commitment. Long-term commitment is a prerequisite for any effective Six Sigma project. Corporate-wide communication provides a degree of involvement that assists in any Six Sigma effort (Liker & Convis, 2011).

There is rising concern across industry sectors regarding the failure of many Six Sigma DMAIC projects (Angel & Pritchard, 2008). Nearly 60% of all corporate Six Sigma initiatives fail to yield desired results, according to S Gupta (as cited in Chakravorty, 2010), a noted author on methodology and Six Sigma Master Black Belt who has been involved with Six Sigma since its inception in the 1980s. Researchers have documented additional factors to provide insight into what may affect successful Six Sigma DMAIC project implementation. Generally, business leaders should plan to implement Six Sigma DMAIC projects in 6–12 months; typically, projects lose the desired effect as time goes on. The first wave of Six Sigma projects (in the early days of Six Sigma) generated significant results and, nearly 100% of the time, clients experienced true cultural transformation (Eckes, 2001). Eckes's (2001) statement encouraged the "seeing is believing" concept to sway a culture toward adopting Six Sigma methodologies.

Six Sigma—Another Managerial "Fad"?

Six Sigma methodologies include a set of tools that a professional person can deploy at different times during a project or task (Duggan, 2013). The Six Sigma methodology broadly and most frequently uses the DMAIC methodology, which is well defined and structured. Six Sigma DMAIC addresses the VOC, process improvements, and expected financial returns. A Six Sigma DMAIC project hones in on improving an existing process by reducing defects, increasing quality, and increasing throughput (Sasikala & Stephen, 2010).

Foster (2007) concluded that Six Sigma was a necessary catalyst for improving the performance of an organization. The approach has many positives. Six Sigma approaches aid organizations in meeting performance goals. Strategists have perceived Six Sigma methodologies as being yet another management strategy that does not work (AlSagheer, 2011; Burge, 2008; McManus, 2008). Workers in departments receiving Six Sigma DMAIC project benefits have sometimes refused to participate as directed, even though the benefits of successful Six Sigma implementations have been documented (Burge, 2008).

For example, Barlow (2008) compared lean manufacturing to Six Sigma management improvement programs and TQM and continuous quality improvement programs. In this comparison, Barlow emphasized the role played by lean manufacturing and Six Sigma in health-care supply chain management. Of particular interest was the former concentration on waste and inefficiencies in the supply chain and the difference in breadth and depth between the programs. Barlow based his conclusions not on holistic research, but on conversations.

The key strengths in Barlow (2008) comparisons were those between Six Sigma and Lean Sigma, which typically are associated with each other, and between TQM and continuous quality improvement. Both sets of tools have been in use for many years, but industry leaders have swayed more toward Six Sigma and lean enterprise because of the statistical tools offered by Six Sigma. Six Sigma represents a quality control system leaders of many companies have embraced to mitigate problems such as production defects, whereas lean manufacturing aims to remove defects and variation from processes. Despite many successful implementations, nearly 60% of all companies deploying Six Sigma methodologies have failed to achieve the sought-after desired results (Chakravorty, 2010). Quality is not an accident. People held to higher levels of accountability will either rise to the occasion and learn new methods or they will sit down and be left behind.

Organizational structures require designs that allow for the expression of creativity and innovation as catalysts of performance. Deming and Orsini (2013) emphasized improving the efficiency of business structures by implementing innovation and change. Paton (2004) broadly assumed that business leaders will not use Six Sigma in the long term and that Six Sigma is not packaged to get real work completed. Taunting that Six Sigma is the latest management craze to enthrall corporate America, Paton claimed this approach yields lowly results. According to Paton, Six Sigma is another disjointed quality movement that will come and go. Although admitting the Six Sigma content is solid, Dalgeish (2003) asserted the Six Sigma methodology package would disappear as a method of conducting business.

Innovation is a key part of the performance of an organization because innovation has a direct impression on customers and markets. Innovation has a role in organizations meeting customers' needs and expectation. For this reason, Arthur (2011) recommended hospitals use Six Sigma strategies to achieve fast, affordable, flawless healthcare for billing, collections and patient flow. Business leaders intend Six Sigma project implementation to ensure the organization is able to achieve its goals. Six Sigma is a highly disciplined approach that ensures all members of the organization work toward a common end. A Six Sigma project also relies on management commitment to thrive.

Why Six Sigma DMAIC Projects Fail

Six Sigma projects can yield a rewarding experience and immense benefits for an organization; however, not all Six Sigma projects achieve the expected. Six Sigma is not a one-size-fits-all approach for all project work; business leaders must select the appropriate project (Clifford, 2001; Peteros & Maleyeff, 2015). Six Sigma projects fail because of lack of management support. Support and commitment for a Six Sigma deployment from the leadership of an organization are the key drivers for success. If support and commitment are absent, the methodology fails. Incorrect strategy deployment contributes to the failure of organizational business goals to achieve expected deployment results and to sustain the commitment to Six Sigma in the organization (Lucian et al., 2010; Sarkar, Mukhopadhyay, & Ghosh, 2013). Lack of alignment may cause confusion among the key stakeholders and associates about the value of the entire effort; this gap delays deployment in many organizations (Nonaka, 1995).

Incorrect project scoping also contributes to Six Sigma project failures (Snee, 2010). Failure to focus on project selection and prioritization can lead to projects that lack data, business leaders' interest, or involve process areas that are outside of the realm of control of both the Green Belt practitioners and Black Belt practitioners. Improper selection of the project results in delayed or scrapped projects and quick disillusionment among the Green Belts and Black Belts involved (Starbird & Cavanagh, 2011).

Most Six Sigma teams want to start with a pilot project that is not too risky. This preference results in the teams majoring in minor projects (Easton & Rosenzweig, 2012). These projects do not achieve the results required to make a case for a Six Sigma DMAIC project in the organization. Inappropriate team members also contribute to Six Sigma DMAIC project failures (Eckes, 2001). Invariably, leaders try to form a Six Sigma team before they have analyzed the data to determine who ought to be on the team. Poorly constructed teams struggle because the team does not include the right people to solve the problem or take the necessary action.

Safety is important in industries as organizations measure their safety by the days they work without lost time injury or number of injuries. Accidents make the organizations incur losses. Concentrating on minimizing the variation in a single critical characteristic of a product allows us to dig deeply enough to discover the real source of improvement (Hammer, 2002). Paladino (2011) suggested that researchers should always err on the side of scoping their projects too narrowly rather than too broadly. Improvement is continuous; teams can always come back later and expand the focus of a project. Cognitive experience includes the immediate data, such as those of sense, which the mind collects, and the interpretation, which represents the activity of the thought (C. I. Lewis, 1929). Harbola (2010) pointed out that 80% of the people are engaged in trying to achieve less than 20% of the benefits. Wall-to-wall implementations can siphon valuable resources away from satisfying customers, creating new products, and exploring new markets (Harry & Schroeder, 2014; Lindsey, 2011; Revere & Black, 2011; Roberts, 2004; Sanders & Karr, 2015; Sehwail & DeYong, 2011).

Gaps in the Literature

The Six Sigma methodology offers many benefits, including increased sales revenue, improved customer satisfaction, and immense cost reduction. Despite its extensive history of success, few researchers have studied the Six Sigma methodology itself. As such, detractors of the methodology have unjustly attributed the failures to the methodology.

A review of the literature exposed a gap between conclusions being drawn about Six Sigma as a valid quality management approach based on statistically valid holistic research and material fallacies (Angel & Pritchard, 2008; Clifford, 2001; Dalgeish, 2003; Harbola, 2010; James, 2010; McManus, 2008; Miller, 2010; Mullavey, 2006). Writers have jumped to the conclusion that Six Sigma is just a passing business concept when a Six Sigma project does not deliver the projected benefits in lieu of conducting statistically valid research to weigh the critical factors (Angel & Pritchard, 2008;

Clifford, 2001; Dalgeish, 2003; Harbola, 2010; James, 2010; McManus, 2008; Miller, 2010; Pettersson & Segerstedt, 2013). As a project-based methodology, the application of Six Sigma approaches thrives on the foundation of identifying a problem in the organization (Hammer, 2002). Business leaders must identify the problem so practitioners can apply the Six Sigma approaches and models designed to solve that particular problem. Managing and implementing this approach are much easier when business leaders identify the problem at the outset.

There is a gap in the literature because individuals (AlSagheer, 2011; Burge, 2008; McManus, 2008) have proclaimed that Six Sigma methodology does not work. Detractors have based their assertions on opinion and not actual research. The gap in the existing literature is this lack of scientific research conducted holistically across Six Sigma DMAIC projects. People have stated that Six Sigma does not work (McManus, 2008). Nearly 60% of all corporate Six Sigma initiatives fail to yield desired results (Angel & Pritchard, 2008). The latest in must-have efficiency movement has spread through corporate America, along with similar-looking knockoffs that have fallen short of producing the desired results (Clifford, 2001; Gijo & Scaria, 2014). This study addressed a gap in the literature to illustrate the lack of understanding of these drivers (e.g., lack of management support, employee engagement, correct project scope). The study also validated that Six Sigma DMAIC projects do not fail as a result of Six Sigma methodologies. Finally, the study demonstrated through empirical research the true drivers that cause Six Sigma DMAIC projects to fail.

Lack of management support can affect a Six Sigma DMAIC project by not providing project leaders (Black Belt or Green Belt) with the proper amount of time (Six Sigma projects are labor-intensive) to work on the project (Pyzdek & Keller, 2014). Considerable employee engagement is also required because Six Sigma DMAIC projects are a team-based approach that must incorporate department heads, subject matter experts, and project managers (Harry & Schroeder, 2014). Six Sigma DMAIC projects are data driven and require continuous data throughout the project. Proper measurement of project performance requires specific project data throughout the project (Li & Zhang, 2014; Pyzdek & Keller, 2014).

Six Sigma projects require research of three main elements to properly determine key success drivers. Those three elements are management, the DMAIC project scope, and Six Sigma methodology. Statistically speaking, none of the literature reviewed has been based on valid statistical data to reinforce with 95% certainty their conclusions represent the facts (Q. Zhang et al., 2011). For example, Antony (2007) based his conclusions on a panel discussion, and McManus (2008) based his conclusions on his personal opinions of his own experiences. James (2010) quoted numbers from an unidentified and uncited article in *Fortune Magazine,* Dalgeish (2003) and Chakraborty and Tan (2012) compared Six Sigma generically with two other quality movements of the past, such as TQM and Plan, Do, Check, and Act (Deming & Orsini, 2013). These authors provided hasty generalizations based on insufficient data, thus skewing their conclusions and failing to represent sufficiently the overall population of the entire Six Sigma project team. Although various authors published in *Fortune Magazine* have lambasted the efficacy of Six Sigma, the majority of the companies listed among the top 500 *Fortune Magazine* in 2015 have used Six Sigma methodology for quality management in their enterprises (Industry Lists, n.d.; Tetteh & Uzochukwu, 2015). If some organizations have experienced failure in implementation of Six Sigma, perhaps the failure is not with Six Sigma itself.

Gap Summarized

This study involved a summary of literature to serve as a foundation of understanding of the key drivers that contribute to the failure of Six Sigma ventures. Ideally, this study will serve as a guidepost for future Six Sigma task leaders to aid in their particular achievement. Failure of Six Sigma programs seems to be due to barricades and obstacles that this study could reveal. Chapter 3 includes a framework of the quantitative technique, example size, and procedure to dissect the overview information. Researchers have attempted to identify key drivers, but fell short because they based their conclusions solely on untested theory (Mullavey, 2006).

The gap in the existing literature comes from a lack of scientific research conducted holistically across Six Sigma projects (Angel & Pritchard, 2008; Clifford, 2001; Dalgeish, 2003; Harbola, 2010; James, 2010; McManus, 2008; Miller, 2010; Mullavey, 2006). Harbola (2010) stated that “Qualpro founder and principal Charles Holland analyzed that out of 58 large companies that announced Six Sigma programs, 91% have trailed the S&P 500 list in the first half of this decade” (p. 1). CEOs of large companies deemed Six Sigma unsuccessful when they were not able to implement Six Sigma successfully, in comparison to former General Electric CEO Jack Welch, who spearheaded the company turnaround with the aid of Six Sigma (Angel & Pritchard, 2008). Angel and Pritchard (2008) and Tjahjono et al. (2010) chronicled Robert Nardelli's Six Sigma journey; Nardelli was fired as former Home Depot CEO. Nardelli's strict adherence to Six Sigma principles had a negative influence on worker morale and consumer sentiment. Stockholders pointed to his actions as the reason for Home Depot to have plummeted from a top spot among major retailers to the bottom of the American Customer Satisfaction Index rankings in 2005.

Key Findings and Themes

This study focused on the Six Sigma approach as a statistical method of solving operational difficulties in organizations. The researcher identified several important elements to project success and reasons for failure. Six Sigma project successes inspired organizational leaders around the world to embrace this method of problem analysis and resolution. Some Six Sigma projects have failed, but the failure of these projects is not the fault of the Six Sigma approach.

Over the years, many researchers have tried to identify the best ways to handle operational performance problems. The consensus is the Six Sigma approach has led to far more successes than failures.

Success of Six Sigma approach. The Six Sigma approach succeeds in several ways:

- The method focuses on how customer needs can be met rather than on how products can be designed without consideration of customers' needs. Preferring customer satisfaction over product performance is a hallmark of the

Six Sigma approach of favoring high customer loyalty over addressing product failures.

- The way the Six Sigma methodology takes into account the collective impact of multiple issues that may affect organizational progress and performance, rather than addressing each possible issue independently. This collective approach facilitates arriving at the best overall resolutions for the problems as a whole.
- The way the methodology focuses on specific goals based on specific data, rather than general improvement based on assumptions or questionable input. This approach demands thorough problem analysis and explains why many organizations that use Six Sigma perform better than those organizations that do not use this approach. Companies such as Toyota have used Six Sigma as an analysis tool for many years, and customer loyalty to the brand is strong.
- The way the methodology allows organizations to achieve their objectives as they focus on both the people perspective as well as the process aspect. This approach requires the analyst to emphasize how people's behavior is likely to affect implementation of a particular strategy relative to achieving a set goal.
- The way the Six Sigma methodology focuses on project participants' efforts to develop and improve products. This approach gives individuals performing project analyses an opportunity to launch new methods with confidence in assured progress in both the short and long term.

- The way the Six Sigma methodology helps business leaders select projects to be analyzed and optimized. Careful selection means the methodology is not a one-size-fits-all framework; it works best when applied in relevant areas.

Failures of the Six Sigma methodology. Some scholars have attributed failure of the Six Sigma approach to the following reasons:

- Technical difficulties resulting from the environment. The appropriate expertise for success may be lacking, and detractors may misinterpret this lack of expertise as nonperformance of the Six Sigma methodology.
- Unfavorable political environments may delay or slow Six Sigma methodology implementation, causing detractors to perceive methodology inefficiency or failure.
- The rate at which the organization is committed to analyze and address the challenges of a particular project has resulted in failure of the effectiveness of the methodology. This lack of success has been evident when the researching group fails to show dedication to the approach as a tool.
- Individuals' stress resulting from increased workloads can lead to the failure of the Six Sigma approach. A proper analysis requires clear thinking and time to reach accurate, correct, action-oriented conclusions. If the analyst feels undue stress, he or she may trigger nonperformance of the methodology.

Considerations in the Use of Six Sigma Methodologies

Management, DMAIC project scope, and methodology put in place during application of the Six Sigma approach are key factors in determining the appropriateness of results from the project analysis. The environment must be conducive to the approach. Six Sigma project participants must believe they can achieve the project objectives, based on the analysis. Management must support the project and ensure the necessary resources are available during both the analysis and application of the proposed solution.

Practitioners must follow the DMAIC methodology when using the Six Sigma methodology to improve the quality of the results. The structure and design of the DMAIC methodology ensures that practitioners can address any defects or errors discovered during the analysis exercise. There is little harm in organizations whose leaders want to “sample” the effectiveness of Six Sigma to invest in pilot programs that carry minimal risk. Small successes can empower individuals to seek bigger successes and attain greater performance. In contrast, attempting to overachieve by pressing Six Sigma neophytes into tackling a Herculean project that is not likely to succeed may undermine the future the Six Sigma team and the program as a whole.

The Six Sigma methodology of analysis is beneficial and leaders of organizations should embrace it when evaluating optimal investment portfolios. Investing wisely in projects with the best return will empower leaders of organizations to make sound, long-lasting business decisions that will yield more profits. Most business leaders are interested in containing costs and optimizing profits, and applying the Six Sigma methodology supports this objective.

Chapter 3: Research Method

Introduction

In this chapter I focus on the research methods used during the study to select and define the most appropriate collection methods, detail the data analysis plan, and apply the sampling and data research design used in the study. How does one explore and identify the relationship between the Six Sigma methodology and failure? How do the two variables of failure and Six Sigma methodology correlate? Empirical research must be conducted to answer the research question posed in this study. The process requires the researcher to validate the study and offer statistical evidence of the truthfulness or the incorrectness of the research. In this chapter I described how I administered the quantitative study and subsequently validated the data. The study relied on honest input from the study cohort of Six Sigma Black Belt practitioners who agreed to participate in the study to aid in understanding the probable sources of failure associated with the Six Sigma methodology.

This chapter includes information on the research design and rationale, the study variables, the research design, and justification of the chosen research design to address the research question. Time and resource constraints are also described in this chapter. Of note to scholars of Six Sigma is that the research design itself is consistent with this discipline. Discussions of data collection and analysis are included in this chapter, as are details of the ethical procedures, sampling, instrumentation, and operationalization of constructs applied while conducting this study.

Research Design and Rationale

When undertaking any particular study, the researcher must understand the concept of the study, discipline, and the rationale for conducting the study to choose the most appropriate method for carrying out the study. This study involved adherence to a quantitative research technique, which is a common exploration methodology used when carrying out business-related studies. A dearth of adequate and sufficient information reinforced the need to use a qualitative research methodology. A quantitative approach might have answered specific questions of *when* and *how much* but would not have answered the questions posed in this study.

The quantitative researcher seeks to understand a phenomenon or correlation by developing and employing mathematical models, theories, and hypotheses pertaining to the phenomenon in question (Given, 2008; Ulrich, Eppinger, & Goyal, 2011). A quantitative researcher must demonstrate the relationship between the data collected and analyzed with the objective of the study in mind. Generally, researchers conduct a qualitative study to answer questions such as the following:

- Is there an observable or evident relationship between the two variables? In this study, the objective was to understand whether there is a relationship between the independent variables (Six Sigma management support and Six Sigma project scope) and the dependent variable (Six Sigma project failures; Given, 2008).

- After establishing the presence of a relationship between the variables, the researcher should then ascertain the direction of the relationship (Given, 2008).
- Finally, the researcher should clarify the magnitude of the relationship because this clarification provides insight into the extent of the relationship and its importance to the organization implementing Six Sigma (Given, 2008).

Identifying the most appropriate research design is a fundamental component of any study. For a quantitative research study, the scholar can choose from designs such as quasi-experimental research, descriptive research, correlation research, survey research, and evaluation research. The questions to which the researcher sought answers supported the need for a correlation study to understand the relationships between the variables. A correlation study is a quantitative research methodology useful for understanding the relationship between two or more variables in a study.

Researchers employ quantitative research designs to collect tangible statistical data, but they may face resource and time constraints. Resource constraints can occur when the data needed are not readily available or easily obtained. The constraint of time might be encountered by both the researcher and the study participants; high-demand Six Sigma Black Belt practitioners might be inconvenienced by participation in a study and undermine the whole study.

A research design and approach for this study was chosen to address the following questions:

1. Is the lack of management support the driver of Six Sigma project failures? This question was posed to determine whether the management structure of the businesses or enterprises in which the Six Sigma methodology had failed were supportive of the methodology and personnel involved in the Six Sigma project.
2. Did the failures that followed Six Sigma methodology adoption result from lack of accurate adoption of the Six Sigma methodology and framework? This question was posed to understand whether project participants followed the methodology framework or whether project participants did not follow the methodology in implementation.
3. Is the Six Sigma methodology the driver of failure in Six Sigma projects? This question was posed to understand whether the driver of failure in Six Sigma projects originated within the project implementation itself. Six Sigma project failure might be the result of a failure of the methodology framework.

These questions guided the researcher and facilitated focus on the main objective of the study. This study sought input from experienced Six Sigma Black Belt practitioners who provided information on management support and project scope, which served as the independent variables, and project outcome (success or failure), which served as the dependent variable. Black Belt practitioners are professionals certified by the International Association for Six Sigma Certification (n.d.) and are well versed in the functioning, theoretical use, and practical applicability of the Six Sigma methodology (V. Gupta et al., 2013). A Black Belt practitioner possesses full understanding of DMAIC and can apply all the aspects under its phases (Eckes, 2001). In addition, Six Sigma project participants were engaged in the study to provide perspective on Six Sigma projects that had succeeded or failed (dependent variables).

The "posttest-only non-experiment design," as discussed by Reed, Lemak, and Montgomery (1996) was implemented by targeting Six Sigma Black Belt practitioners, Six Sigma project participants, and specifically inquiring about Six Sigma DMAIC projects that had been completed. Researchers use the post-only nonexperimental design for an intervention group only. This design lacks a control group and, as such, the study design is weaker because, without a control group, a comparison cannot be made between the intervention group and the control group. The researcher who chooses to omit the opportunity for comparison may do so because of resource constraints or because the study population cannot accommodate a control group (Myers, Well, & Lorch, 2013; Watson & DeYong, 2010). As Frankfort-Nachmias and Nachmias (2008) stated, "The posttest is taken for all cases after the experimental group has been exposed to the independent variable" (p. 90). In this case, the independent variables were Six Sigma management support and Six Sigma project scope. Frankfort-Nachmias and Nachmias (2008) explained, "The posttest-only non-experiment design will also serve to control for all intrinsic sources of invalidity" (p. 106).

The research was conducted using the web survey tool SurveyMonkey.com, which I used to administer the questions (see Appendix A) to Six Sigma Black Belt practitioners and Six Sigma DMAIC project participants identified through LinkedIn, UnitedHealth Group, and Kaiser Permanente. I measured study responses on a 5-point

Likert scale (see Appendix B). Exploration questions must prompt speculations or hypotheses that are particular, testable, and negatable (Adams, Khan, & Raeside, 2014; Cezar Lucato, Araujo Calarge, Loureiro Junior, & Damasceno Calado, 2014; Frankfort-Nachmias & Nachmias, 2008). The speculation speaks to a solitary forecast so that, when tried, it is either totally rejected or altogether upheld (Senge, 1990). The zenith of the overview reactions will either dismiss the invalid speculation or acknowledge the option theory (Frankfort-Nachmias & Nachmias, 2008).

Population

Because the purpose of this study was to investigate the relationship between management support of Six Sigma methodology, project scope, and Six Sigma project failures, the study population was Six Sigma Black Belt practitioners and Six Sigma project participants. The population included the whole cohort of companies, businesses, enterprises, and organizations that use the Six Sigma methodology (DMAIC) and experienced project failures. The exact number of organizations in which Six Sigma methodology is used cannot be accurately established because not all companies report the effectiveness of the methodology.

Setting and Sample

Sampling is an important aspect of research. Using an appropriate sample representative of the target population guarantees greater probabilities of accuracy than when the sample is not a subset of the population. The sampling strategy I employed accurately represented the population, which reduced the percentage for error. According to Frankfort-Nachmias and Nachmias (2008), “a sample is considered to be representative if the analyses made using the sampling units produce results similar to those that would be obtained had the entire population been analyzed" (p. 167). Sample size is important to consider because an overly large sample can lead to a waste of resources and lead to results that do not represent the whole population. An overly small sample can be prone to bias. In quantitative research, a good sample size has a 95%–99.9% confidence level, meaning the sample has only $f(5) = -0.1\%$ probability of being unrepresentative of the whole population (Adams et al., 2014).

Common terms associated with sampling include *population*, *sample*, *eligibility criteria*, *inclusion criteria*, *exclusion criteria*, *representativeness*, *sampling designs*, *sampling bias*, *sampling error*, *power analysis*, *effect size*, *attrition* (Witcher & Butterworth, 2012). The population is the group being investigated (Given, 2008). The sample is a section of the population that undergoes the practical research, representing the whole population (Given, 2008). Eligibility criteria are the set standards or measures participants must fulfill to be included in the study or research (Given, 2008). Inclusion criteria are the factors that allow an individual to be included in the study (Given, 2008). Exclusion criteria are factors that preclude a participant from being included in the study (Given, 2008). Sampling error is an error that emerges from the observation of a sample in place of the whole population (Given, 2008). Representativeness indicates as how well the participants of the study reflect upon the sample (Given, 2008). Sampling designs are the rules and procedures researchers use to include some elements of the population in the research (Given, 2008). Power analysis allows researchers to have a certain degree of confidence that a certain sample size will produce a desired effect of a given size (Given, 2008). Attrition is the consistent loss of data in research. Sampling bias occurs when the sample collected is likely to have more members of the intended population than others (Given, 2008; Witten, Frank, & Hall, 2011). Effect size involves an investigation of a cause-and-effect relationship (Given, 2008).

Accurate representation of Six Sigma DMAIC project participants was an important aspect of sampling to ensure an honest reflection of the key characteristics of the population studied. For this study, I used random sampling because I sought to describe some characteristic of the population under study.

The study cohort included in the study was composed of 206 individuals, organized into three distinct groups: individuals who had achieved Six Sigma Black Belt certification; individuals who had participated in Six Sigma DMAIC projects, as designated by their respective institution; and individuals who had managed to complete at least one Six Sigma DMAIC project.

Inclusion and exclusion criteria reflected these three categories of participants. I based my decision to include 206 participants because I assumed that fewer than 206 participants would actually complete the survey. Essentially, beginning with this large sample size allowed for a margin for error. I determined the minimum sample size by conducting a statistical two-sample *t* test with a power of 0.80, effect size of .80, and confidence of 0.95. The two-sample *t* test represented the best option to use in the circumstances because of its proficiency in testing hypotheses; the test answers questions such as whether the difference between two groups is significant or due to random chance. In this case, the test indicated statistically how many individuals would likely participate in the survey (Myers et al., 2013). The results (see Table 2 and Figure 1) provided a minimum of 26 on each side of the tail, which equaled a minimum of 52 valid sample responses. These results meant that a significant number of individuals would participate in the study so that the results obtained would represent accurately the population without experiencing any sampling error.

Table 2

*Chart G*Power Output*

***t* tests: –** Means: Difference between two independent means (two groups)

Analysis: a priori: Compute required sample size

Input: Tail(s) = 2

Effect size *d* = 0.8

α err prob = 0.05

Power (1-β err prob) = .80

Allocation ratio N2/N1 = 1

Output: Noncentrality parameter δ = 2.8844410

Critical *t* = 2.0085591

Df = 50

Sample size Group 1 = 26

Sample size Group 2 = 26

Total sample size = 52

Actual power = 0.8074866

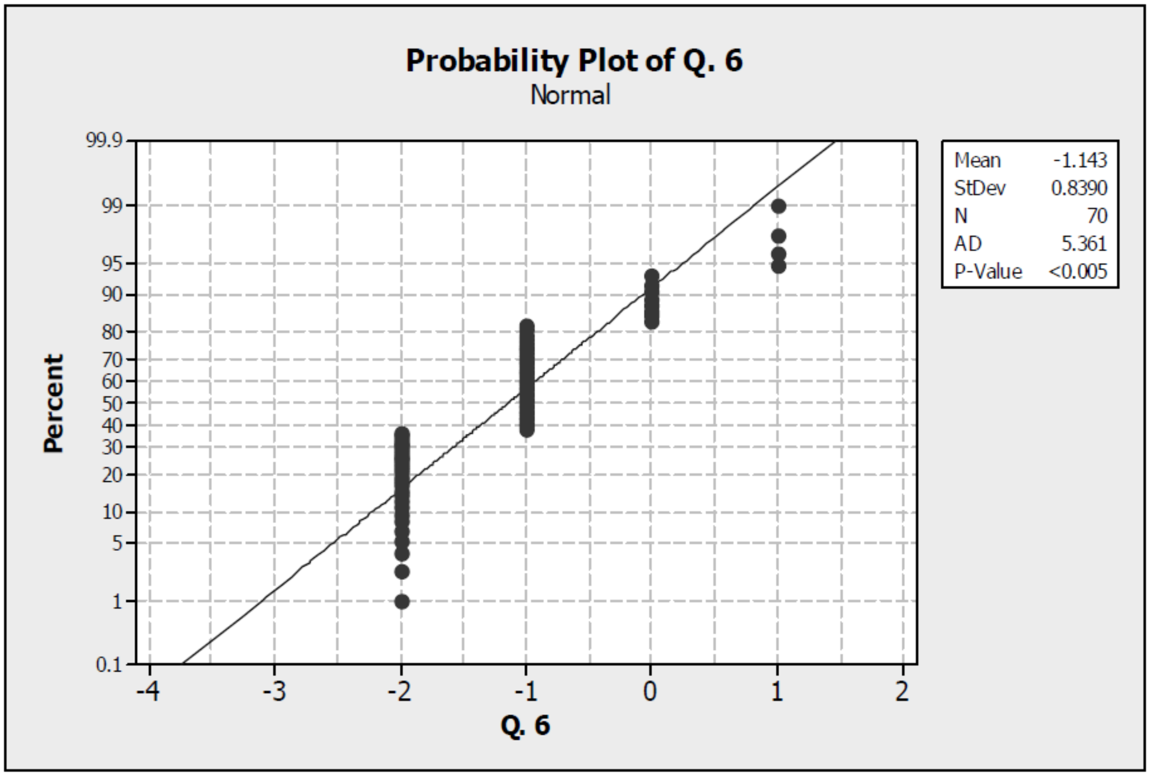


Figure 1. Probability plot of Q.6.

I defined a *project* as one following the Six Sigma DMAIC model. The research population for the sample was equal to a minimum of 206 Six Sigma Black Belt practitioners or Six Sigma DMAIC project participants identified through LinkedIn, UnitedHealth Group, and Kaiser Permanente, which, according to Frankfort-Nachmias and Nachmias (2008), would represent a "qualified probability sample design" (p. 167). Cohen (1969) described an effect size of 0.2 as small, an effect size of 0.5 as medium, large as big "enough to be visible to the naked eye," and an effect size of 0.8 as "grossly perceptible and therefore large" (p. 23). Each element of a qualified probability sample must have an equal probability of being chosen. If the researcher cannot affirm all the elements in the study have an equal and nonzero probability of selections, generalizations to the insignificant populations can be adversely limited.

The researcher was contacted 206 researchers, of which 70% (144) responded, as explained in detail in Chapter 4.

Recruitment Participation and Data Collection Procedures

To ensure study validity and replicability, I indicated the procedure I used for recruitment. For this study, I sought to recruit 206 participants chosen without bias or partiality. I chose Six Sigma Black Belt practitioners through three distinct organizations renowned for efficiency and success. These organizations were

- LinkedIn, a professional networking corporation formed in 2003 with more than 300 million users worldwide.
- UnitedHealth Group, a managed healthcare enterprise headquartered in Minnetonka, Minnesota, and which serves an average of 70 million individuals annually.
- Kaiser Permanente, an integrated managed care consortium established in 1945 and based in Oakland, California.

Through these institutions, the researcher was able to make contact with Six Sigma methodology experts who could participate in the study without the knowledge of one another.

Data Collection and Analysis

This section discusses the procedure the researcher followed to conduct data collection and analysis. The data collection component of the process began with securing the survey participants and concluded with collecting the surveys. Data collection is the assembling and measuring of gathered data with the intention of answering the research question or hypothesis and evaluating the subsequent outcome. Data analysis is the ensuing validation of the collected data to ensure the data are satisfactory and to detect any errors.

Data collection plays an important role in research; inaccurate data collection can lead to unwanted results, which can affect the study and ultimately lead to invalid results. Researchers collect data using either quantitative methods or qualitative methods. For this study, I used quantitative data collection methods. These methodologies include

- Interviews, which can be used to obtain either qualitative or quantitative data, and usually involve face-to-face interviews, telephone interviews, and computer-assisted personal interviews.
- Questionnaires, which usually involve pencil-and-paper instruments or web-based instruments.
- Surveys.

A total of 206 Six Sigma Black Belt practitioners and Six Sigma DMAIC project participants were contacted via e-mail. Participants were randomly selected from UnitedHealth Group, Kaiser Permanente, and LinkedIn. Recruiting participants from UnitedHealth Group, Kaiser Permanente, and LinkedIn was intentional because these organizations are both reputable and creditable. The 34% response rate yielded 70 participants, which surpassed the required 26% response rate.

Written consent was obtained before data was collected. Potential participants were emailed the approved consent form and requested individuals willing to participate in the study to complete the form to gain access to the online survey via SurveyMonkey.com (see Appendix A). Completed informed consent forms were collected through e-mail. To each Six Sigma Black Belt practitioner who returned a completed informed consent form, I sent an e-mail with the open-ended survey questions and a link to the SurveyMonkey.com site. Each of the survey questions fully explored the full extent of the information pool the researcher was trying to access. Once participants answered all of the survey questions, they clicked the Submit button. SurveyMonkey survey software confidentially tabulated the results and stored the data. After survey data were tabulated, I conducted a follow-up interview to ensure I had followed ethical procedures.

Data analysis is the systematic process of transforming, cleaning, modeling, and inspecting data to discover useful information and suggest conclusions that will ultimately lead to the answering the research question or hypothesis. There are several ways to analyze data, including:

- Frequency distribution, which yields a graphical view of the data.
- Descriptive statistics, which uses the measures of central tendency such as mean or medium.
- Statistical testing, which typically involves conducting *t* tests.

The quantitative 5-point Likert scale survey administered via SurveyMonkey.com yielded clean and complete results. To ensure the results were clean and complete, the researcher conducted data screening to review the completeness of each survey. Participants answered all 18 questions on the 5-point Likert scale included in the survey. I used Microsoft Excel and Minitab 16 to stratify and analyze the data.

I computed the data, calculated the survey results, and analyzed these results to evaluate the null hypothesis. Survey questions addressed factors that have contributed to the success or failure of Six Sigma DMAIC projects. I used the two-sample *t*-test confidence interval to make inferences about the difference between population means and the chi-square test to test for dependency between survey responses and survey questions.

Pilot Study

A pilot study is a test study carried out on a small scale before the main study to estimate variables involved in the study. Examples of variables estimated using pilot studies are cost, time, feasibility, effect size, and test-out of proposed methodology. For this study, I did not carry out a pilot study because the research in question was to gather the specific data and analyze the results.

Instrumentation and Materials

In research, an instrument is a measurement device, while instrumentation is the course of action. Some instruments can be completed by the researcher, and some can be completed by the subject(s). The choice of instrument to use depends on the researcher. Some instruments include questionnaires, *t* tests, interview schedules, tally sheets, attitude scales, observation forms, performance and aptitude tests, and sociometric devices.

Two popular statistical methods are the two-sample *t* test, which is a test for comparing means, and the chi-square test, which is a test of independence. According to both Yang (2011) and Frankfort-Nachmias and Nachmias (2008, p. 528), the "two-tailed test is a statistical test where extreme results leading to the rejection of the null-hypothesis will be located at both left and right tails." The simplest form of the two-tailed test is the *t* test. Design 6 (the posttest-only control group design) is perhaps the only setting in which this test is optimal. I also ran a chi-square test to compare the observed counts on data for survey questions 17 and 18 to confirm the expected counts under the null hypothesis. According to Frankfort-Nachmias and Nachmias (2008),

> A test statistic that allows one to decide whether observed frequencies are essentially equal or significantly different from frequencies predicted by a theoretical model. The outcome of the test allows decisions as to whether or not frequencies are distributed equally among categories, whether or not a distribution is normal, or whether or not two variables are independent. (p. 515)

The researcher administered following subject-completed instrument to collect data for this study. The survey presented specific questions on characteristics salient to successful Six Sigma DMAIC projects. The survey instructions directed participants to provide answers on a 5-point Likert scale regarding failed Six Sigma DMAIC in which projects they had participated. Participants rating scale where 1 to 5 as follows:

1 = Strongly disagree, 2 =Disagree, 3 = Neither agree nor disagree, 4 = Agree,

5 = Strongly agree

#	Question	Scale
1.	Was your Six Sigma DMAIC* project supported by management?	1 2 3 4 5
2.	Was your Six Sigma DMAIC* project financially based?	1 2 3 4 5
3.	Was your Six Sigma DMAIC* project solution implemented?	1 2 3 4 5
4.	Was your Six Sigma DMAIC* project supported with good baseline data?	1 2 3 4 5
5.	Was your Six Sigma DMAIC* project scope too large for the DMAIC format?	1 2 3 4 5
6.	Was your Six Sigma DMAIC* project too small for the DMAIC format?	1 2 3 4 5
7.	Are you properly trained in the Six Sigma DMAIC* process?	1 2 3 4 5
8.	Was your organization ready for a Six Sigma DMAIC* project?	1 2 3 4 5
9.	Was your Six Sigma DMAIC* project properly resourced?	1 2 3 4 5
10.	Was there enough time allotted to complete your Six Sigma DMAIC* project?	1 2 3 4 5
11.	Was your Six Sigma DMAIC* project properly selected?	1 2 3 4 5
12.	Did management in your Six Sigma DMAIC* project hierarchy understand Six Sigma?	1 2 3 4 5
13.	Was your Six Sigma DMAIC* project too complex to solve?	1 2 3 4 5
14.	Did your Six Sigma DMAIC* project Champion understand the statistics behind your Six Sigma project?	1 2 3 4 5
15.	Was your Six Sigma DMAIC* project negatively affected by company politics?	1 2 3 4 5
16.	Was your organization affected when your Six Sigma DMAIC* project failed?	1 2 3 4 5
17	Did your Six Sigma DMAIC* project fail because of Six Sigma methodology?	1 2 3 4 5
18	Did your Six Sigma DMAIC* project fail for reason(s) other than Six Sigma methodology?	1 2 3 4 5

Note. * DMAIC = define, measure, analyze, improve, and control.

Variables

Variables are generally the elements in the study that have quality and quantities that may be change. Research typically includes two types of variables: independent and dependent. An independent variable is the variable the researcher measures or manipulates to determine its relationship to an observed phenomenon (Adams et al., 2014; Zaheer, 2013). In research, antecedent conditions presumed to affect dependent variables are usually referred to as independent variables. The researcher observes or manipulates independent variables to relate their values to the dependent variable. The researcher observes or manipulates a dependent variable to determine the independent variable effect on an observed phenomenon (Adams et al., 2014).

According to Frankfort-Nachmias and Nachmias (2008), "The variable whose changes the researcher wishes to explain is termed the 'dependent variable', whereas the variable the researcher thinks induces or explains the change is the 'independent variable" (p. 49). For this study, the independent variable was the one the researcher thinks will induce or explains the change:

- Independent Variable 1: Six Sigma management support; this independent variable was used to evaluate the correlation between Six Sigma management and Six Sigma project failures.
- Independent Variable 2: Six Sigma project scope; this independent variable was used to evaluate the correlation between project scope of Six Sigma and Six Sigma DMAIC project failures.

The dependent variable was the one whose changes the researcher wishes to explain:

- Six Sigma DMAIC project failures; this was the variable under investigation, the variable that depends on the independent variable to ascertain the research question hypothesis.

Reliability and Validity

Reliability and validity speak to the integrity of the instruments, data, and participants involved in the study. It is important for a researcher to be able to analyze quantitative research correctly. In quantitative research, consideration applies to both the results and the rigor of the research. Rigor refers to the effort the researcher put into the study ensure the quality of the study. In quantitative studies, validity and reliability demonstrate rigor (Fei & Wang, 2013). Validity refers to the accuracy of measuring a concept in a quantitative study; types of validity include construct, content, internal, conclusion, external, and criterion validity (Adams et al., 2014). Reliability refers to a research instrument and the consistency with which repeated use of the instrument in subsequent studies produces the same results Yi, Feng, Prakash, & Ping, 2012). Types of reliability in quantitative research include internal consistency, interrater, parallel, and test-retest reliability (Singer & Ye, 2013).

According to Frankfort-Nachmias and Nachmias (2008),

> A certain measuring instrument (I) measures a variable (V). To assess the predictive validity of the instrument, the researcher employs a valid external criterion (C). The results obtained are correlated with the results obtained by C.

The size of the validity coefficient (r_{rc}) indicates the predictive validity of the instrument. (p. 151).

For this study to determine whether Six Sigma management support and Six Sigma project scope (independent variables) make Six Sigma DMAIC projects to fail (dependent variable), the researcher needed to predict in what settings or environments Six Sigma DMAIC projects will be successful. If two variables have a correlation of plus or minus 1.00, the corresponding coefficient of determination will equal +1.00. In other words, 100% of the variance of one variable would be predictable using the other variable, and vice versa. Conversely, if two variables have a correlation of zero, the coefficient of determination would equal zero, suggesting that none of the variance of one variable is linearly predictable from the other variable (Adams et al., 2014; Zhu, Gavirneni, & Kapusciniski, 2010).

I calculated scores for each survey question and ranked questions using the calculated scores. Once I had ranked the questions, I drew conclusions as to the effect on the null hypothesis.

Ethical Procedures

I adhered to the relevant ethical procedure needed to undertake this research, as approved by the Institutional Review Board. Ethics are the necessary rules and codes of conduct implemented by the university and other relevant institutions. Following are the codes to which I adhered:

- Honesty: I received informed consent from the participants, and all the data, procedure, results, and publication statuses were approved and vindicated.

- Objectivity: I conducted the study impartially with peer reviews, data analysis, data interpretation, participation, and other aspects of the research conducted objectively.
- Integrity: I maintained participants' integrity with sincerity.
- Respect for intellectual property: I obtained permission or acknowledged all published data, methods, and ideas used in the study.
- Confidentiality: I maintained participants' confidentiality, including identity, all personal communications, and participants' permissions.

In addition to protecting the participants, I protected all data related to the study. I provided ample protection for the data considered confidential to the study. These data were not and will not be exposed to the public. I kept and will continue to keep confidential the participants' involvement in the study.

Quantitative Data Collected

A total of 206 Six Sigma Black Belt practitioners and Six Sigma DMAIC project participants were contacted via e-mail. Of the 206 individuals contacted, 70 individuals responded, indicating a 34% response rate, which surpassed the required 26% response rate as noted previously. Participants answered all 18 questions on the 5-point Likert scale to complete each survey. I stratified and analyzed the collected data using Microsoft Excel and Minitab 16.

The three research questions were analyzed using descriptive statistics to describe the set of known data in a clear and concise method. These included the mean, sum count, percentage of total, and associated standard deviation. The mean provided the central tendency, and the standard deviations provided the variations between mean for agree and disagree, respectively, as reflected in Table 3. Data were further stratified categorically depicting “Supports Six Sigma DMAIC project success” and “Does not support Six Sigma DMAIC project success.”

The survey responses collected as part of this research were treated as both discrete (counts) and continuous. The count of respondents replying to each of the five points on the Likert scale were treated as discrete data. These count data proved useful in creating proportions and comparing expected versus observed counts for the chi-square test. I also scored each question on a continuous scale from −2 to 2. I assigned a value as follows: strongly disagree = −2, disagree = −1, neutral = 0, agree = 1, and strongly agree = 2. Calculating statistics for this measure on each question allowed for a comparison of how much each question departed from a neutral ranking, showed toward which direction the results leaned (e.g., agree, disagree), and provided the ability to conduct pair-wise or multiple comparisons using the appropriate hypothesis test for comparing two or more samples.

Chapter 4: Analysis and Findings

Introduction

This chapter describes the data collected from surveying in the field and presents in detail the approaches I used to analyze the data to accomplish the research objectives. The content includes justification for performing the analysis and presentation of the results of the analysis. In this chapter, I justify each choice, decision, option made regarding the use of the data or technique employed during the analysis. I interpret technical results produced by the analysis in an economic sense, and display them accessibly.

The study aimed at testing the efficiency of the Six Sigma program and performance outcomes. The primary goal of this research was to use empirical research to determine which drivers can cause Six Sigma DMAIC projects to fail. There has been no comprehensive study based on a cross-section of Six Sigma practitioners and the associated project teams to demonstrate a link between Six Sigma project failures and the associate drivers. For this study, I collected and examined data to determine the relationship between failed Six Sigma DMAIC projects and the key drivers that cause these projects to fail.

Hypotheses and Research Questions

The hypotheses and research questions that guided this study are as follows:

H_o = Six Sigma projects do not fail because of Six Sigma methodology.

H_a = Six Sigma projects fail because of Six Sigma methodology.

1. Is the lack of management support the driver for Six Sigma project failures?

2. Did failure occur because Six Sigma projects were not scoped in accordance with Six Sigma methodology framework?
3. Is Six Sigma methodology the driver for Six Sigma project failures?

Demographic Characteristics

I collected data via an 18-question survey that was anonymous, electronic, and used a 5-point Likert scale. The tallies for agree and disagree, as shown in Table 3, represent my having combined the responses for strongly agree and agree, and strongly disagree and disagree, respectively.

I administered the survey through SurveyMonkey.com and focused on failed Six Sigma DMAIC (define, measure, analyze, improve, and control) projects. None of the 18 quantitative survey questions inquired about personal information or issues, so I did not anticipate an adverse event resulting from the survey questions. Criteria for inclusion of participants in this study were those who were Six Sigma Black Belt practitioners and Six Sigma DMAIC project participants.

Data Collection Procedures

This study involved collecting the data through an anonymous survey of Six Sigma Black Belt practitioners and Six Sigma DMAIC project participants located in the United States. Participants answered survey questions on a 5-point Likert scale; survey questions addressed factors potentially affecting Six Sigma DMAIC project success. The data collection procedure included a step-by-step process, from securing the survey participants to collecting the surveys. Data collection steps were as follows:

Table 3

Survey Question Results

Extraneous variables	Agree	Disagree
Was your Six Sigma DMAIC* project supported by management?	8	54
Was your Six Sigma DMAIC* project financially based?	19	44
Was your Six Sigma DMAIC* project solution implemented?	23	36
Was your Six Sigma DMAIC* project supported with good baseline data?	15	48
Was your Six Sigma DMAIC* project scope too large?	45	20
Was your Six Sigma DMAIC* project too small for the DMAIC format?	58	4
Are you properly trained in the Six Sigma DMAIC* process?	4	64
Was your organization ready for a Six Sigma DMAIC* project?	18	41
Was your Six Sigma DMAIC* project properly resourced?	24	40
Was there enough time allotted to complete your Six Sigma DMAIC* project?	18	47
Was your Six Sigma DMAIC* project properly selected?	20	41
Did management in your Six Sigma DMAIC* project hierarchy understands Six Sigma?	20	39
Was your Six Sigma DMAIC* project too complex to solve?	50	10
Did your Six Sigma DMAIC* project Champion understand the statistics behind your Six Sigma project?	19	40
Was your Six Sigma DMAIC* project negatively impacted by company politics?	24	34
Was your organization affected when your Six Sigma DMAIC* project failed?	29	21
Independent attribute variables		
Did your Six Sigma DMAIC* project fail because of Six Sigma methodology?	58	3
Did your Six Sigma DMAIC* project fail for reason(s) other than Six Sigma methodology?	7	52

Note. * DMAIC = define, measure, analyze, improve, and control.

1. Recruitment of participants: I contacted via e-mail a total of 206 Six Sigma Black Belt practitioners and Six Sigma DMAIC project participants to request

their participation in this study. I chose participants from UnitedHealth Group, Kaiser Permanente, and LinkedIn.

2. Obtaining consent: I e-mailed the participants the university-approved consent form along with the link to the survey. I required no signature on the consent form because consent was implied by the action of clicking on the link to take the survey.
3. Data collection: Participants launched the SurveyMonkey.com survey via the e-mailed link. Once participants answered all of the survey questions, they clicked the Submit button. SurveyMonkey software tabulated by the survey software confidentially and data were stored in SurveyMonkey.com. Because I conducted the research using an anonymous electronic survey, potential participants could choose to move forward and take the survey or quit. I did not know which participants actually took the survey. I launched and completed data collection between October 18, 2013, and November 12, 2013.
4. The data: I transferred the electronic data from SurveyMonkey.com into Microsoft Excel and saved the data to my personal secure Dropbox account. I then uploaded the data into Minitab 16 to facilitate quantification of results and then stratified the results in Microsoft Excel. I quantified the survey data, analyzed them, and then I generated conclusions. I will store raw data and results in my personal secure Dropbox account for a minimum of 5 years and then destroy them.

Quantitative Data Collected

A total of 206 Six Sigma Black Belt practitioners and Six Sigma DMAIC project participants were contacted via e-mail. This action yielded 70 participants, resulting in a 34% response rate, which surpassed the required 26% response rate discussed in Chapter 3. Survey instructions told participants to answer all 18 questions using the 5-point Likert scale. I used Microsoft Excel and Minitab 16 to stratify and analyze the collected data.

The three research questions were analyzed using descriptive statistics to describe the set of known data in a clear and concise method. These statistics included the mean, sum count, percentage of total, and associated standard deviation. The mean provided the central tendency, and the standard deviations provided the variations between mean for agree and disagree, respectively, as reflected in Table 3. I further stratified the data categorically to depict “Supports Six Sigma DMAIC project success” and “Does not support Six Sigma DMAIC project success.”

I treated survey responses collected as part of this research study as both discrete (counts) and continuous data. I treated them as discrete data to count respondents’ replies to each category on the Likert scale (e.g., strongly disagree, disagree). These count data proved useful in creating proportions and comparing expected versus observed counts for the chi-square test. I also scored each question on a continuous scale from −2 to 2. I assigned a value to each response according to the point on the Likert scale as follows: strongly disagree = −2, disagree = -1, neutral = 0, agree = 1, and strongly agree = 2. Calculating statistics for this measure on each question allowed for a comparison of how much each question departed from a neutral ranking, showed toward which direction the participants lean (e.g., agree, disagree), and provided the ability to conduct pair-wise or multiple comparisons using the appropriate hypothesis test for comparing two or more samples. Table 4 includes the results of the sample *t* test.

Table 4

Sample t Test

Two-sample *t* test and CI between Does not support project success and Supports project success

N	Mean*	*SD*	*SE*	Mean
Does not support project	18	15.39	7.31	1.7
Supports project success	18	45.56	9.20	2.2

Difference = mu (Does not support project success) – mu (Supports project success)

Estimate for difference: -30.17

95% CI for difference: (-35.81, -24.53)

t test of difference = 0 (versus not =): *t* value = -10.89 *p* value = 0.000 *DF* = 32

Note. * See Appendix C for data used to calculate the mean.

The survey presented to the respondents contained specific questions on characteristics salient to successful Six Sigma DMAIC projects. It then directed participants to provide answers on a 5-point Likert scale relative to failed Six Sigma DMAIC on which projects they have participated. This section analyzes the survey responses to the research questions and discusses if the data support retaining or rejecting the null hypothesis.

Research Question 1

Research Question 1 was, “Is the lack of management support the driver for Six Sigma project failures?”

Finding 1. As shown in Table 5, Finding 1 for Research Question 1 is that 77.2% (41 + 13 = 54/70 = 77.2%) of the participants answered that management had supported their respective failed Six Sigma DMAIC project.

Table 5

Descriptive Statistics for Research Question 1

Survey questions (*N* = 70)	Strongly disagree	Disagree	Neither	Agree	Strongly agree
Q1: Was your Six Sigma DMAIC project supported by management?	2	6	8	41	13
	2.9%	8.6%		58.6%	18.6%
Sum count	8		8	54	
Sum % of total	11.5%		11.4%	77.2%	

This finding supports Chowdhury's (2003) assertion that "if the top management doesn't take the time to learn about Six Sigma or support it, the project leaders (Black Belts) don't stand a chance" (p. 48). While this component of the Six Sigma DMAIC project was fulfilled as expected to enable project success, the project failed for other reasons, but not because of lack of management support.

Finding 2. As shown in Table 6, the Finding 1 for Research Question 1 for Survey Question 9 (which asked, "Was your Six Sigma DMAIC project properly resourced?"; see Appendix A) was that out of the 70 respondents, 57.1% (29 + 11 = 40/70 = 57.1%) answered that their respective failed Six Sigma DMAIC project was properly resourced.

Table 6

Descriptive Statistics for Research Question 1

Survey questions (*N* = 70)	Strongly disagree	Disagree	Neither	Agree	Strongly agree
Q9: Was your Six Sigma DMAIC project properly resourced?	7 10.0%	17 24.3%	6 8.6%	29 41.4%	11 15.7%
Sum count	24		6	40	
Sum % of total	34.3%		8.6%	57.1%	

Six Sigma DMAIC project participants involved at multiple levels of the project are required to have attained a certain level of understanding of what Six Sigma is and what it is not. Company leaders must understand the training required and become actively involved in the project methodology to enable the project to succeed (Eckes, 2001). The research data supported the conclusion that this component of the Six Sigma DMAIC project must be fulfilled as expected to achieve success. When company leaders support projects and the projects fail regardless of that support, the projects failed for other reasons.

Therefore, the analysis, interpretation, and findings of the data for Research Question 1 close the gap in the literature that implies projects fail because of Six Sigma methodology. Forces outside the Six Sigma methodology contributed to the failures of the Six Sigma DMAIC projects.

Research Question 2

Research Question 2 was, “Is failure due to that fact that Six Sigma projects were not scoped in accordance with Six Sigma methodology framework?”

Finding 1. Finding 1 from the data, as shown in Table 7, indicates that survey participants answered 41.4% (6 + 23 = 29/70 = 41.4%) that their projects failed (see Appendix A). Six Sigma DMAIC projects did not have a negative impact on the organization, rejecting the premise that drivers caused Six Sigma DMAIC projects to fail.

Table 7

Descriptive Statistics for Research Question 2

Survey questions (*N* = 70)	Strongly disagree	Disagree	Neither	Agree	Strongly agree
Q16: Was your organization affected when your Six Sigma DMAIC project failed?	6 8.6%	23 32.9%	20 28.6%	19 27.1%	2 2.9%
Sum count	29		20	21	
Sum % of total	41.4%		28.6%	30.0%	

The uncertainty in these cases is not detrimental to the purpose of this study because 41.5% did not believe that failure of the project affected their organizations. This belief might indicate external or internal factors affected the organizations and may have been beyond Six Sigma methodology approaches.

Finding 2. The responses to survey questions 5 and 6, as shown in Table 8 ("Was your Six Sigma DMAIC project scope too large?" and "Was your Six Sigma DMAIC project too small for the DMAIC?"; see Appendix A), revealed 73.6% (14 + 26 + 31 + 32 = 103/140 = 73.6%) of the participants believed their respective failed Six Sigma DMAIC project was properly scoped.

I performed a test for normality by directly comparing questions 5 and 6 using Minitab 16 to generate a normal probability plot. I then performed a hypothesis test to examine whether or not the observations followed normal distribution. For the normality test, the hypotheses are H_o, Data follow a normal distribution, versus H_a, Data do not follow a normal distribution. The vertical scale on the graph resembles the vertical scale found on normal probability paper. The horizontal axis is a linear scale. The line forms an estimate of the cumulative distribution function for the population from which data are drawn. The plot displays the numerical estimates of the population parameters *m* and *s*, the normality test value, and the associated *p* value.

The graphical output is a plot of normal probabilities versus the data. The data depart from the fitted line most evidently in the extremes, or distribution tails. The Anderson-Darling test *p* value indicates that, at a level less than 0.005, there is evidence that the data do not follow a normal distribution. There are five distinct vertical distributions of survey results, coded as follows: strongly disagree = −2, disagree = −1, neither = 0, agree = 1, and strongly agree = 2. This coding allowed distribution for each question on an ordinal scale with natural ordering from −2 to 2. These values tend to act more continuously and allow for summary statistics and other hypothesis tests to compare outside of the limited ones pertaining to discrete data. See Appendix D for the probability plot generated from coded responses to Survey Question 5, and see Appendix E for the probability plot generated from coded responses to Survey Question 6.

I ran a 1-sample Wilcoxon test on survey questions 5 and 6 individually because the survey results data for questions 5 and 6 were determined to be not normal. Survey questions 5 and 6 are worded to imply the survey respondents' respective Six Sigma DMAIC projects were scoped either too large or too small. There is no benefit to test on any values less than 0 using 1-Sample Wilcoxon test. Additionally, the respondents already disagreed via the 5-point Likert scale that their respective Six Sigma DMAIC projects were scoped too large or too small. This situation only leaves one side of 0 to test; anything greater than 0 suggests the participants agreed their Six Sigma DMAIC projects were scoped too large or too small. There was no purpose to performing a two-sided test because the survey respondents already declared (see Table 8) that their DMAIC projects were scoped too large or too small. Therefore, using the 1-sample Wilcoxon test to prove statistically whether there was any evidence to support that survey respondents agreed that the DMAIC projects were scoped too large or too small is moot.

The 1-sample Wilcoxon test null and alternative hypotheses for Survey Question 5 are H_o, the median is ≤ 0 (i.e., project was scoped appropriately), and H_a, the median is > 0 (i.e., the project was scoped too large), respectively. The 1-sample Wilcoxon test null and alternative hypotheses for Survey Question 6 are H_o, the median is ≤ 0 (i.e., project was scoped appropriately), and H_a, the median is > 0 (i.e., the project was scoped too small).

Interpreting the results for Survey Question 5. $N = 70$, n for test = 65, Wilcoxon statistic = 700.0, $p = 0.993$, and the estimated median = −0.500. These results support my conclusion that the Wilcoxon test statistic of 700.00 is the number of Walsh averages exceeding 0. Because five test scores equaled the hypothesized value, I reduced the sample size for the test by 5 to 65, as indicated under "*n* for test." The population median is not statistically different from 0.00, with an estimated median of −0.500 being the median of the Walsh averages. This median may be different from the median of the data, which is 0.0 for Survey Question 5. The −0.500 estimated median and a *p* value of 0.993 further support the descriptive statistics (see Table 8), indicating the Six Sigma DMAIC project did not fail because the scope was too large.

Interpreting the results for Survey Question 6. *N* = 70, *n* for test = 62, Wilcoxon statistic = 74.0, *p* = 1.000, and the estimated median = −1.000. These results support my conclusion that the Wilcoxon test statistic of 74.0 is the number of Walsh averages exceeding 0. Because eight test scores equaled the hypothesized value, I reduced the sample size for the test by 1 to 62, as indicated in the results under "*n* for test" as noted above. The population median is not statistically different from 0.00, with an estimated median of −1.000 being the median of the Walsh averages. This median may be different from the median of the data, which is 0.0 for Survey Question 6. The −1.000 estimated median and a *p* value of 1.0 further support the descriptive statistics (see Table 8), indicating the Six Sigma DMAIC project did not fail because it was too small.

Table 8

Descriptive Statistics for Research Question 2

Survey questions (*N* = 70)	Strongly disagree	Disagree	Neither	Agree	Strongly agree
Q5: Was your Six Sigma DMAIC project scope too large?	14	31	5	12	8
	20.0%	44.3%	7.1%	17.1%	11.4%
Q6: Was your Six Sigma DMAIC project too small for the DMAIC format?	26	32	8	4	0
	37.1%	45.7%	11.4%	5.7%	0.0%
Sum count	103		13	24	
Sum % of total	73.6%		9.3%	17.1%	

While Six Sigma methodology is a powerful technique for solving problems, those selecting the project must be specific to the Six Sigma construct and scope. Six Sigma is not a one-size-fits-all method for project selection. One of the first steps in the Six Sigma DMAIC process is selection of the appropriate project for which to deploy the Six Sigma methodology. Selection of the appropriate project is a major criterion to ensuring short- and long-term acceptance of the Six Sigma methodology within the organization. There is a high chance for project failure if business leaders and practitioners do not apply this rigorous discipline to project selection.

The data shown in Table 8 indicate that the failure of these projects had little to do with the scoping of the project as being either too large or too small to function properly in the Six Sigma DMAIC project structure. Therefore, 76.7% (14 + 26 + 39 + 31 + 32 + 19 = 161/210 = 76.7%) of the participants disagreed that their respective failed Six Sigma DMAIC projects were the results of the Six Sigma methodology or being incorrectly scoped, which supports rejection of the premise of being drivers causing Six Sigma DMAIC projects to fail. Therefore, the interpretation of these data close the gap in the literature that projects fails because of Six Sigma methodology. This interpretation supports the conclusion that forces outside the Six Sigma methodology contributed to failure of the Six Sigma DMAIC projects.

Analysis and interpretation of the findings based on the data to answer Research Question 2 close the gap in literature that projects fail because of Six Sigma methodology. These findings support the conclusion that forces outside the Six Sigma methodology contributed to the failure of the Six Sigma DMAIC project.

Research Question 3

Research Question 3 was, “Is Six Sigma methodology the driver for Six Sigma project failures?”

Finding 1. According to responses to Survey Question 17, as shown in Table 9, 82.9% (39 + 19 = 58/70 = 82.9%) of the participants answered that their respective failed Six Sigma DMAIC project involved correct deployment of Six Sigma methodologies. Data in Table 9 represent whether participants believed the actual methodology of Six Sigma was at fault for the failure of their respective projects. The data indicate that, while most participants disagreed that their Six Sigma DMAIC project failed because of Six Sigma methodology, a significant number (more than 50% or 39 respondents) had positive strong feelings about the influence of Six Sigma methodologies.

Table 9

Descriptive Statistics for Research Question 3

Survey questions (*N* = 70)	Strongly disagree	Disagree	Neither	Agree	Strongly agree
Q17: Did your Six Sigma DMAIC project fail because of Six Sigma methodology?	39 55.7%	19 27.1%	9 12.9%	3 4.3%	0 0.0%
Sum count	58		9	3	
Sum % of total	82.9%		12.9%	4.3%	

Finding 2. The data in Table 9 indicate that practitioners followed the processes appropriately and that processes were not significant drivers of the ultimate failure of the Six Sigma project. Management should consider properly implementing these methodologies a management philosophy. Eckes (2001) stated, “It is a commitment to

managing through process, not function and making decisions based on fact and data rather than the inherent skills management believe make them great executives” (p. 185). Therefore, analysis and interpretation of the findings based on the data to answer Research Question 3 close the gap in literature that projects fail because of Six Sigma methodology. The conclusion is that forces outside the Six Sigma methodology contributed to the failure of the Six Sigma DMAIC projects.

Testing the Null Hypothesis

For this hypothesis test, I used data from the online survey conducted via SurveyMonkey.com to determine which statement is best supported by the data. These two statements are the null hypothesis and the alternative hypotheses. I performed the chi-square statistical test to compare the survey data with data expected to be obtained according to the hypothesis. The test yielded the results shown in Table 10.

Table 10

Minitab 16 Chi-Square Test for Research Hypothesis

N	Values	Strongly disagree	Disagree	Neither	Agree	Strongly agree	Total
Q17. Did your Six Sigma DMAIC project fail because of Six Sigma methodology?	Observed	39.0	19.0	9.0	3.0	0.0	70
	Expected	21.5	11.0	10.0	12.5	15.0	
	Chi square	14.2	5.8	0.1	7.2	15.0	
Q18. Did your Six Sigma DMAIC project fail for reason(s) other than Six Sigma methodology?	Observed	4.0	3.0	11.0	22.0	30.0	70
	Expected	21.5	11.0	10.0	12.5	15.0	
	Chi square	14.2	5.8	0.1	7.2	15.0	
Total		43.0	22.0	20.0	25.0	30.0	140
Results: Chi square = 84.765, *DF* = 4, *p* value = 0.000							

The chi-square statistic is a measure of the extent to which observed counts vary from expected counts. If observed counts differ significantly from expected counts, then the value of X2 will be large, demonstrating relationship, or dependency, between variables. The results of this chi-squire test indicate there is a relationship between survey respondents' answers and why Six Sigma projects fail. The *p* value from the test is 0.000. Because it is less than our alpha of 0.05, we can reject the null hypothesis—there is no relationship between our variables, or they are independent—and accept the alternative hypothesis, which is that there is a relationship between variables, and thus there is dependence.

What is different from the observed counts versus the expected counts? For Survey Question 17, few people agreed that their projects failed because of the Six Sigma methodology. I tabulated three observed counts for agree and strongly agree combined, versus expected counts of 17.5. Because far fewer survey respondents agreed that projects failed because of the Six Sigma methodology than the expected count, the data support a position that Six Sigma projects failed for reasons other than the methodology. Survey Question 18 yielded 52 observed counts for which respondents agreed or strongly agreed that projects failed for reasons other than the Six Sigma methodology, versus expected counts of 17.5. The data support the position that Six Sigma projects fail for reasons other than the methodology. The results and interpretation of this chi-squire analysis support accepting the main null hypothesis: Six Sigma projects do not fail because of Six Sigma methodology.

The respondents who were not sure of the impact of the Six Sigma methodology in their organizations may have assumed independence of the methodology to the overall performance of the organization; in other words, they were uncertain whether the organization did well or did not do well. If the organization did not do well, application of the Six Sigma methodology could not affect performance of the organization. However, the integral issue of using the Six Sigma methodology was to boost performance of the company and to have a positive effect on the VOC.

Data Analysis

The Six Sigma DMAIC project yielded various responses that offered considerable insight into the influence of Six Sigma DMAIC projects for the management and its team members. For every project to succeed, the team must support the company leaders' ideas where the findings reflected considerably on the Six Sigma DMAIC methodology (Jankowski, 2013). Therefore, results from the data collected were as follows.

Six Sigma DMAIC Management Support

At least 77.2% of respondents reported their managers urged them to use the Six Sigma DMAIC; 62.9% had the Six Sigma DMAIC financed, 51.4% had their project solutions implemented, and 68.6% had their project supported with good baseline data. This broad support also meant that, as long as the management approved the use of the Six Sigma DMAIC in their projects, there was an impressive level of acceptance of Six Sigma DMAIC. In fact, any management teams that supported the Six Sigma DMAIC methodology in their management ventures qualified for visionary leadership because the Six Sigma methodology guaranteed superior organizational.

George (2010) applauded implementation of Six Sigma projects as beneficial because these projects overcome organizational challenges, facilitate organizational transition, and encourage organizational growth to prosperity. They argued that customer focus is an instrumental aspect that determines the performance and design of the Six Sigma approach. The DMAIC process aids management in comprehending customer requirements and strategies to meet these customers' needs.

Preparation Toward the Six Sigma DMAIC Project

Results of this study showed that 91.4% of the participants were trained during the Six Sigma DMAIC process and 58.6% believed that the organization was ready for the project. In addition, at least 55.7% understood the Six Sigma of the hierarchy of their project. These data results also indicate that most of the respondents were adequately prepared for the application of Six Sigma methodology on their projects and never felt lost during the process. Indeed, these findings indicate clarity regarding project expectations.

Ease in Using the Six Sigma Methodology

Results of this study showed that 57.1% of participants believed their Six Sigma DMAIC project was well resourced, 67.1% had enough time to complete the project, and 58.6% believed that project selection was appropriate for the Six Sigma methodology. Furthermore, 71.5% agreed that the Six Sigma methodology was not too complex for their organizations to solve, while 57.2% of their project champions understood the statistics behind their Six Sigma DMAIC project. These findings indicate the ease and comfort the participants felt in using the Six Sigma methodology, from how the management resourced the project to understanding the Six Sigma methodology statistics. As long as the management understood the importance of Six Sigma and fully supported the process, the participants indicated that the success of the Six Sigma DMAIC project implementation would be inevitable. In fact, as long as management teams used the Six Sigma model as a benchmark in their organization, participants believed doing so would offer them appropriate platforms to define the future of the organization.

Estimation and Results

Prior to estimating multiple regression equations to test the study hypotheses, I assessed the skew of the two independent variables that are, as stated in chapter 3, the variables that I believe induce or explain the change. These are Independent Variable 1, Six Sigma management support, and Independent Variable 2, Six Sigma project scope.

Hypotheses 1 and 2: This research proposed that the two independent variables would have a direct and positive impact on Six Sigma DMAIC project performance, as outlined in hypotheses 1 and 2.

Overall Findings of the Responses

It is apparent from the findings that the Six Sigma methodology is one of the best methodologies to adopt and that it embraced almost all TQM aspects (Levine et al., 2015). Of the 1,047 total responses, 791 responses represented full support of the Six Sigma DMAIC methodology. This finding also meant that at least 75% of the responses represented a belief in the Six Sigma methodology quite strongly, while the other 25% of the responses represented either disagreement or were neutral on the importance of the methodology. Based on the findings, the majority of participants surveyed appreciated the importance of the Six Sigma approach in their project management efforts.

The data collected as part of this study support the conclusion that there was a statistical significance to retain the null hypothesis: Six Sigma projects do not fail because of Six Sigma methodology. The significance of the study and findings fills the gap in literature refuting that Six Sigma is just a “fad” and does not work. This study and its findings will provide insights into future Six Sigma DMAIC projects. Through empirical research, they study statistically addressed the gap in the literature by measuring key drivers to validate that Six Sigma DMAIC projects do not fail as a result of Six Sigma methodologies. This validation will assist Six Sigma Black Belt practitioners and business leaders in making decisions in deploying Six Sigma on their projects.

Summary of Findings

The objective of Chapter 4 was to analyze data I obtained from the semi structured interviews that participants completed as part of the research study. I developed the interview questions based on studies described in chapters 1, 2, and 3. Respondents who were unsure of the impact of the Six Sigma methodology in their organizations may have assumed the methodology was independent of the overall performance of the organization; in other words, they were uncertain whether the organization did well or did not do well. If the organization did not do well, applying Six

Sigma methodology could not affect performance of the organization. However, the integral reason for using the Six Sigma methodology is to boost company performance and to have a positive effect on operations.

Findings from this study are clear: one of the best methodologies business leaders can adopt and that includes almost all TQM aspects is Six Sigma (Levine et al., 2015). Of the 1,047 responses, 791 responses indicated full support of the Six Sigma DMAIC methodology. This finding also means that at least 75% of the responses indicated participants' strong belief in the Six Sigma methodology, while the other 25% of the responses represented either disagreement or were neutral on the importance of the methodology. Based on the findings, the majority of participants appreciated the importance of the Six Sigma approach to their project management efforts.

While conducting this primary research, I was conscious of the need to extract lessons from the respondents' experiences of having used Six Sigma. There is clear evidence, based on qualitative analysis of the respondents' interview data and quantitative scoring of performance of the tool, that Six Sigma could be used effectively in an accounting environment. Introducing Six Sigma to the accounting environment could benefit users of that accounting environment. The respondents reported issues and deficiencies, particularly the lack of an effective, all-encompassing framework to support the Six Sigma methodology. I recommend the program leadership team should address this problem. Other, more mundane issues and deficiencies should be worked on at the project team level.

In summary, the findings indicate practitioners and Six Sigma project participants clearly appreciate the Six Sigma methodology because it can be used to create organizational benchmarks and, based on those benchmarks, support long-lasting solutions. Statistically significant data support my conclusion to retain the null hypothesis: Six Sigma projects do not fail because of Six Sigma methodology. The significance of the study and findings fill a gap in literature and refute claims that Six Sigma is just a “fad” and does not work. This study and its findings will provide insights for practitioners into future Six Sigma DMAIC projects. Through empirical research, I statistically addressed the gap in the literature by measuring key drivers to validate that Six Sigma DMAIC projects do not fail as a result of Six Sigma methodologies. This validation will assist Six Sigma Black Belt practitioners and business leaders in making decisions about deploying Six Sigma on their projects.

Interpretation of these data compelled me to reject the premise that Six Sigma methodology is the driver that causes Six Sigma DMAIC projects to fail. These findings also close a gap in literature that projects fail because of Six Sigma methodology, given previously identified drivers of Six Sigma DMAIC project success on projects correctly deploying Six Sigma methodology and the Six Sigma DMAIC project being correctly scoped. For instance, what is different from the observed counts versus the expected counts? In response to Survey Question 17, few people agreed that their projects failed because of the Six Sigma methodology. I tabulated combined observed counts of agree and strongly agree at three, versus expected counts of 17.5. Because far fewer survey respondents agreed that projects failed because of the Six Sigma methodology than the expected count, the data support a position that Six Sigma projects failed for reasons other than the methodology. Survey Question 18 yielded 52 observed counts representing respondents agreed or strongly agreed that projects failed for reasons other than the Six Sigma methodology, versus expected counts of 17.5. The data support the position that Six Sigma projects fail for reasons other than the methodology. The results and interpretation of this chi-squire analysis support accepting the main null hypothesis: Six Sigma projects do not fail because of Six Sigma methodology. The conclusion here is that forces outside the Six Sigma methodology contributed to the failure of some Six Sigma DMAIC projects study participants experienced.

Although the Six Sigma methodology is a powerful technique for solving problems, projects must be selected appropriate to the Six Sigma construct and scope. The results indicate that these project failures had little to do with how the project was scoped—either too large or too small—to function properly in the Six Sigma DMAIC project structure. My interpretation of these data calls for rejecting the premise that these drivers cause Six Sigma DMAIC projects to fail. These findings also close a gap in literature that projects fail because of Six Sigma methodology, given the previously identified drivers. The conclusion is that forces outside the Six Sigma methodology contribute to the failure of some Six Sigma DMAIC projects.

Researchers have raised several issues regarding the Six Sigma methodology. Experts have remarked that, although practitioners have been using the Six Sigma methodology for decades, reports have only recently begun to articulate its theoretical foundations. At issue is whether the methodology encompasses innovative theoretical insights. The Six Sigma methodology warrants a theoretical approach to explain its success and how this approach can increase performance in any industry. I conducted this study to advance the Six Sigma research. The findings and conclusions of this study represent a first step to effectively and empirically validate the effectiveness of the Six Sigma methodology. Without scientific evidence of its effectiveness, assertions of the advantages and benefits of the Six Sigma methodology are hollow.

Chapter 5: Summary, Conclusion, and Recommendations

Introduction

I present and discuss my findings in this chapter and I review the results of the analysis presented in Chapter 4 in the context of the research questions presented in Chapters 1, 3, and 4. The discussion focuses on the extent to which the research has addressed the issues raised by the research questions. The interest is in what the data reveal and how these results relate to previous research findings and the existing theory and practices in the area. The discussion also highlights how the research findings contribute to, extend, or confirm the body of knowledge on the topic. I offer suggestions or recommendations based on the specific context of the study. Finally, I identify new insights into the research topic and future research questions. The chapter concludes with a recap of the purpose and research questions of the study, presents a discussion of the evaluation and survey results as they related to the research questions, and provides an understanding of the findings. The chapter also addresses implications for social change, offers recommendations for further action and study, and presents my reflections.

Summary of the Investigation

In Chapters 1 and 2, I examined the breakdown of Six Sigma and identified a gap in literature relative to Six Sigma. The gap I identified reflects the lack of scientific, research-based conclusions stating that Six Sigma does not work. I developed research questions to address the gap, and then I prepared survey questions to answer the research questions. I chose SurveyMonkey.com to administer the surveys to 206 qualified Six Sigma Black Belt practitioners and individuals who have participated in a DMAIC project. I stratified 70 responses and derived calculations using Microsoft Excel and Minitab 16. I examined 70 survey responses using descriptive statistics, including means and standard deviations, and performed two-sample *t* tests and chi-square tests. I used the results of these statistical tests to draw conclusions about answers to the survey questions and thereby address the gap.

Interpretation of Findings

This section states the findings on the surveyed responses to the research questions.

Research Question 1. Research Question 1 was, "Is the lack of management support the driver for Six Sigma project failures?" Participants indicated that management supported their respective failed Six Sigma DMAIC projects. This finding reflects that, if the top management does not take the time to learn about Six Sigma or support it, then the project participants also do not support the project. This finding indicates that there were other reasons why Six Sigma has failed owing to factors other than lack of management support.

It is evident that Six Sigma DMAIC project participants involved at multiple levels of the project must have a certain level of understanding Six. The research data support this component of the Six Sigma DMAIC project was fulfilled as expected to achieve success; the projects failed for other reasons. Therefore, I interpret these findings to conclude that some projects do not fail because of Six Sigma methodology. Rather, forces outside the Six Sigma methodology contributed to the failure of the Six Sigma DMAIC projects.

Research Question 2. Research Question 2 was, "Is it because the Six Sigma project was not scoped in accordance with Six Sigma methodology framework?" My interpretation of the findings was that the respective failed Six Sigma DMAIC projects did not negatively affect the organization, rejecting the premise that projects out of scope are drivers causing Six Sigma DMAIC projects to fail. This interpretation indicates the presence of external or internal factors that affected the organizations and may have been beyond the Six Sigma methodology approach.

Finding 2 led me to interpret that the Six Sigma methodology is a powerful technique for solving problems in that those selecting the project must be specific to the Six Sigma construct and scope. This finding suggests that the failure of these projects had little to do with the scoping of the project as either too large or too small to function properly in the Six Sigma DMAIC project structure. The conclusion is that the integral issue of using the Six Sigma methodology was to boost company performance and gauge whether the project leaders appreciated the usefulness of the methodology.

According to W. Zhang, Hill, and Gilbreath (2011), practitioners develop Six Sigma projects with the sole purpose of comprehending and identifying crucial customer satisfaction characteristics. Leaders of organizations employ Six Sigma to help meet the needs and expectations of their customers. Six Sigma methodologies assist organizations in meeting their respective customer needs and leveraging their resources to achieve company performance metrics.

Research Question 3. Research Question 3 was, "Is Six Sigma methodology the driver for Six Sigma project failures?" The findings were that the actual methodology of

Six Sigma was not at fault for the failure of participants' respective projects. Finding 2 indicates that practitioners followed the process correctly and therefore the process was not a driver of the ultimate failure of the undertaking.

Hypothesis. This study tested the hypothesis that Six Sigma projects do not fail simply because of Six Sigma methodology and yielded statistical significances. I developed the hypothesis based on existing literature that indicated Six Sigma DMAIC projects fail due to reasons other than Six Sigma methodology (Angel & Pritchard, 2008; Clifford, 2001; Dalgeish, 2003; Harbola, 2010; James, 2010; McManus, 2008; Miller, 2010; Mullavey, 2006). The null hypothesis (H_o) was, "Six Sigma projects do not fail because of Six Sigma methodology." The alternate hypothesis (H_a) was, "Six Sigma projects fail because of Six Sigma methodology." I computed descriptive analysis of the data and calculated the survey results, and the results supported retaining the null hypothesis.

Roberts (2004) discussed the different Six Sigma signals by assessing the performance of companies whose leaders have adopted the use of Six Sigma. Focusing on the U.S. banking industry, he discussed Citigroup and Bank of America as examples of the companies that have benefitted immensely from heavily investing in the use of Six Sigma. He concluded that the use of Six Sigma is an accelerator of performance and a measure of the success. Hall and Saygin (2012) discussed the importance of information sharing in high performing supply chains which should also be prescribed for Six Sigma.

Summary

The interpretation of these data call for rejecting the premise that Six Sigma methodology is the driver that causes Six Sigma DMAIC projects to fail. These findings also close the gap in literature that projects fail because of Six Sigma methodology. Projects do not fail because of the drivers of Six Sigma DMAIC projects. Projects on which practitioners correctly deployed Six Sigma methodology do not fail. Projects do not fail because the Six Sigma DMAIC project was incorrectly scoped. The conclusion is that forces outside the Six Sigma methodology contributed to the failure of some Six Sigma DMAIC projects.

Although the Six Sigma methodology is a powerful technique for solving problems, those selecting the project must be specific to the Six Sigma construct and scope. The results indicate that the failure of these projects had little to do with the scoping of the projects as either too large or too small to function properly in the Six Sigma DMAIC project structure. The interpretation of these data calls for rejecting the premise that these drivers cause Six Sigma DMAIC projects to fail. These findings also close the gap in literature that projects fail because of Six Sigma methodology, given the previously identified drivers. The conclusion is that forces outside the Six Sigma methodology contributed to the failure of some Six Sigma DMAIC projects.

This research answered several issues raised regarding the Six Sigma methodology. Experts have remarked that, although the Six Sigma methodology has been in practice for decades, its theoretical foundations have only recently begun to be articulated. At issue is whether the methodology encompasses innovative theoretical insights. The Six Sigma methodology warrants a theoretical approach to explain its success and how this approach can increase performance in any industry. I intended, by conducting this study, to aid in the progressions of Six Sigma research. These findings and conclusions represent a first step in the pursuit of effective and empirical validation of the effectiveness of the Six Sigma methodology. Without scientific evidence of the effectiveness of the Six Sigma methodology, assertions of its advantages and benefits are hollow.

Implications for Social Change

As explained in Chapter 1, I undertook this study to support social and scholarly commitments. The consequences of this exploration will likely add to Six Sigma data. Six Sigma ventures conducted to transform precision and throughput for insurance agencies and the Centers for Medicare & Medicaid Services can result in positive social change. Expanded efficiencies ought to prompt enhanced income for specialists and healing centers. These efficiencies and added income will influence these organizations and their workers. The consequences of the examination should give Six Sigma Black Belt practitioners engaged in Six Sigma tasks the data to help them choose this methodology for fruitful Six Sigma activities. The aftereffects of this examination should help build the Six Sigma DMAIC venture achievement rate, which will bring about organization funds through expanded efficiencies, decreased imperfections, and enhanced assets. Finally, the consequences of this exploration demonstrate a standard for further research. The results presented in chapter 4 reflect that Six Sigma DMAIC projects do not fail because of Six Sigma methodology. The results indicate instead a negative correlation between the key Six Sigma DMAIC project drivers and project failure, which indicates the Six Sigma DMAIC projects failed for reasons other than Six Sigma methodology.

Recommendations for Action

Results of the survey administered for this study indicated that participants' respective failed Six Sigma DMAIC project did not fail because of Six Sigma methodology. This finding resulted in rejecting the premise that Six Sigma methodology drivers were causing Six Sigma DMAIC projects to fail. Based on these data, Six Sigma DMAIC projects are failing because of reasons other than Six Sigma methodology. The significance of the study and findings fills the gap in literature that Six Sigma is just a "fad" and does not work. This study will provide insights for future Six Sigma DMAIC projects. This study, through empirical research, statistically addressed the gap in the literature by measuring key drivers to validate that Six Sigma DMAIC projects do not fail because of Six Sigma methodologies.

Recommendations for Future Research

The quantitative research design for this study called for conducting a two-sample t-test and a chi-square test on answers to 18 questions. I measured the answers to these questions on a 5-point Likert scale and focused on failed Six Sigma DMAIC projects. Participants self-administered the surveys. A total of 206 Six Sigma Black Belt practitioners and Six Sigma DMAIC project participants agreed to take the survey via SurveyMonkey.com. I did not collect data on participant gender, age, length of experience, industry, location of work because all participants were located in the United

States, or the type of Six Sigma DMAIC project. I discovered that participants used specific methods within each of the DMAIC phases. While this study provides insight into the lack of correlation between failed Six Sigma DMAIC projects and the key Six Sigma DMAIC drivers, future researchers could collect these additional data points to support further analysis of the effect on the failed Six Sigma DMAIC projects.

The literature of contextual theory calls for more studies on the possible interaction effect of contextual factors and practices on performance. The unexpected findings of this study underscore the continued urgent need for a closer investigation of the organizational contexts that critically influence the implementation of Six Sigma improvement programs. Given the current growth of Six Sigma, I recommend future researchers explore the factors that affect the failure or success of Six Sigma in an approach to achieve organizational excellence (Paladino, 2011).

Research concerning the Six Sigma methodology has offered support of anecdotal evidence, but little empirical data regarding performance of the methodology. This study represents a first step in that direction. Six Sigma is usually implemented at diverse levels and dimensions throughout an organization. Researchers should consider conducting further research to address these various levels and dimensions. Because the methodology generally improves quality management, financial performance, operative performance, and competitive performance, future researchers should focus on these dimensions. Implications of performance on various organizational levels (e.g., corporate, plant, project, and division) also warrant scholarly investigation. Understanding the impact of Six Sigma at levels above the individual project will aid Six Sigma practitioners in understanding under more minute projections. Research on Six Sigma should take center stage to extend our understanding of the workings of this methodology.

Finally, the literature suggests two points of view regarding the performance and failure of Six Sigma. These two approaches not only indicate the sequence of applications of the programs, but also demonstrate the method of combining the programs and managing improvement activities in firms. The issue of which methodology is more or less important in creating an optimal joint model is subject to debate. The current literature still lacks a holistic study. Researchers should ask questions regarding which method can accurately reflect the implications of drivers on the failure of Six Sigma projects.

The experiments and surveys conducted on the appropriateness of Six Sigma methodology application in project analysis led me to make the following recommendations:

- The failure of the Six Sigma approach may at times result from external forces originating from the environment. Management is not the only group of people who may contribute to failure. In some cases, external threats affected the effectiveness of this methodology. These threats must be mitigated to allow the project team to achieve the goals of the project. External threats may be unpredictable, and their unpredictability is another challenge practitioners must overcome. Practitioners and business leaders must put proper strategies into place to neutralize external threats as early as possible. Business leaders must eliminate management weaknesses by ensuring that the right people are involved in the decision-making process, as well as in the running of day-to-day business operations. Putting the right people on the project team and in management positions will improve Six Sigma methodology usefulness.

- Scoping of any project as too large or small has nothing to do with the performance of the Six Sigma results. The Six Sigma methodology ensures good and consistent project performance. It should curb unnecessary losses. The methodologies designed during the use of this Six Sigma usually help to improve targeted performances and trigger an increase in the number of customers. Organizations using Six Sigma must ensure that the selected project takes full advantage of the analysis results generated from applying the Six Sigma approach. Business leaders must take full advantage of Six Sigma efforts on every project that undergoes the Six Sigma methodology treatment. They must make judicious use of these efforts and restrict the number of irrelevant projects considered for review.
- Six Sigma DMAIC methodology is beneficial to any organization in the management of operations and day-to-day performance. This methodology advocates for leadership as well integrity with transparency. Proper leadership is fundamental. It ensures that the appropriation of resources—financial, functional, and human personnel—is done wisely, resulting in the rights and responsibilities of each employee being respected. Good leadership advocates that no resource is overused or neglected. The Six Sigma approach emphasizes these same attributes.

- The Six Sigma methodology makes it easy to analyze projects and relevant combinations of components to make proper investment decisions. This ease of use means that young, incubator-stage companies and companies with inexperienced leaders who are beginning to make investment strategies can ensure appropriateness of decisions when using this methodology. This methodology can also be of quantifiable benefit to companies experiencing retrenchment and have a need to devise ways of reviving themselves. The ease of use of this methodology in foreseeing performance improvements can encourage both young and retrenching firms to grow and develop.

The Six Sigma methodology has been in use for many decades. Its applicability is undoubtable. There is a great need for professionals to make informed decisions when identifying and applying methodologies for conducting business analyses. Selecting and applying sound methodologies can ensure business leaders will analyze profitability as well as performance using the right tools rather than using inappropriate tools that offer no benefit or proof of effectiveness to the desired results.

Reflections of the Researcher

Before commencing this final section of my dissertation, I took time to reflect on my journey from early dissertation topic considerations to reading the many books and journal articles to gap analysis to conducting the research to quantifying the data, which all led to this final section. While I have been involved with process improvement-type work for most of my career and then Six Sigma specifically since 2009, I was unaware of how many other Six Sigma Black Belts and Six Sigma DMAIC project participants shared my passion and would be interested in participating in my surveys. I was uncertain what the data would reflect. It was exciting for me to see that other Black Belt practitioners' Six Sigma DMAIC projects did not fail because of Six Sigma methodology or that the data supporting their respective Six Sigma DMAIC projects failed for reasons other than Six Sigma methodology.

My dissertation journey has been an opportunity to grow as a student, a professional, and a person. I have gained a deeper understanding of what does not affect the success of a Six Sigma DMAIC project throughout the research and conclusion phases of my dissertation. Six Sigma methodology is a powerful tool and helpful a way of thinking, but it alone is not enough to guarantee project success.

References

Abid, M. A., Rehman, A. U., & Anees, M. (2010). *How to minimize the defects rate of final product in textile plant by the implementation of DMAIC tool of Six Sigma* (Master's thesis, University of Borås, Borås, Switzerland). Retrieved from http://bada.hb.se/bitstream/2320/6914/1/Abid Rehman Anees.pdf

Adams, J., Khan, H. T. A., & Raeside, R. (2014). *Research methods for business and social science students* (2nd ed.). Thousand Oaks, CA: Sage.

Aggarwal, N., Kumar, A., Khatter, H., & Aggarwal, V. (2012). Analysis the effect of data mining techniques on databases. *Advances in Engineering Software, 47*(1), 164–169. http://dx.doi.org/10.1016/j.advengsoft.2011.12.013

AlSagheer, A. (2011). Applying Six Sigma to achieve enterprise sustainability: Preparations and aftermath of Six Sigma projects. *Journal of Business & Economics Research, 9*(4), 51–58.

Al-Zubi, A. A., & Basha, I. (2010). Six Sigma in libraries: A management perspective. *Canadian Journal on Computing in Mathematics, Natural Sciences, Engineering and Medicine, 1*, 86–93.

Angel, D. C., & Pritchard, C. (2008). Behavior test Six Sigma. *Industrial Engineer, 40*(8), 41.

Ansari, A., Lockwood, D., Thies, E., Modarress, B., & Nino, J. (2011). Application of Six-Sigma in finance: A case study. *Journal of Case Research in Business and Economics, 3*(2), Art. No. 9. Retrieved from http://www.aabri.com/jcrbe.html

Antony, J. (2007). Is Six Sigma a management fad or fact? *Assembly Automation, 27*(1), 17–19. http://dx.doi.org/10.1108/01445150710724658

Antony, J. (2011). Six Sigma vs. Lean: Some perspectives from leading academics and practitioners. *International Journal of Productivity and Performance Management, 60*(2), 185–190. http://dx.doi.org/10.1108/17410401111101494

Antony, J. (Ed.). (2012). Integrating Lean and Six Sigma for achieving and sustaining operational and service excellence [Special issue]. *International Journal of Quality & Reliability Management, 29*(1). Retrieved from http://www.emeraldinsight.com/loi/ijqrm

Antony, J., Krishan, N., Cullen, D., & Kumar, M. (2012). Lean Six Sigma for higher education institutions (HEIs): Challenges, barriers, success factors, tools/techniques. *International Journal of Productivity and Performance Management, 61*(8), 940–948. http://dx.doi.org/10.1108/17410401211277165

Arthur, J. (2009, December 10). Six Sigma tricks of the trade: Less tricks, more trade. *Quality Digest.* Retrieved from http://www.qualitydigest.com/inside/quality-insider-article/six-sigma-tricks-trade-less-tricks-more-trade.html

Arthur, J. (2011). *Lean six sigma for hospitals: Simple steps to fast, affordable, flawless healthcare*. New York, NY: McGraw-Hill.

Assarlind, M., & Aaboen, L. (2014). Forces affecting one Lean Six Sigma adoption process. *International Journal of Lean Six Sigma, 5*(3), 324–340. http://dx.doi.org/10.1108/IJLSS-07-2013-0039

Baril, C., Yacout, S., & Clément, B. (2011). Design for Six Sigma through collaborative multi-objective optimization. *Computers & Industrial Engineering, 60*(1), 43–55. http://dx.doi.org/10.1016/j.cie.2010.09.015

Barlow, R. D. (2008). Erasing the stigma of Six Sigma and lean principles. *Healthcare Purchasing News, 32*, 42–45. Retrieved from http://www.hpnonline.com/

Bhamu, J., & Singh, S. K. (2014). Lean manufacturing: Literature review and research issues. *International Journal of Operations & Production Management, 34*(7), 876–940. http://dx.doi.org/10.1108/IJOPM-08-2012-0315

Bhat, S., Gijo, E. V., & Jnanesh, N. A. (2014). Application of Lean Six Sigma methodology in the registration process of a hospital. *International Journal of Productivity and Performance Management, 63*(5), 613–643. http://dx.doi.org/10.1108/IJPPM-11-2013-0191

Brook, Q., & Brook, Q. (2010). *Lean Six Sigma & Minitab: The complete toolbox guide for all Lean Six Sigma practitioners* (3rd ed.). Winchester, England: Opex Resources.

Burge, R. (2008). Ready, set, change: Reducing resistance to Six Sigma projects. *Industrial Engineer, 40*(10), 35–39. Retrieved from http://www.iienet2.org/IndustrialEngineer/Issue.aspx

Büyüközkan, G., & Öztürkcan, D. (2010). An integrated analytic approach for Six Sigma project selection. *Expert Systems with Applications, 37*(8), 5835–5847. http://dx.doi.org/10.1016/j.eswa.2010.02.022

Cezar Lucato, W., Araujo Calarge, F., Loureiro Junior, M., & Damasceno Calado, R. (2014). Performance evaluation of lean manufacturing implementation in Brazil. *International Journal of Productivity and Performance Management*, *63*(5), 529–549. http://dx.doi.org/10.1108/IJPPM-04-2013-0085

Chakraborty, A., & Tan, K. C. (2012). Case study analysis of Six Sigma implementation in service organisations. *Business Process Management Journal*, *18*(6), 992–1019. http://dx.doi.org/10.1108/14637151211283384

Chakravorty, S. S. (2010, January 25). Where process-improvement projects go wrong. *Wall Street Journal*. Retrieved from http://www.wsj.com/

Charles, J.-P., Hannane, F., El-Mossaoui, H., Zegaoui, A., Nguyen, T. V., Petit, P., & Aillerie, M. (2014). Faulty PV panel identification using the design of experiments (DOE) method. *International Journal of Electrical Power & Energy Systems*, *57*, 31–38. http://dx.doi.org/10.1016/j.ijepes.2013.11.037

Cheng, C.-Y., & Chang, P.-Y. (2012). Implementation of the Lean Six Sigma framework in non-profit organisations: A case study. *Total Quality Management & Business Excellence*, *23*(3-4), 431-447. http://dx.doi.org/10.1080/14783363.2012.663880

Chiarini, A. (2011a). Integrating lean thinking into ISO 9001: A first guideline. *International Journal of Lean Six Sigma*, *2*(2), 96–117. http://dx.doi.org/10.1108/20401461111135000

Chiarini, A. (2011b). Japanese total quality control, TQM, Deming's system of profound knowledge, BPR, Lean and Six Sigma. *International Journal of Lean Six Sigma*, *2*(4), 332–355. http://dx.doi.org/10.1108/20401461111189425

Cima, R. R., Hale, C., Kollengode, A., Rogers, J. C., Cassivi, S. D., & Deschamps, C. (2010). A surgical case listing accuracy: Failure analysis at a high-volume academic medical center. *Archives of Surgery, 145*(7), 641–646. http://dx.doi.org/10.1001/archsurg.2010.112

Clifford, L. (2001, January). Why you can safely ignore Six Sigma. *Fortune Magazine*, 140. Retrieved from http://www.fortune.com

Cohen, J. (1969). *Statistical power analysis for the behavioral sciences*. New York, NY: Academic Press.

Cole, R. E. (1999). *Managing quality fads*. New York, NY: Oxford University Press.

Cournoyer, M. E., Renner, C. M., Lee, R. J., Trujillo, C. M., Krieger, E. W., Neal, G. E., & Kowalczyk, C. L. (2011). Lean Six Sigma tools for a Glovebox Glove Integrity Program: Part II: Output metrics. *Journal of Chemical Health and Safety, 18*(1), 22–30. http://dx.doi.org/10.1016/j.jchas.2010.04.002

Cronemyr, P., & Witell, L. (2010). Changing from a product to a process perspective for service improvements in manufacturing companies. *The TQM Journal, 22*(1), 26–40. http://dx.doi.org/10.1108/17542731011009603

Cronholm, K. (2013). Design of experiment based on VMEA (Variation mode and effect analysis). *Procedia Engineering, 66*, 369–382. http://dx.doi.org/10.1016/j.proeng.2013.12.091

Cudney, E. A., & Furterer, S. L. (2012). *Design for Six Sigma in product and service development: Applications and case studies*. Boca Raton, FL: CRC Press.

DALBAR. (2012). *Quantitative analysis of investor behavior*. Boston, MA: Author. Retrieved from http://www.dalbar.com

DALBAR. (2013). *Quantitative analysis of investor behavior 2012*. Boston, MA: Author. Retrieved from http://www.dalbar.com

Dalgeish, S. (2003). Six Sigma? No thanks. *Quality Magazine, 42*, 22–23. Retrieved from http://www.qualitymag.com

De Feo, J., & Juran, J. M. (2010). *Juran's quality handbook: The complete guide to performance excellence* (6th ed.). New York: McGraw Hill.

De Mast, J., Kemper, B., Does, R. J. M. M., Mandjes, M., & van der Bijl, Y. (2011). Process improvement in healthcare: Overall resource efficiency. *Quality and Reliability Engineering International, 27*(8), 1095–1106. http://dx.doi.org/10.1002/qre.1198

De Mast, J., & Lokkerbol, J. (2012). An analysis of the Six Sigma DMAIC method from the perspective of problem solving. *International Journal of Production Economics, 139*(2), 604–614. http://dx.doi.org/10.1016/j.ijpe.2012.05.035

DelliFraine, J. L., Langabeer, J. R., II, & Nembhard, I. M. (2010). Assessing the evidence of Six Sigma and Lean in the health care industry. *Quality Management in Health Care, 19*(3), 211–225. http://dx.doi.org/10.1097/QMH.0b013e3181eb140e

Deming, W. E., & Orsini, J. N. (2013). *The essential Deming: Leadership principles from the father of quality management*. New York: McGraw-Hill.

Desai, D. K. (2010). *Six sigma*. Mumbai, India: Himalaya Publishing House.

Dieterich, C. (2014, February 6). Investors bolt from stock funds into bonds. *Wall Street Journal*. Retrieved from http://www.wsj.com

Douglas, P. C., & Erwin, J. (2000). Six Sigma's focus on total customer satisfaction. *Journal for Quality and Participation, 23*(2), 45–49. Retrieved from http://asq.org/pub/jqp/

Drohomeretski, E., Gouvea da Costa, S. E., Pinheiro de Lima, E., & Andrea da Rosa Garbuio, P. (2014). Lean, Six Sigma and Lean Six Sigma: An analysis based on operations strategy. *International Journal of Production Research, 52*(3), 804–824. http://dx.doi.org/10.1080/00207543.2013.842015

Duffy, G. L., Laman, S. A., Mehta, P., Ramu, G., Scriabina, N., & Wagoner, K. (2012). Beyond the basics–Seven new quality tools to help innovate, communicate and plan. *Quality Progress, 45*(4), 18–29. Retrieved from http://asq.org/pub/

Duggan, K. J. (2013). *Creating mixed model value streams: Practical lean techniques for building to demand* (2nd ed.). Boca Raton, FL: CRC Press.

Easton, G. S., & Rosenzweig, E. D. (2012). The role of experience in six sigma project success: An empirical analysis of improvement projects. *Journal of Operations Management, 30*(7-8), 481–493. http://dx.doi.org/10.1016/j.jom.2012.08.002

Eckes, G. (2001). *Making Six Sigma last: Managing the balance between cultural and technical change*. New York, NY: Wiley.

Erturk, S. M., & Ondategui-Parra, S. (2012). Quality management in radiology: Historical aspects and basic definitions. *Journal of the American College of Radiology, 2*(12), 985–991. http://dx.doi.org/10.1016/j.jacr.2005.06.002

Fei, Y., & Wang, Z. (2013). Effects of information technology alignment and information sharing on supply chain operational performance. *Computer and Industrial Engineering, 65*(3), 370–377. http://dx.doi.org/10.1016/j.cie.2013.03.012

Foster, S. T. (2007). Does Six Sigma improve performance? *Quality Management Journal, 14*(4), 7–20. Retrieved from http://asq.org/pub/qmj/

Frankfort-Nachmias, C., & Nachmias, D. (2008). *Research methods in the social sciences*. New York, NY: Worth.

Fraser, N., & Fraser, J. (2011). Lean Six Sigma applied to a customer service process with a commercial finance organization: An empirical case study. *International Journal of Business and Social Science, 2*(9), 24–36. Retrieved from http://ijbssnet.com/journals

Ganguly, K. (2012). Improvement process for rolling mill through the DMAIC Six Sigma approach. *International Journal for Quality Research, 6*, 221–231. Retrieved from http://www.ijqr.net

George, M. O. (2010). *The lean Six Sigma guide to doing more with less: Cut costs, reduce waste, and lower your overhead*. Hoboken, NJ: Wiley.

Gijo, E. V., & Scaria, J. (2014). Process improvement through Six Sigma with beta correction: A case study of manufacturing company. *International Journal of Advanced Manufacturing Technology, 71*(1), 717–730. http://dx.doi.org/10.1007/s00170-013-5483-y

Given, L. M. (Ed.). (2008). *The Sage encyclopedia of qualitative research methods*. Thousand Oaks, CA: Sage.

Goldstein, D. (2011). *The battle between your present and future self*. Presentation to the TED Salon. New York, NY. Retrieved from https://www.ted.com

Gorman, A., Donnell, L., Hepp, H., & Mack, T. (2011). Improving communication and documentation concerning preliminary and final radiology reports. *Journal for Healthcare Quality, 29*(2), 13–21. http://dx.doi.org/10.1111/j.1945-1474.2007.tb00179.x

Gowen, C. R., McFadden, K. L., & Settaluri, S. (2012). Contrasting continuous quality improvement, Six Sigma, and lean management for enhanced outcomes in US hospitals. *American Journal of Business, 27*(2), 133–153. http://dx.doi.org/10.1108/19355181211274442

Gupta, S., & Jain, S. K. (2013). A literature review of lean manufacturing. *International Journal of Management Science and Engineering Management, 8*(4), 241–249. http://dx.doi.org/10.1080/17509653.2013.825074

Gupta, V., Acharya, P., & Patwardhan, M. (2013). A strategic and operational approach to assess the lean performance in radial tyre manufacturing in India: A case based study. *International Journal of Productivity and Performance Management, 62*(6), 634–651. http://dx.doi.org/10.1108/IJPPM-Jun-2012-0057

Hall, D. C., & Saygin, C. (2012). Impact of information sharing on supply chain performance. *International Journal of Advanced Manufacturing Technology, 58*(1), 1–4. http://dx.doi.org/10.1007/s00170-011-3389-0

Hallencreutz, J., & Turner, D.-M. (2011). Exploring organizational change best practice: Are there any clear-cut models and definitions?. *International Journal of Quality and Service Sciences, 3*(1), 60–68. http://dx.doi.org/10.1108/17566691111115081

Hammer, M. (2002). Process management and the future of Six Sigma. *MIT Sloan Management Review, 43*(2), 26–32. Retrieved from http://sloanreview.mit.edu/

Harbola, A. (2010). Six Sigma a fad [Blog post]. Retrieved from http://ashutoshharbola13071985.blogspot.com/2010/08/six-sigma-fad-by-ashutosh-harbola.html

Harry, M. J., Mann, P. S., De Hodgins, O. C., Hulbert, R. L., & Lacke, C. J. (2011). *Practitioner's guide to statistics and Lean Six Sigma for process improvements*. Hoboken, NJ: Wiley.

Harry, M. J., & Schroeder, R. (2014). *Six Sigma: The breakthrough management strategy revolutionizing the world's top corporations*. Cork, Ireland: Primento Digital.

Hasenkamp, T. (2010). Engineering design for Six Sigma: A systematic approach. *Quality and Reliability Engineering International, 26*, 317–324. v

The history of Six Sigma. (n.d.). Retrieved from http://www.isixsigma.com/new-to-six-sigma/history/history-six-sigma/

Hugos, M. H. (2011). *Essentials of supply chain management*. Hoboken, NJ: Wiley.

Hung, W.-H., Ho, C.-F., Jou, J.–J., & Tai, Y.-M. (2011). Sharing information strategically in a supply chain: Antecedents, content and impact. *International Journal of Logistics Research and Applications, 14*(2), 111–133. http://dx.doi.org/10.1080/13675567.2011.572871

Hutchins, D. (1995). The history of managing for quality in the United Kingdom. In J. M. Juran (Ed.), *History of managing for quality: The evolution, trends, and future directions of managing for quality* (pp. 433–474). Milwaukee, WI: ASQC Quality Press.

Industry lists. (n.d.). Retrieved from http://www.isixsigma.com/industries/industry-lists/

Inozu, B. (2012). *Performance improvement for healthcare: Leading change with lean, Six sigma, and constraints management.* New York: McGraw-Hill

International Association for Six Sigma Certification. (n.d.). *Black Belt certification*. Retrieved from http//www.iassc.org/six-sigma-certification/black-belt-certification

Ismyrlis, V., & Moschidis, O. (2013). Six Sigma's critical success factors and toolbox. *International Journal of Lean Six Sigma*, *4*(2), 108–117. http://dx.doi.org/10.1108/20401461311319310

James, G. (2010, October 12). *The 8 stupidest management fads of all time. Money Watch*. Retrieved from http://www.cbsnews.com/news/the-8-stupidest-management-fads-of-all-time/

Jankowski, J. (2013). Successful implementation of Six Sigma to schedule student staffing for circulation service desks. *Journal of Access Services*, *10*(4), 197–216. http://dx.doi.org/10.1080/15367967.2013.830930

Jin, T., Janamanchi, B., & Feng, Q. (2011). Reliability deployment in distributed manufacturing chains via closed-loop Six Sigma methodology. *International*

Journal of Production Economics, 130 (1), 96–103. http://dx.doi.org/10.1016/ j.ijpe.2010.11.020

Jirasukprasert, P., Garza-Reyes, A. J., Kumar, V., & Lim, M. K. (2014). A Six Sigma and DMAIC application for the reduction of defects in a rubber gloves manufacturing process. *International Journal of Lean Six Sigma, 5*(1), 2–21. http://dx.doi.org/10.1108/IJLSS-03-2013-0020

Jit Singh, B., & Bakshi, Y. (2014). Optimizing backup power systems through Six Sigma. *International Journal of Lean Six Sigma, 5*(2),168–192. http://dx.doi.org/ 10.1108/IJLSS-09-2012-0008

Jonny, J. C. (2012). Improving the quality of asbestos roofing at PT BBI using Six Sigma methodology. *Procedia-Social and Behavioral Sciences, 65,* 306–312. http://dx.doi.org/10.1016/j.sbspro.2012.11.127

Kaltenbach, H.-M. (2012). *A concise guide to statistics*. New York, NY: Springer.

Kang, J., Kim, M., Hong, S., Jung, J., & Song, M. (2011). The application of the Six Sigma program for the quality management of the PACS. *American Journal of Roentgenology, 185,* 1361–1365. Retrieved from http://www.ajronline.org/

Kaushik, P., & Khanduja, D. (2010). Utilising Six Sigma for improving pass percentage of students: A technical institute case study. *Educational Research & Review, 5,* 471–483. Retrieved from http://www.academicjournals.org/ERR2

Kemmis, S., McTaggart, R., & Nixon, R. (2014). *The action research planner: Doing critical participatory action research*. New York, NY: Springer.

Kim, D.-S. (2010). Eliciting success factors of applying Six Sigma in an academic library: A case study. *Performance Management and Metrics, 11*(1), 25–38. http://dx.doi.org/10.1108/14678041011026847

Kim, Y., Kim, E. J., & Chung, M. G. (2010). A Six Sigma-based method to renovate information services: Focusing on information acquisition process. *Library Hi Tech, 28*(4), 632–647. http://dx.doi.org/10.1108/07378831011096286

Knight, J. E., Allen, S., & Tracy, D. L. (2010). Using Six Sigma methods to evaluate the reliability of a teaching assessment rubric. *Journal for American Academy of Research Cambridge, 15*(1), 1-6. Retrieved from EBSCOhost database.

Knowles, G., Whicker, L., Femant, J. H., & Del Campo Canales, F. (2005). A conceptual model for the application of Six Sigma methodologies to supply chain improvement. *International Journal of Logistics: Research and Applications, 8*(1), 51–65. http://dx.doi.org/10.1080/13675560500067459

Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (2000). *To err is human: Building a safer health system.* Washington, DC: Institute of Medicine, National Academies Press.

Köksal, G., Batmaz, I., & Testik, M. C. (2011). A review of data mining applications for quality improvement in manufacturing industry. *Expert Systems with Applications, 38*(10), 13448–13467. http://dx.doi.org/10.1016/j.eswa.2011.04.063

Kotter, J. P. (1998). *Harvard Business Review on change.* Boston, MA: Harvard Business School Press.

Kruskal, J. B., Reedy, A., Pascal, L., Rosen, M. P., & Boiselle, P. M. (2012). Quality initiatives: Lean approach to improving performance and efficiency in a radiology department. *Radiographics, 32*(2), 573–587. http://dx.doi.org/10.1148/rg.322115128

Kübler-Ross, E. (1969). *On death and dying.* New York, NY: Macmillan.

Kuo, A. M.-H., Borycki, E., Kushniruk, A., & Lee, T.-S. (2011). A healthcare Lean Six Sigma system for post anesthesia care unit workflow improvement. *Quality Management in Health Care, 20,* 4–14. http://dx.doi.org/10.1097/QMH.0b013e3182033791

Kwak, Y. H., & Anbari, F. T. (2012). History, practices, and future of earned value management (EVM) in government: Perspectives from NASA. *Project Management Journal, 43*(1), 77–90. http://dx.doi.org/10.1002/pmj.20272

Larson, V., & Carnell, M. (n.d.). *Developing Black Belt change agents.* Retrieved from http://www.isixsigma.com/implementation/change-management-implementation/developing-black-belt-change-agents/

Lee, J., & Peccei, R. (2011). Lean production and quality commitment: A comparative study of two Korean auto firms. *Personnel Review, 37,* 5–25. http://dx.doi.org/10.1108/00483480810839941

Levine, D. M., Gitlow, H. S., & Melnyck, R. (2015). *A guide to six sigma and process improvement for practitioners and students: Foundations, DMAIC, tools, cases, and certification.* Upper Saddle River, NJ: Financial Times/Prentice Hall

Lewis, C. I. (1929). *Mind and the world-order: Outline of a theory of knowledge*. New York, NY: Dover.

Lewis, M. A. (2011). Lean production and sustainable competitive advantage. *International Journal of Operations & Production Management, 20*(8), 959–978. http://dx.doi.org/10.1108/01443570010332971

Li, S., & Zhang, Y. (2014). Model complexity in carbon sequestration: A design of experiment and response surface uncertainty analysis. *International Journal of Greenhouse Gas Control, 22*, 123–138. http://dx.doi.org/10.1016/j.ijggc.2013.12.007

Liker, J. K., & Convis, G. L. (2011). *The Toyota way to lean leadership: Achieving and sustaining excellence through leadership development*. New York: McGraw-Hill.

Linderman, K., Schroeder, R. G., Zaheer, S., & Choo, A. S. (2003). Six Sigma: A goal-theoretic perspective. *Journal of Operations Management, 21*(2), 193–203. http://dx.doi.org/10.1016/S0272-6963(02)00087-6

Lindsey, T. C. (2011). Sustainable principles: Common values for achieving sustainability. *Journal of Cleaner Production, 19*(5), 561–565. http://dx.doi.org/10.1016/j.jclepro.2010.10.014

Liu, R., & Kumar, A. (2011). Leveraging information sharing to configure supply chains. *Information Systems Frontiers, 13*(1), 139–151. http://dx.doi.org/10.1007/s10796-009-9222-8

Lucian, C. E., Liviu, I., & Ioana, M. (2010). Six Sigma: A metric, a methodology and a management system. University of Oradea, 1(1), 651–656. Retrieved from https://ideas.repec.org/a/ora/journl/v1y2010i1p651-656.html

Lunau, S., & Staudter, C. (2013). *Design for Six Sigma & Lean tool set: Mindset for successful innovations*. New York, NY: Springer

Madlberger, M. (2011). What drives firms to engage in interorganizational information sharing in supply chain management? In N. Kock (Ed.), *E-collaboration technologies and organizational performance: Current and future trends* (pp. 101–124).http://dx.doi.org/10.4018/978-1-60960-466-0.ch007

Manuj, I., & Sahin, F. (2011). A model of supply chain and supply chain decision-making complexity. *International Journal of Physical Distribution and Logistics Management, 41*(1), 511–549. http://dx.doi.org/10.1108/09600031111138844

Martin, J. W. (2014). *Lean Six Sigma for supply chain management: A 10-step solution process*. New York, NY: McGraw-Hill.

Martínez-Jurado, P. J., Moyano-Fuentes, J. M., & Jerez-Gómez, P. J. (2014). Human resource management in Lean Production adoption and implementation processes: Success factors in the aeronautics industry. *BRQ Business Research Quarterly, 17*(1), 47–68. http://dx.doi.org/10.1016/j.cede.2013.06.004

Maskell, B. H., Baggaley, B., & Grasso, L. (2011). *Practical lean accounting: A proven system for measuring and managing the lean enterprise* (2nd ed.). New York, NY: CRC Press.

McClusky, R. (2000). Six Sigma special: The rise, fall and revival of Six Sigma. *Measuring Business Excellence, 4*(2), 6–17. Retrieved from EBSCOhost database.

McManus, K. (2008). So long Six Sigma? *Industrial Engineer, 40*(10), 18. Retrieved from EBSCOhost database.

Mehrabi, J. (2012). Application of Six-Sigma in educational quality management. *Procedia—Social and Behavioral Sciences, 47*(1), 1358–1362. http://dx.doi.org/10.1016/j.sbspro.2012.06.826

Mehrjerdi, Y. Z. (2011). Six Sigma: Methodology, tools and its future. Assembly Automation, *31*(1), 79–88. http://dx.doi.org/10.1108/01445151111104209

Meredith, J. R., & Mantel, S. J., Jr. (2010). *Project management: A managerial approach* (7th ed.). New York, NY: Wiley.

Miller, R. M. (2010, October 19). *The stupidest management fads of all time*. Retrieved from http://businessmanagementleaders.com/business/management-fads

Miltenburg, J. (2011). One-piece flow manufacturing on U-shaped production lines: A tutorial. *IIE Transactions, 33*(4), 303–321. http://dx.doi.org/10.1080/07408170108936831

Ministry of Finance, Malaysia. (2013). *Economic report, 2013–2014*. Retrieved from http://www.treasury.gov.my

Minitab 16. (2010). *2-sample t test* [White paper]. Retrieved from http://www.Minitab16.com/support/documentation/Answers/Assistant White Papers/2SampleT_MtbAsstMenuWhitePaper.pdf

Montgomery, D. C. (2012). A modern framework for achieving enterprise excellence. *International Journal of Lean Six Sigma, 1*(1), 56–65. http://dx.doi.org/10.1108/20401461011033167

Mullavey, F. (2006, September). Shackled by bad Six Sigma? Q*uality Digest,* Art. No. 3. Retrieved from http://www.qualitydigest.com/sept05/articles/03_article.shtml

Myers, J. L., Well, A. D., & Lorch, J. R. F. (2013). *Research design and statistical analysis* (3rd ed.). Hoboken, NJ: Taylor and Francis.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5,* 14–37. http://dx.doi.org/10.1287/orsc.5.1.14

Nonaka, I. (1995). The recent history of managing for quality in Japan. In J. M. Juran (Ed.), *History of managing for quality: The evolution, trends, and future directions of managing for quality* (pp. 517–552). Milwaukee, WI: ASQC Quality Press.

Nooramin, A. S., Ahouei, V. R., & Sayareh, J. (2011). A Six Sigma framework for marine container terminals. *International Journal of Lean Six Sigma, 2*(3), 241–253. http://dx.doi.org/10.1108/20401461111157196

Ohno, T. (1988). *Toyota production system: Beyond large-scale production*. Cambridge, MA: CRC Press.

Pacheco, D. A. J., Lacerda, D. P., Neto, S. L. H. C., Jung, F., & Antunes, J. A. V., Jr. (2014). Balancing or flow balancing capacity? Systemic analysis and propositions. *Management & Production, 21*(2), 355–368. http://dx.doi.org/10.1590/S0104-530X2014005000006

Pacheco, D. A. J., Pergher, I., Vaccaro, G. L. R., Jung, C. F., & ten Caten, C. (2015). 18 comparative aspects between lean and Six Sigma: Complementarity and implications. *International Journal of Lean Six Sigma, 6*(2), 161–175. http://dx.doi.org/10.1108/IJLSS-05-2014-0012

Paladino, B. (2011). *Innovative corporate performance management: Five key principles to accelerate results*. Hoboken, NJ: Wiley.

Pamfilie, R., Petcu, A. J., & Draghici, M. (2012). The importance of leadership in driving a strategic Lean Six Sigma management. *Procedia—Social and Behavioral Sciences, 58*(1), 187–196. http://dx.doi.org/10.1016/j.sbspro.2012.09.992

Pande, P. S., Neuman, R. P., & Cavanagh, R. R. (2014). *The Six Sigma way: How GE, Motorola, and other top companies are honing their performance* (2nd ed.). New York, NY: McGraw-Hill.

Parast, M. M. (2011). The effect of Six Sigma projects on innovation and firm performance. *International Journal of Project Management, 29*(1), 45–55. http://dx.doi.org/10.1016/j.ijproman.2010.01.006

Paton, S. (2004, February). Tick tock . . . time to transition to ISO 9001:2000 is running out. *Quality Digest*. Retrieved from http://www.qualitydigest.com/feb03/departments/first_word.shtml

Pepper, M. P. J., & Spedding, T. A. (2010). The evolution of lean Six Sigma. *International Journal of Quality & Reliability Management, 27*(1), 138–155. http://dx.doi.org/10.1108/02656711011014276

Peteros, R. G., & Maleyeff, J. (2013). Application of behavioral finance concepts to investment decision-making: Suggestions for improving investment education courses. *International Journal of Management, 30,* 249–261. Retrieved from http://www.theijm.com

Peteros, R. G., & Maleyeff, J. (2015). Using Lean Six Sigma to improve investment behavior. *International Journal of Lean Six Sigma, 6*(1), 59–72. http://dx.doi.org/10.1108/IJLSS-03-2014-0007

Pettersson, A. I., & Segerstedt, A. (2013). Measuring supply chain cost. *International Journal of Production Economics, 143*(2), 357–363. http://dx.doi.org/10.1016/j.ijpe.2012.03.012

Pinto, A., & Brunese, L. (2011). Spectrum of diagnostic errors in radiology. *World Journal of Radiology, 2*(10), 377–383. http://dx.doi.org/10.4329/wjr.v2.i10.377

Pinto, L. & Tenera A. (2013). *The DMAIC cycle applied to project management.* IRF'03-Integrity, Reliability and Failure International Conference, Paper 4745, Madeira, Portugal.

Prasad, K. D. G., Subbaiah, K. V., & Padmavathi, G. (2012). Application of Six Sigma methodology in an engineering educational institution. *International Journal of Emerging Sciences, 2,* 222–237. Retrieved from http://ijes.info/

Prashar, A. (2014). Process improvement in farm equipment sector (FES): A case on Six Sigma adoption. *International Journal of Lean Six Sigma, 5*(1), 62–88. http://dx.doi.org/10.1108/IJLSS-08-2013-0049

Project Management Institute. (2014). *Implementing organizational project management*. Newtown Square, PA: Author.

Pryor, M. G., Alexander, C., Taneja, S., Tirumalasetty, S., & Chadalavada, D. (2015). The application of Six Sigma methodologies to university processes: The use of student teams. *Journal of Case Studies in Accreditation and Assessment, 2*, 1–14. Retrieved from http://www.aabri.com/jcsaa.html

Pyzdek, T., & Keller, P. A. (2014). *The Six Sigma handbook* (4th ed.). New York, NY: McGraw-Hill.

Qu, L., Ma, M., & Zhang, G. (2011). *Waste analysis of Lean service*. 2011 International Conference on Management and Service Science (MASS 2011), pp. 1–4, Wuhan, China.

Rahman, N. A. A., Sharif, S. M., & Esa, M. M. (January 01, 2013). Lean manufacturing case study with Kanban system implementation. *Procedia—Economics and Finance, 7*(1), 174–180. http://dx.doi.org/10.1016/S2212-5671(13)00232-3

Raisinghani, M. S., Ette, H., Pierce, R., Cannon, G., Daripaly, P. (2005). Six Sigma: Concepts, tools and applications. *Industrial Management & Data Systems, 105*(4), 491–505. http://dx.doi.org/10.1108/02635570510592389

Ramanan Lakshminarayanan, R. K. M. (2014). Six Sigma methodology for addressing employability issue of engineering graduates. *International Journal of Modern Education Forum, 3*(1), 59–66. http://dx.doi.org/10.14355/ijmef.2014.0302.04

Ramasubramanian, P. (2012). Six Sigma in educational institutions. *International Journal of Engineering and Practical Research, 1*(1), 1–5. Retrieved from http://www.seipub.org/ijepr

Ranjan, G., & Vora, T. (2014). *Implementing Lean Six Sigma in 30 Days: Implement the world's most powerful improvement methodology in 30 days*. Birmingham, England: Impackt Publishing.

Rattan, P., & Lal, P. (2012). Pros and cons of Six Sigma: A library perspective. *International Journal of Digital Library Services, 2*(4), 24–33. Retrieved from http://www.ijodls.in

Razaki, K. A., & Aydin, S. (2011). The feasibility of using business process improvement approaches to improve an academic department. *Journal of Higher Education Theory and Practice, 11*(2), 19–32. Retrieved from http://www.na-businesspress.com/jhetpopen.html

Reed, R., Lemak, D. J., & Montgomery, J. C.(1996). Beyond process: TQM content and firm performance. *Academy of Management Review, 21,* 173–202. http://dx.doi.org/10.5465/AMR.1996.9602161569

Rehman, A. U. (2012). Safety management in a manufacturing company: Six Sigma approach. *Engineering, 4,* 400–407. http://dx.doi.org/10.4236/eng.2012.47053

Reosekar, R. S., & Pohekar S. D. (2013). Design and development of Six Sigma implementation framework for Indian industries. *International Journal of Engineering, Business and Enterprise Applications, 5,* 147–152. Retrieved from http://www.iasir.net

Rever, H. (2010). *Six Sigma can help project managers improve results.* Retrieved from http://download.microsoft.com/download/2/C/6/2C6233FE-D463-437C-A4E2-6B71972B4AB6/Six Sigma and Project Management.pdf

Revere, L., & Black, K. (2011). Integrating Six Sigma with total quality management: A case example for measuring medication errors. *Journal of Healthcare Management, 48,* 377–390. Retrieved from https://ache.org/pubs/jhm/jhm_index.cfm

Roberts, C. M. (2004). Six Sigma signals. *Credit Union Magazine, 70*(1), 40–43. Retrieved from http://news.cuna.org/

Sanders, J. H., & Karr, T. (2015). Improving ED specimen TAT using Lean Six Sigma. *International Journal of Health Care Quality Assurance, 28*(5), 428–440. http://dx.doi.org/10.1108/IJHCQA-10-2013-0117

Sarkar, S.A., & Mukhopadhyay, A.R., & Ghosh, S.K. (2013). Root cause analysis, LeanSix Sigma and test of hypothesis. *The TQM Journal, 25*(2), 170–185. http://dx.doi.org/10.1108/17542731311299609

Sasikala, S., & Stephen, V.G. (2010). Infrastructure and learning resources in higher education institutions (HEIS) using Six Sigma quality strategy. *Library Progress International, 30,* 97–109. Retrieved from http://www.indianjournals.com/ijor.aspx

Schön, K., Bergquist, B., & Klefsj, B. (2010). The consequences of Six Sigma on job satisfaction: a study at three companies in Sweden. *International Journal of Lean Six Sigma, 1*(2), 99–118. http://dx.doi.org/10.1108/20401461011049494

Schroeder, R. G., Linderman, K., Liedtke, C., & Choo, A. S. (2008). Six Sigma: Definition and underlying theory. *Journal of Operations Management, 26*(1), 536–554. http://dx.doi.org/10.1016/j.jom.2007.06.007

Sehwail, L., & DeYong, C. (2011). Six Sigma in health care. *International Journal of Health Care Quality Assurance Incorporating Leadership in Health Services, 16*(4), 1–5. http://dx.doi.org/10.1108/13660750310500030

Selden, G. C. (2012). *The psychology of the stock market*. New York, NY: Ticker. (Original work published 1912)

Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization*. New York, NY: Doubleday/Currency.

Singer, E., & Ye, C. (2013). The Use and Effects of Incentives in Surveys. *Annals of the American Academy of Political and Social Science*, *645*, 112–141. http://dx.doi.org/10.1177/0002716212458082

Snee, R. D. (2010). Lean Six Sigma—Getting better all the time. *International Journal of Lean Six Sigma, 1*(1), 9–29. http://dx.doi.org/10.1108/20401461011033130

Sparrow, P., & Otaye-Ebede, L. (2014). Lean management and HR function capability: the role of HR architecture and the location of intellectual capital. *International Journal of Human Resource Management, 25*(21), 2892–2910. http://dx.doi.org/10.1080/09585192.2014.953975

Sperl, T., Ptacek, R., & Trewn, J. (2013). *Practical Lean Six Sigma for healthcare: Using the A3 and lean thinking to improve operational performance in hospitals, clinics and physician group practices*. Chelsea, MI: MCS Media.

Starbird, D., & Cavanagh, R. R. (2011). *Building engaged team performance: Align your processes and people to achieve game-changing business results*. Chicago, IL: McGraw-Hill.

Suresh, N. (2011). *Application of Six Sigma concept to effective academic library management and users satisfaction*. National Conference on Future Academic Libraries Challenges and Opportunities 2011, Tamil Nadu, India.

Taghizadegan, S. (2014). *Mastering Lean Six Sigma: Advanced Black Belt concepts*. New York: Momentum Press.

Taner, M. T., Sezen, B., & Antony, J. (2011). An overview of Six Sigma applications in healthcare industry. *International Journal of Health Care Quality Assurance, 20*(4), 329–340. http://dx.doi.org/10.1108/09526860710754398

Teichgräber, U. K., & du Bucourt, M. (2012). Applying value stream mapping techniques to eliminate non-value-added waste for the procurement of endovascular stents. *European Journal of Radiology, 18*(1), e47–e52. 10.1016/j.ejrad.2010.12.045

Tetteh, E. G., & Uzochukwu, B. M. (2015). *Lean Six Sigma approaches in manufacturing, services, and production*. Hershey, PA: Business Science Reference.

Tjahjono, B., Ball, P., Vitanov, V. I., Scorzafave, C., Nogueira, J., Calleja, J., Minguet, M., . . . Yadav, A. (2010). Six Sigma: A literature review. *International Journal of Lean Six Sigma, 1*(3), 216–233. http://dx.doi.org/10.1108/20401461011075017

Ulrich, K. T., Eppinger, S. D., & Goyal, A. (2011). *Product design and development* (Vol. 2). New York, NY: McGraw-Hill/Irwin.

Watson, G. H., & DeYong, C. F. (2010). Design for Six Sigma: Caveat emptor. *International Journal of Lean Six Sigma, 1*(1), 66–84. http://dx.doi.org/10.1108/20401461011033176

Witcher, B. J., & Butterworth, R. (2012). Hoshin Kanri: Policy management in Japanese-owned UK subsidiaries. *Journal of Management Studies, 38*(5), 651–674. http://dx.doi.org/10.1111/1467-6486.00253

Witten, I. H., Frank, E., & Hall, M. A. (2011). *Data mining: Practical machine learning tools and techniques* (3rd ed.). Burlington, MA: Elsevier/Morgan Kaufmann.

Yang, K. (2011). *Cram101: Design for Six Sigma: A roadmap for product development* [Study guide]. LaVergne, TN: Content Technologies.

Yi, T. P., Feng, C. J., Prakash, J., & Ping, L. W. (2012). Reducing electronic component losses in lean electronics assembly with Six Sigma approach? *International Journal of Lean Six Sigma, 3*(3), 206–230. http://dx.doi.org/10.1108/20401461211282718

Zaman, M., Pattanayak, S. K., & Paul, A. C. (2013). Study of feasibility of Six Sigma implementation in a manufacturing industry: A case study. *International Journal of Mechanical and Industrial Engineering, 3*, 96–100. Retrieved from http://www.interscience.in/ijmie.html

Zaheer, R. (2013). Analyzing the performance of agriculture sector in Pakistan. *International Journal of Humanities and Social Science Invention, 2*(5), 1–10. Retrieved from http://www.ijhssi.org/

Zhang, Q., Vonderembse, M. A., & Lim, J. S. (2011). Manufacturing flexibility: Defining and analyzing relationships among competence, capability, and customer satisfaction. *Journal of Operations Management, 21*(2), 173–191. http://dx.doi.org/10.1016/S0272-6963(02)00067-0

Zhang, W., Hill, A. V., & Gilbreath, G. H. (2011). A research agenda for Six Sigma research. *Quality Management Journal, 18*(1), 39–53. Retrieved from http://asq.org/pub/qmj/

Zhu, W., Gavirneni, S., & Kapusciniski, R. (2010). Periodic flexibility, information sharing, and supply chain performance. *IIE Transactions, 42*(3), 173–187. http://dx.doi.org/10.1080/07408170903394314

Appendix A: Sample Survey Request E-mail

From: Richard J. Sands <richard.sands@waldenu.edu>

Subject: Invitation to participate in Doctoral Student Research (Student is in the PhD program at Walden University)

CONSENT FORM

You are invited to take part in a research study.

Please read all of the following information. If you would like to participate, the link to the survey is at the bottom of this e-mail.

This study is being conducted by a researcher, Richard J. Sands, a doctoral student pursuing a PhD in management at Walden University.

Background Information

The purpose of the study is to examine why Six Sigma projects fail.

Inclusion Criteria

You have been chosen because you are either a Six Sigma Black Belt or you have participated on a Six Sigma DMAIC (define, measure, analyze, improve, and control) project(s).

Procedures

If you agree to be in this study, you will be asked to complete a short, confidential questionnaire (18 questions ranked on a scale 1 to 5), administered through SurveyMonkey.com.

Sample Questions

- Was your Six Sigma DMAIC* project supported by management?
- Was your Six Sigma DMAIC* project financially based?
- Was your Six Sigma DMAIC* project solution implemented?
- Was your Six Sigma DMAIC* project supported with good baseline data?
- Was your Six Sigma DMAIC* project scope too large for the DMAIC format?
- Was your Six Sigma DMAIC* project too small for the DMAIC format?

* DMAIC = define, measure, analyze, improve, and control

Voluntary Nature of the Study

This study is voluntary. Everyone will respect your decision of whether or not you choose to be in the study. If you decide to join the study now, you can still change your mind during or after the study and may stop at any time.

Risks and Benefits of Being in the Study

Being in this study will not pose risk to your safety or well-being. It is hoped that the results of this study will benefit the outcomes of future Six Sigma DMAIC projects.

Payment

No compensation/incentives will be given for participation in this study.

Privacy

Any information you provide will be kept anonymous. Data will be kept secure by keeping it on a password-protected Dropbox.com drive. Data will be kept for a period of at least 5 years, as required by the university.

Contacts and Questions

You may ask any questions you have now, and, or if you have questions later, you may contact the researcher via my e-mail, Richard.sands@waldenu.edu. If you want to talk privately about your rights as a participant, you can call Dr. Leilani Endicott, a Walden University representative, who can discuss this with you. Her phone number is 1-800-925-3368, extension 3121210. Walden University's approval number for this study is **10-09-13-0157029**, and it expires on **October 8, 2014.**

Please print or save this consent form for your records.

Statement of Consent

I have read the above information, and I feel I understand the study well enough to make a decision about my involvement. By clicking on the link below, I understand that I am agreeing to the terms described above.

Take the Survey

Click the URL link below or copy and paste it into your Internet browser:

https://...

Appendix B: Survey Questions

1 = Strongly disagree, 2 =Disagree, 3 = Neither agree nor disagree, 4 = Agree,

5 = Strongly agree

#	Question	Scale
1.	Was your Six Sigma DMAIC* project supported by management?	1 2 3 4 5
2.	Was your Six Sigma DMAIC* project financially based?	1 2 3 4 5
3.	Was your Six Sigma DMAIC* project solution implemented?	1 2 3 4 5
4.	Was your Six Sigma DMAIC* project supported with good baseline data?	1 2 3 4 5
5.	Was your Six Sigma DMAIC* project scope too large for the DMAIC format?	1 2 3 4 5
6.	Was your Six Sigma DMAIC* project too small for the DMAIC format?	1 2 3 4 5
7.	Are you properly trained in the Six Sigma DMAIC* process?	1 2 3 4 5
8.	Was your organization ready for a Six Sigma DMAIC* project?	1 2 3 4 5
9.	Was your Six Sigma DMAIC* project properly resourced?	1 2 3 4 5
10.	Was there enough time allotted to complete your Six Sigma DMAIC* project?	1 2 3 4 5
11.	Was your Six Sigma DMAIC* project properly selected?	1 2 3 4 5
12.	Did management in your Six Sigma DMAIC* project hierarchy understand Six Sigma?	1 2 3 4 5
13.	Was your Six Sigma DMAIC* project too complex to solve?	1 2 3 4 5
14.	Did your Six Sigma DMAIC* project Champion understand the statistics behind your Six Sigma project?	1 2 3 4 5
15.	Was your Six Sigma DMAIC* project negatively affected by company politics?	1 2 3 4 5
16.	Was your organization affected when your Six Sigma DMAIC* project failed?	1 2 3 4 5
17	Did your Six Sigma DMAIC* project fail because of Six Sigma methodology?	1 2 3 4 5
18	Did your Six Sigma DMAIC* project fail for reason(s) other than Six Sigma methodology?	1 2 3 4 5

* DMAIC = define, measure, analyze, improve, and control.

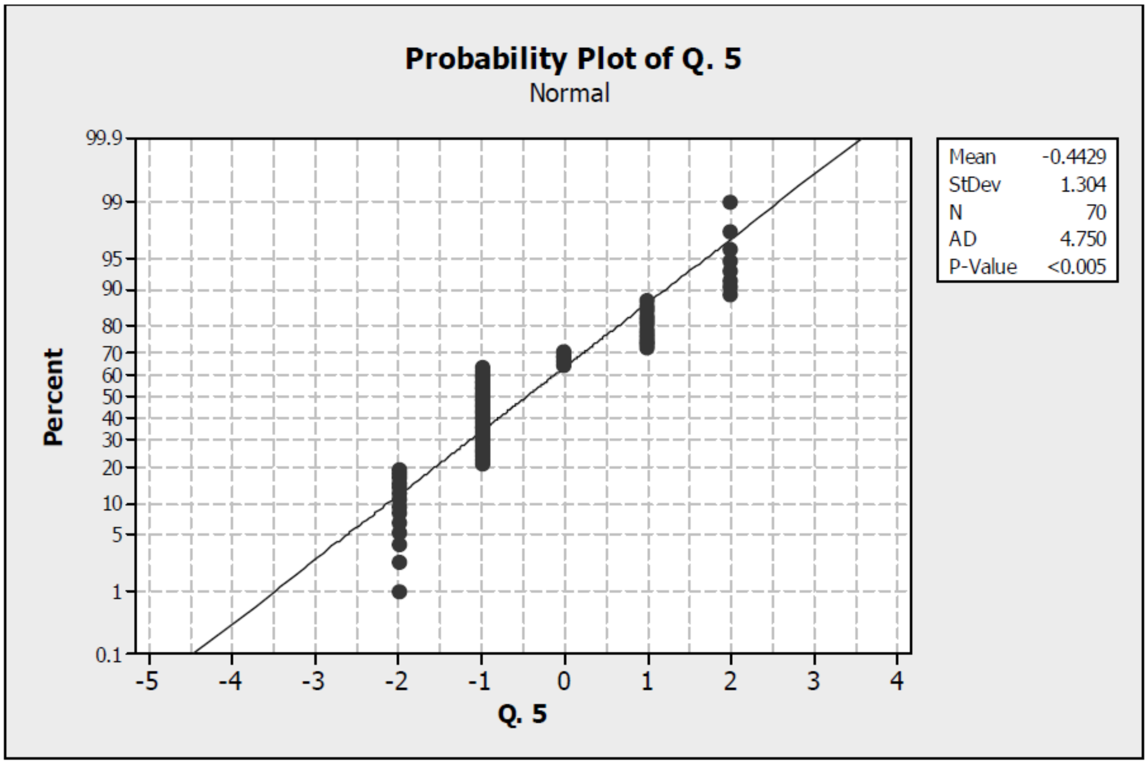
Appendix C: Table 4 Data Used in Mean Calculations

Survey question	Does not support project success	Supports project success	H_0: Does not fail	H_A: Fails
1. Was your Six Sigma DMAIC* project supported by management?	8	54	1	0
2. Was your Six Sigma DMAIC* project financially based?	19	44	1	0
3. Was your Six Sigma DMAIC* project solution implemented?	23	36	1	0
4. Was your Six Sigma DMAIC* project supported with good baseline data?	15	48	1	0
5. Was your Six Sigma DMAIC* project scope too large?	20	45	1	0
6. Was your Six Sigma DMAIC* project too small for the DMAIC format?	4	58	1	0
7. Are you properly trained in the Six Sigma DMAIC* process?	4	64	1	0
8. Was your organization ready for a Six Sigma DMAIC* project?	18	41	1	0
9. Was your Six Sigma DMAIC* project properly resourced?	24	40	1	0
10. Was there enough time allotted to complete your Six Sigma DMAIC* project?	18	47	1	0
11. Was your Six Sigma DMAIC* project properly selected?	20	41	1	0
12. Did management in your SIX Sigma DMAIC* project hierarchy understand Six Sigma?	20	39	1	0
13. Was your Six Sigma DMAIC* project too complex to solve?	10	50	1	0
14. Did your Six Sigma DMAIC* project champion understand the statistics behind your Six Sigma project?	19	40	1	0
15. Was your Six Sigma DMAIC* project negatively impacted by company politics?	24	34	1	0
16. Was your organization affected when your Six Sigma DMAIC* project failed?	21	29	1	0
17. Did your Six Sigma DMAIC* project fail because of Six Sigma methodology?	3	58	1	0

Survey question	Does not support project success	Supports project success	H_0: Does not fail	H_A: Fails
18. Did your Six Sigma DMAIC* project fail for reason(s) other than Six Sigma method?	7	52	1	0
Mean	15.39	45.56		
SD	7.31	9.20		

* DMAIC = define, measure, analyze, improve, and control.

Appendix D: Question 5 Probability Plot



Appendix E: Question 6 Probability Plot