2020

Determining Six Sigma Critical Failure Factors

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This is to certify that the doctoral dissertation by

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2020

Abstract

Determining Six Sigma Critical Failure Factors

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MSc, Management Philosophy, 2019

MSc, Quality Assurance, 2010

BSc, Medical Engineering, 2004

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Management - Engineering Management

Walden University

January 2020

Abstract

In the current economy, many companies use the Six Sigma concept in enhancing performances by reducing process and product variations in the manufacturing and service sectors. Unacceptable process and product variations have led to high costs of production and less customer satisfaction. After examining the related literature, a quantitative research study was conducted to determine if Six Sigma implementation failures are dependent on the critical effective factors (CEF) and whether the failures are predictable. Six Sigma methodology requires a robust implementation specifically designed to achieve the best project objectives. The identified independent variables (organizational management and statistical tools application) and dependent variable (implementation failure) addressed the research questions, which were related to whether the lack of organizational management and statistical tools application could affect Six Sigma implementation failures. A quantitative survey with a sample size of 115 Six Sigma practitioners in the United States was conducted. The obtained data from the survey were analyzed using descriptive statistics and multiple linear regression. The results indicated a relationship between the CEF and Six Sigma implementation failure. However, predicting the causes of Six Sigma implementation failure remains inconclusive. A more rigorous study design with statistically proven data is recommended to enable conclusive arguments in the future. The study advances the need for quality management tools, which will lead to an increased return on investments. Successfully implementing Six Sigma improves human development, creates a stable socioeconomic and cultural environment that leads to positive social change.

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Dedication

I want to dedicate this dissertation to my two beautiful daughters, Arielle and Arlyn, and my Lovely wife, Cynthia. I also want to dedicate it to my mother, who poured all she had on her children with much resiliency and sacrifice.

Acknowledgments

I want to acknowledge all my dissertation committee members (Dr. Craig Barton, Dr. Godwin Igein) who tremendously helped through this Journey. Special thanks to my committee chair, Bryan L. Forsyth. Dr. B, thank you for all your advice, timely revisions, and positive suggestions throughout the dissertation process.

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Chapter 1: Introduction to the Study

In the global pace of business competition, many companies use the Six Sigma concept as a continuous improvement methodology in enhancing organizational performances and reducing process variations that exist in many manufacturing and service sectors. The Six Sigma method involves designing, planning, and implementation of projects with the use of techniques, which specifically aim at achieving the desired results that benefit organizations (Rajkumar, 2014). The different methods of implementation pose some problems for companies. Therefore, Six Sigma practitioners must understand the critical success factors (CSF) and the critical failure factors (CFF) of implementation. Most of the literature focuses on the holistic shortcomings of Six Sigma but not the CFF of implementation and the rationale for predicting such outcomes.

The quantitative study was used to determine the CFF of Six Sigma implementation in the manufacturing and service industries. Identifying such factors would enable the successful implementations that lead to efficient results of Six Sigma deployments. Continuous improvements of products through successful Six Sigma deployments would reduce variations and defects while increasing the quality of goods and services. Such opportunities for improvement lead to increased revenue and improved economic advantages for employees, thus, triggering a positive social change in the work culture and services provided by the organization (Spilka, Sakaluk, & Kania, 2012). In Chapter 1, I addressed the need to conduct the research study and the approach in determining the CFF of Six Sigma. This included a background understanding of Six Sigma, the identified literature gap, purpose, and the study significance.

Background of the Study

The wake of globalization enhanced the idea of necessitating the adaptation of different management techniques that met the fast changes and challenges in the business world (Singh, 2014). One of the factors, which created a difference in every competitive environment, is the management factor. That means companies, which provided the right technical equipment, with the right customer relations to a sustainable market, could succeed if the top management supports quality improvement programs like the Six Sigma methodology. Thus, adopting the total quality management method was a common strategy that most companies incorporate in challenging market conditions. Producing quality goods and services provided not just a guarantee for investment, but a better brand for the image and prestige of the company. Total quality management (TQM) drove the restructuring of most business structures and functions, making companies realize that quality was not only the means of profit but also a vital tool of attraction. Boosting quality increases customer satisfaction (Saud & Faihan, 2014).

Many quality frameworks and models used in the past five decades to improve quality performances faded away after a short period (Aboelmaged, 2010). Many organizations implemented process models or frameworks such as TQM, Kaizen, Balanced scorecards, and other improvement programs (Antony, 2007). The constructs of the frameworks advocated the idea of quality as being the responsibility of everyone in an organization (Aboelmaged, 2010). These models or frameworks all focus on process improvements, cultural change in organizations, training and education, customer satisfaction, and teamwork (Antony, 2007).

Despite all these success counts on quality improvement methods, researchers discovered that most organizations indicated mixed results on process implementation (Cheng, 2008). For example, many companies such as Volkswagon and Ford claimed that TQM produces excellent results in improving quality and performance, while others like Walmart did not believe the implementation of TQM was successful. Hammer and Champy (2006) claimed that many organizations never achieved the predicted benefits of these programs. Furthermore, records of a survey that includes 80 Fortune 500 companies show that only a quarter of the executives were happy with TQM results but had no replacement for TQM (Dahlgaard, & Dahlgaard-Park, 2006).

Six Sigma is another model that aims at achieving quality improvements and business performance. Motorola and General Electric (GE) popularized the Six Sigma model in the 80s (Douglas, 2006). Harry Mikel (1998) defined Six Sigma in terms of improving the business returns on investments through the redesigning and monitoring of processes that eliminate waste. Pande and Holpp (2002) called Six Sigma a business approach seeking to eliminate variations and focused on the best customer service. The Six Sigma methodology produces a quality advantage of 3.4 defects per million opportunities (DPMO) to processes, products, and services. The Six Sigma approach combines both initiatives of quality improvement and techniques for solving problems with the use of statistical tools.

The hallmark of every Six Sigma project is characterized by define measure, analyze, improve, and control (DMAIC) stages. These stages, if efficiently deployed, benefited the entire organization. In a short period, Motorola claimed a fantastic growth of about a 20% annual increase with cumulative savings of about 30 billion dollars (Douglas, 2006). Many companies have implemented Six Sigma, making it become one of the most successful process improvement methodologies available to businesses. In general, the Six Sigma methodology improves processes and leads to a reduction in product defects and variations and contributes to improving the manufacturing process capability (Dahlgaard & Dahlgaard-Park, 2006). Successful implementation of Six Sigma increases profits and financial gains for the company.

Furthermore, Six Sigma increases customer satisfaction through the production of high-quality products. As employees gain new knowledge and capabilities, business processes become more organized. Consequently, problem-solving and decision-making processes become more efficient (Angel & Pritchard, 2008). The deployment of Six Sigma depends on the practical implementation and understanding of the process (Chiarini, 2011b). The implementation and application require qualified individuals such as Six Sigma black belts to champion Six Sigma projects (Kwak & Anbari, 2006). However, less mentioned are the obstacles faced during its implementations and other common roadblock solutions needed to improve on the methodology. One of the challenges or gaps existing is realizing the lack of management commitment. A company’s commitment to Six Sigma depends more on its management (Gillett, Fink, & Bevington, 2010). The decision to choose which employees should participate in a project should be based on availability and competence because it determines the success of the Six Sigma deployment process (Hahn, Doganaksoy, & Standard, 2001).

In order for any organization to successfully implement the Six Sigma concept, statistical data analysis must be adequately understood. Six Sigma methodology provides a platform that is often used in coordinating and aligning processes that lead to innovation and better product quality. Better quality requires organizational management that strives to meet business challenges (Smyrlis & Moschidis, 2015). Most often, management systems fail to meet specific business objectives, and this leads to inefficient control or deployment of Six Sigma. Understanding the need for efficient management and organizational structure is vital for the smooth running of the program. It is essential to understand the factors responsible for the failure of six sigma implementation before implementing this concept of management. Thus, because the tools of quality improvement are prime ingredients of TQM, some quality improvement practitioners believed that a combination of the Six Sigma program and TQM could boost the process and quality improvement framework. These debates lead to inconsistent results, which vary between companies and pose doubts that lead to questions on the CFF of Six Sigma implementation. The effects of CFF of Six Sigma from an organizational and management standpoint was investigated. Such an investigation was necessary to provide a better understanding of how the CFF could be implemented to avoid defects and increase revenue to Six Sigma user organizations.

Problem Statement

At the rate of today's competitive market, many companies have sought strategies like ISO 9000, TQM, and Six Sigma implementation to improve the processes and quality of their products. Because of the complexities involved in the Six Sigma process, a better-organized organization, organizational management, and extensive understanding of the application tools are support initiatives needed for successful implementation (Rajkumar, 2014). In the past three decades, companies like Motorola and General electric implemented Six Sigma in anticipation of reducing the number of manufacturing defects and substantially controlling the costs of production and services. These companies have experienced increases in profits due to the reduction of product defects and variations in their business processes (Wojtaszak & Baily, 2015). For example, General Electric increased its revenue savings on communication satellites to $1.3 million per year since Six Sigma implementation and Texas Instruments saved over $60 million per year (Mihir & Darshak, 2018).

Despite such success stories, many companies are still experiencing failures in implementing the Six Sigma methodology. In the last decade, many Six Sigma implementation programs failed, but researchers have not adequately exploited the reasons for these failures. The general problem was the ineffective implementation of Six Sigma, which occur through poor leadership and management, inadequate resources, reduced statistical tools application, and reluctance in focusing on the critical factors that affect its implementation (Parsana & Desai, 2016). These problems lead to inefficiencies in production, less cost reduction, less quality, and loss of potential customers. The specific problem is the need for further evaluation of the critical factors, such as organizational management, statistical application tools, and a rationale for predicting failures of Six Sigma implementation. Addressing these issues builds on previous research that suggests a closer look at such critical factors (Krotov & Mathrani, 2017).

The reduction of defects and an increase in the quality of goods and services leads to organizational benefits. Such opportunities for improvement enhance economic advantages for employees and society, hence, creating positive social change in the work culture and the environment.

Purpose of the Study

The purpose of this quantitative study was to determine and develop knowledge of the critical factors that lead to Six Sigma implementation failures. Empirical evidence of both CSF and CFF during implementation was used to illustrate the critical aspects of Six Sigma implementation. The research constituted a survey, which further examined the relationship between failed Six Sigma implementation projects and critical factors that cause these failures. Two independent variables and a dependent variable (Failure variable) were considered. The IVs are Six Sigma organizational structure and statistical tools application. The DV is Six Sigma implementation failures. One of the goals was directed towards providing a correlation between the IVs and Six Sigma implementation failures (DV). Descriptive statistical techniques and multiple linear regression we conducted for data analysis and providing answers to the research questions.

Research Question(s) and Hypotheses

The framework focused on understanding the various reasons behind the failures of Six Sigma implementation. Testing the framework involved a proposed research hypothesis on the relationship between failures of Six Sigma implementation and Six Sigma statistical tools application and organizational management. Three variables considered are two independent variables (Critical Effective Factors) and a DV (Six Sigma implementation failures)

- Independent Variable A: Six Sigma organizational management. These are the roles and responsibilities involved in supporting Six Sigma implementation. A 5-point Likert scale was used to measure variables. The variable was used to assess a correlation between Six Sigma organizational management and Six Sigma implementation failures.
- Independent Variable B: Six Sigma statistical tools. These are problem-solving statistical tools used to support process and operation improvement techniques of Six Sigma. A 5-point Likert scale was used to measure variables. The variable was used to assess a correlation between Six Sigma statistical tools and Six Sigma implementation failures.
- Dependent Variable: Six Sigma implementation failure. A Six Sigma implementation in which an insufficient return on investment (ROI) as primarily identified and approved is achieved (Albliwi, Antony, Abdul Halim Lim, & van der Wiele, 2014). The DV is the variable for investigation, which is measured based on the certainty of the answers provided for question 16

The hypothesis depends on this variable to ascertain the laid down conditions.

The research questions and hypothesis are as follows:

Research Question 1: Does the lack of organizational management affect Six Sigma implementation failure?

$H_0 1$: Six Sigma implementation does not fail because of organizational management.

$H_1 1$: Six Sigma implementation fail because of organizational management

Research Question 2: Does the lack of Six Sigma statistical tools application affect Six Sigma implementation failures?

$H_0 2$ = Six Sigma statistical tools application are not the drivers of Six Sigma implementation failures.

$H_1 2$ = Six Sigma statistical tools application are the drivers of Six Sigma implementation failures.

Use a 5-point Likert scale was used to measure the variables of the survey. These questions focused on understanding the various reasons behind the failures of Six Sigma implementation.

Theoretical Foundation

Quality Management (QM) is a management science discipline aimed at defining, setting controlling, and improving organizational activities within its constraints (Kamran & Ali, 2010). There has been a shift in paradigm in which the core concept expanded to measurement, control, and improvement of processes in many companies within the last sixty years (Kettinger, Teng, & Guha, 1997). The QM approach to organizational management is comprehensive and structured to improve the quality of products and services through continuous process improvements. The Six Sigma approach represents one of the QM-focused processes that ensures the removal of various defects and variations to enhance customer satisfaction. Using some QM concepts, companies like

Motorola evolved and introduced the Six Sigma theory in 1981 as part of the continuous improvement framework (Eckes, 2001).

The previous quality improvement methods were based on standard organizational structure and management principles. The bases of Six Sigma implementation theoretical framework rely on the innovative aspects of management, application of statistical and scientific methods in effecting dramatic changes on product and service performances geared towards improving customer satisfaction, reducing variation and defects of goods and services (Kwak & Anbari, 2006). The framework starts with organizational, operational, strategic, and performance activities that lead to organizational change. In this study, the theoretical approach on the Six Sigma methodology is defined by Pande and Holpp (2002) as a method that provides organizations with the tools to improve their business processes, leading to an increase in performance and profits.

Six Sigma implementation sometimes loses momentum if the management capabilities are either weakened or a sense of urgency and sustainability towards the project is lacking (Hung, Ho, Jou, & Tai, 2011). The team requires the motivation to ensure that all groups associated with the project remain to focus on their assigned tasks and meet useful timelines. The implementation of Six Sigma may start with good progress, but over time, team members might become frustrated, and change is affected. The perspective of change must be defined for employees and management to understand the need for developing a learning organization while embracing streamline processes that will reduce waste and defects (Wojtaszak & Baily, 2015). Most researchers concentrated on the technical aspects of the Six Sigma methodology and tools. In recent years, the studies are more associated with psychological and human aspects of the methodology. The shift in focus has made Six Sigma practitioners value it as a threat to organizational failures and opportunities to excel (Laureani & Antony, 2018).

According to Gillett et al. (2010). There have been praises of Six Sigma by most executives of U.S Fortune 500 companies (such as General Electric, Motorola, Caterpillar) as the best continuous process improvement methodology because of its ability to reduce defects, increase productivity, customer satisfaction and increase profitability. However, not every implementation in other organizations has yielded satisfactory benefits. These conflicting results cause practitioners to ponder if the CEFs for successful implementation is failing, leading researchers such as Garg and Garg (2013) to start examining the external factors that affect Six Sigma implementation. The rising concern has led to some premature conclusions that implementation failures occur due to technical, political, management, and organizational difficulties in most working environments (Saja et al., 2014). Therefore, this gap in both practice and theory makes it valuable in deeply identifying the CFF of Six Sigma implementation and capitalizing on the questions and hypothesis of the research.

Nature of the Study

One of the reasons why Six Sigma remains popular is because of the human aspects involved when implementing Six Sigma projects (Formby & Dave, 2016). That means organizational behavior plays a vital role in project management. The organizational structure consists of change agents of different management roles depending on the expertise needed for the related functions (Aboelmaged, 2010). The Six methodology challenges business leaders to accept or show a willingness to embrace the change process. The Six Sigma process requires the commitment of time and resources to yield objective goals. The Six Sigma methodology relies on business metrics that strive for positive results (Hahn et al., 2001). Positive results can only be obtained by creating new ways of reducing defects and other efficiencies (Kwak & Anbari, 2006). That is why practitioners prefer a combination of Six Sigma concepts and other organizational management concepts.

Six Sigma deployment involves changes in organizational processes and procedures through well-coordinated and organized efforts within a structured quality system (Kamran & Ali, 2010). Thus, Six Sigma changes the management style through changes in deployment strategies and managing the work culture that employees should be willing to embrace (Laureani & Antony, 2018). The roles include Executives, Managers, Champions, Master Black Belts, and Black Belts. Deming (2000) believed that achieving high-quality products and services and reducing process-related issues involves the use of the best statistical tools and techniques. The Six Sigma methodology involves team tools, process tools, and statistical tools. The variables include two independent variables and a dependent variable. The independent variables are Six Sigma organizational management and Six Sigma statistical application tools. The dependent variable is Six Sigma implementation failures.

A correlational research design was considered for the research. The correlational research design was preferred because the independent variables cannot be manipulated to prove the presence of causality. Therefore, the quantitative approach is the appropriate research methodology for the study. The approach included a survey, which involved Six Sigma executives, managers, champions, master black belts, and black belts, who have implemented the Six Sigma program in their respective companies. The sample size was determined with a confidence level of 95% of the respondents, a margin of error of 5% to get an ideal sample with the goal of addressing the posed hypothesis that affects Six Sigma implementation failures and interpretation with the use of statistical tools.

The factors that affect both failures and successes of Six Sigma implementation and their outcomes were also examined. Besides, issues related to organizational and implementation processes that constitute the Six Sigma methodology and practices that result in quality improvements and failures when measuring performance in both process capability and management were analyzed. Data collection involved a survey/questionnaire design approach (see Appendix B). The individuals received the questionnaire by electronic mailings. The questionnaire was made of questions relating to implementation, project costs, management support, organizational structure, and Six Sigma statistical tools. The collected data was analyzed using the Statistical Package for Social Science (SPSS). The analysis included descriptive, multiple regression, and other correlational analyses, including Chi-Square.

Definitions

The terms involved in this study provide the meaning of key concepts. The definitions are as follows:

Critical failure factors (CFF): The CFF are vital areas, conditions, and variables that contribute to failures during the Six Sigma implementation. That means factors that contribute to no returns on investment on Six Sigma projects ((Saja et al., 2014).

Critical success factors (CSF): The CFF are vital areas, conditions, and variables that affect the effectiveness, excellence, and efficiency of Six Sigma implementation. (Raja, Vijaya, & Raju, 2018).

Six Sigma organizational management: These are the roles and responsibilities involved in supporting Six Sigma implementation (Anbari, 2003).

Six Sigma application tools: These are problem-solving tools used to support process and operation improvement technics of Six Sigma (Ismail, Ghani, Ab Rahman, Md Deros, & Che Haron, 2014).

Six Sigma implementation failures: A Six Sigma implementation in which an insufficient return on investment (ROI) as primarily identified and approved achieved (Albliwi et al., 2014).

Practitioner: Someone who is professionally involved in practicing or participating in a field or occupation (Eckes, 2001)

Six Sigma: A data-driven disciple or methodology used to eliminate defects in both maturity and service process (Mehrjerdi, 2011)

Quality: A distinguishing attribute of benefits provided to a customer through improved commodity or service within a business relationship (Harry, 1998)

Six Sigma black belts: These are fulltime experts playing vital operational roles in the project. These are the leaders of the most improvement projects (Anbari, 2003).

Assumptions

In this study, I assumed that all survey participants were honest in answering questions and that most participants were present or past Six Sigma practitioners who participated in Six Sigma implementation projects. Another assumption was related to measuring organizational culture. Measuring organizational culture is very complex because each one has a human influence on their measurements. Hence, the individual response may only reflect individual perception and be relative to activities of previous or current project responsibilities. Furthermore, assessment of project outcomes depends on the level of defects and variations reduced.

Scope and Delimitations

The scope of the study involved the population that relates to Six Sigma and quality management. A theoretical foundation involving quality improvement applications described Six Sigma based on past research and review of current literature.

Furthermore, the concept of new quality tools integration as a framework that avoids conflict in implementation was addressed. Regarding delimitation, other quality system assessments before implementation in the respondents' companies were not included. Consideration in making the right choice for dispersing the survey question to participants, including the data synthesis process, was necessary. Recruiting participants was based on their participation in Six Sigma projects. The participants had to fulfill conditions such a Six Sigma certified in either Master Black Belt, Black Belt, or Six Sigma project coordinators.

Limitations

The certification of Six Sigma practitioners involved a wide range of institutions with different criteria. The wide range of tools needed for Six Sigma deployment is not the same for every project. Therefore, the choice of tools provides different experiences for each participant. Consequently, careful considerations were made during results interpretations. Furthermore, measuring organizational management had some challenges. Obverting the characteristics of management varied for each participant.

The research project was constrained due to specific factors relating to the study variables. Based on the inclusion criteria, recruiting individuals to participate in the survey was not an easy task. The research was a cross-sectional study; the time range to conduct the investigation was limited, thereby constraining the scope to focus on aspects related explicitly to the research questions and hypothesis. The survey was limited to participants in the United States and those subscribed to social media in the United States. Unfortunately, other countries and regions were never represented. Such actions reduce the level of generalizing the study results.

Significance of the Study

The approach within the last decade has been promising in improving goods and services to consumers by reducing the variation of goods and services at the supplier, process, product, and service levels. Many companies today continue to implement Six

Sigma programs as a method of intervening, due to the lack of professional skills found in many organizations. Reducing defects and improving the quality of goods and services has a profound impact on the manufacturing and service industry. Successful implementation reduces customer claims and increases the financial benefits of the company.

Significance to Theory

Theoretically, this study strengthens the theoretical principles and facets of quality management theory. Like Six Sigma, the methodology is implemented in industries, institutions, communities, and economies, the individual level of developmental change increases. Improvements in Six Sigma and quality management applications lead to an increase in learning while reducing the cost of transactions and training (Antony, 2007). From the management point of view, empowering individuals in using new tools to manage projects is cost-effective with better outcomes. Therefore, as a method of quality improvement, Six Sigma makes it comprehensive and meaningful to every company, thus laying a solid foundation for future research. The changes incorporate opportunities for management improvement while interpersonal relationships contribute to changing the discrepancies that exist between individuals, lifespan, and personal transformation during development (Spilka et al., 2012).

Significance to Practice

This research study provides a practical contribution to the understanding of how organizations can improve their quality level through the identification of CFF and CSF of Six Sigma methodology. The role of organizational management in Six Sigma implementation was examined, including the key factors that lead to improved customer services. Six Sigma helps most companies overcome the challenge faced in improving quality with increasing demands and cost reduction. Through the successful implementation of Six Sigma, the reduction in product defects influenced its introduction into many other sectors. The survey respondents help to inform Six Sigma practitioners about the necessary changes that positively affect the company. Service providers use such information to improve the cycle times in which services are provided to customers.

Most companies may overcome the challenge faced in improving quality with increasing demands and cost reduction through this study. Furthermore, through improvements in Six Sigma and efficiencies in quality management, the learning of new techniques, which lead to reducing the cost of transactions are realized. The rise in cost and the soaring demand for better products has increased the search for better information in the manufacturing and service sectors.

Significance to Social Change

The study also advances the need for organizations to satisfy customer demands. The adaptation to new development involves economic, professional, and social variables. The financial constraints of every project lead to dissatisfaction, which extends to virtually all other aspects of sociocultural development within the organization and society. The changes brought about by a successful Six Sigma implementation explores human development for socio-economic and cultural change in the organization. Cultural change involves contextual dynamics and adapting to new development patterns. The financial constraints of most companies are partially caused by low returns on investment

(ROI), leading to economic dissatisfaction the extends to virtually all other aspects of socio-cultural development. Implementing the Six Sigma methodology creates a phenomenon of positive social change as a result of available opportunities for both human and economic development. Positive social change leads to a transformation of existing social structures, institutions, norms, and values of the society (Phulpoto & Shaikh, 2011). Furthermore, Six Sigma methodology enhances personal development within the organization, but employees become aware of the challenges and pressure they faced from competitors.

Summary and Transition

Chapter one involved a summary of the past research and detailed background that explores Six Sigma methodology and quality management. The problem statement was based on previous research findings and focuses on the gaps that currently exist. Six Sigma addresses a wide range of manufacturing issues, including defects and variations. The objective was to identify the critical failure factors and benefits of implementing Six Sigma. The scope equally included the study's population as it relates to Six Sigma and quality management. A theoretical foundation involving quality improvement applications described Six Sigma based on past research and review of current literature. Furthermore, it will explain the research limitations, including the significance of the study on its application and literature gaps examined. The effects of Six Sigma implementation CFF shall be explored using the responses from Six Sigma practitioners for projects that have failed and those that have succeeded.

In Chapter 2, scholarly literature on Six Sigma is addressed. The review examined the complexities of these factors and the benchmarks relating to project success or failure as perceived by business leaders. Thus, the chapter establishes a basic understanding of the principles of sigma and a review of previous work, including sources of literature reviews from academic and professional literature related to Six Sigma.

Chapter 2: Literature Review

The quality of manufactured products and services is essential, and product variations are of critical concern to the manufacturers and consumers. Most variations in the manufacturing process lead to product defects, high production costs, and loss of consumers (Ahuja, 2012). The main problem relates to the management of structural support to Six Sigma implementation. The purpose of this quantitative study is to explore the critical factors that lead to Six Sigma implementation failures. The goal is to use empirical evidence of both CSF and CFF during implementation. The research involves a survey that further examines the relationship between failed Six Sigma implementation projects and critical factors that cause these failures.

The research concentrates on two independent variables (CEFs) and a dependent variable (Failure variable). The IVs are Six Sigma organizational management and statistical application tools. The DV is Six Sigma implementation failures. Both IVs provide a correlation with Six Sigma implementation failures (DV). The quantitative study explores the factors that lead to Six Sigma failures during implementation. This chapter establishes a basic understanding of the principles of sigma and a review of previous work done on the topic. The chapter involves sources of literature reviews from academic and professional literature related to Six Sigma. The review describes the basis of the study, a cross-section of the history, Six Sigma management tools, TQM, and the challenges of Six Sigma implementation.

Literature Search Strategy

In recent years, Six Sigma methodology has been part of the quality management philosophy, but the studies on Six Sigma implementation failures are less comprehensive. (Sparrow & Otaye-Ebede, 2014). The project-based methodology involves specific problems facing organizations. In this study, the focus is to address the CFF of Six Sigma implementation. Literature search involves the following areas academic journals, academic magazines, Six Sigma books, and electronic databases. The literature review sources for primary research data are as follows:

- Academic journals: Management, Business Excellence, Quality, Organizational journals.
- Professional Magazines : TQM, ASQ, Six Sigma Magazines.
- Top Six Sigma Book: Six Sigma Deployment, Six Sigma way.
- Web resources, such as www.isixsigma.com, www.asq.org.
- Academic search databases like Emerald, ProQuest.

The process of selecting the available literature needed for the review includes both inclusion and exclusion of some articles and journals based on the material and the proposed period. The process begins with the title review, abstracts, and removing related literature. The key search terms include Six Sigma, TQM, quality improvements, critical success factors, critical failure factors, quality tools. The scope of the literature review involves the history of quality methods, including Six Sigma and the quality management tools, as introduced by other quality gurus. Six Sigma implementation and its challenges are vital areas to be addressed. More emphasis is laid on articles the last five years on the failures of Six Sigma.

Theoretical Foundation

Six Sigma deployment research bases on the definition suggested by Pande and Holpp (2002). According to Pande and Holpp, Six Sigma is a statistical method that is used to improve business performance processes through the reduction of the variations that exist in a process. Hence, leading to defect reduction and an increase in profits. From a quality perspective, TQM refers to the enhancement of quality and productivity in businesses (Saud & Faihan, 2014). The theoretical origins directly relate to the philosophical principles of quality management and tools of improvements, as described by the various authors. Organizations use different forms of methods of management, but the evolvement of Six Sigma represents a combination of varying quality concepts and principles, including management tools and techniques.

The section demonstrates a broad-based knowledge of the ideas relating to the theoretical concepts, principles, and practical analysis of the contributions by Deming (1982) and Crosby (1979) and other quality gurus. These contributions led to the Six Sigma approach across organizations. The principles reflect nominative processes affecting organizational structures, which involve human factors, machines, and management models. Although the contributions made by Deming and Crosby, differ in some ways, they all focus on the foundation of a functioning quality system that leads to good qualitative outcomes, more reliability, and reduced cost of quality.

The approach by Deming (1982) combines quality tools and the use of statistical thinking within an extensive range of issues across the organization. Deming established 14 points for managing significant quality improvement frameworks and efficiency in business. The 14 points are fertile soil for the cultivation of productive workplace activities, high profits, and maximum productivity. Deming believed that quality improvement could only happen if the top management, employees, and suppliers consider significant organizational changes as part of achieving quality goods and services.

PDCA (Plan – Do – Check – Act)

Deming's approach originated in 1951 as a four-step management method with circular interactions (Chiarini, 2011b). Deming referred to PDCA as the Shewhart Cycle and tried later to modify it, to plan, do, study, act (PDSA) with more emphasis on quality inspection rather than analysis (Singh, 2014). The philosophy behind this approach is that both skill and knowledge are always limited but are reachable through improvements. The PDCA scientific method is a system in which hypotheses are justified through direct feedbacks rather than wasting more time on paralysis (Singh, 2014). The rate of improvement is a key competitive element in modern business. That is why PDCA led to a breakthrough in business improvement.

The recognition that variations occur through information structures, processes, and overall outcomes is what in "out of crises." Deming (2000) discussed why processes do not behave as always predicted. The idea that systems variation existed and managers should be able to understand the difference between variations, which occur through common causes. Deming's theory of variation relates to variations, which occur due to changes in procedure, operator, and shifts of workers, but common cause variations are related to design system processes and procedures.

Zero Defects Theory

The zero defects concept introduced by Crosby (1979) considered defect levels as quality levels that are measurable evidence of failure, which assures success. Crosby (1979) emphasized prevention rather than cure and inspection or correction of failures. Management has the prime responsibility of setting and meeting the goals for the first time and on time. The concept is more related to conformance on product requirements. Non-conformance products increase the cost of quality, as defects were not rooted out from the beginning. The process involves brainstorming, planning, and analyzing all related processes before deciding which path to follow or execute.

These two quality gurus stressed the need for leadership through top management to take responsibility for ensuring quality improvement and communicating objectives, including the vision of the organization. The gurus also advocated the need for continuous training to foster employee skills while ensuring practical quality tools and practices through implementation. Today, technology development and innovations are the reason for global competition in the world market. The world markets are now operating on the same plane, and the concept of TQM is the primary strategy for continuous improvement in the ever-expanding market. TQM is a holistic and comprehensive management approach, which enables its actions from the start of producing a product to post-production (Dahlgaard & Dahlgaard-Park, 2006).

TQM approach focuses on the training of employees to solve problems in a long-term perspective. Hence, preventing the problems from re-occurring again. The total quality management philosophy involves humans (Black & Revere, 2006). The human factor is critical during the planning procedures. TQM constitutes many technics, which remain valuable to the process: Such as PDCA cycle, Six Sigma, Pareto analysis, kaizen, Gap analysis, etc., all these technics help in addressing problems relating to quality.

Six Sigma

The term "sigma" in statistics measures the idea of measuring the defects in a process per million opportunities. Through deviations, the Six Sigma process brings the process close to zero defects. In the early 80s, Motorola developed a quality improvement concept called Six Sigma to meet the challenges of the competitive Japanese market (Lucas, 2002). Motorola's senior engineers introduced the statistical formula for the method (Sokovic, Pavletic, & Fakin, 2005). Motorola's leadership supported the initiative and years of full dedication to the program.

One of the data-driven approaches and methods of eliminating defects is the Sigma effect (Aboelmaged, 2010). Six Sigma incorporates most of the techniques of business and statistical measures (Spilka et al., 2012). The continuous review of business processes is the goal of Six Sigma, whose abbreviated methodology is DMAIC (Define, Measure, Analyze, Improve, and Control). The fundamentals of Six Sigma is a breakthrough strategy involving rigorous data collection and analysis using statistical tools to identify causes and sources of defects and eliminating them (Czajkowska & Stasiak-Betlejewska, 2015).

The process aims at zero defects rather than other methods. Those goals depend on inevitability. Six Sigma's primary goal is to reduce costs substantially, sustain improvement, and enhance efficiencies (Green, 2012). In most competitive manufacturing companies, the main concerns are the value of its products. Six Sigma tools are applied to reduce cycle time, determine waste, and improve quality, and to sustain processes. According to Czajkowska and Stasiak-Betlejewska (2015), Six Sigma methods or approaches enhance workflow through quality and productivity. Most companies consider these aspects as a way of improving processes and building a relationship where both human people and processes contribute to business performance. Most Six Sigma projects relate to customer impact or bottom line.

Over the years, researchers have given little attention has been given to the CFF of Six Sigma. The previous studies engaged more on identifying factors affecting project failures but never considered the effects of long-term implementation. More so, the sample data used in validating research outcomes and targeting the CFFs are insignificant (Saja et al., 2014). Using a quantitative approach to determine the impact of the failures in implementation is still lacking in the literature. The Six Sigma theory and the research questions of this study provide a synopsis of the relation to both successful CSFs and the implications of challenging those failures that fit the implementation of the theories that led to its development. The Six Sigma theory relates more to eliminating defects, a degree of organizational management, and statistical measurements that are necessary for managing the process. These are requirements for practical quality implementations. The research questions constitute the abiding principles of TQM and Six Sigma, nature at which the existing quality theories have been used within the scope of other related studies. The Critical Success Factors (CSF) of Six Sigma are those factors that relate to the success of Six Sigma implementations and the organization (Coronado & Anthony, 2002). Despite all the described successes of Six Sigma, some of the results fall short of yielding satisfactory results. These unsatisfactory results provoked practitioners like Sokovic et al. (2005) to wonder if there are Critical Failure Factors (CFF) of Six Sigma.

Literature Review

Harry Mikel (1998) was one of the first writers to discuss the ideas of Six Sigma. Based on the article, Motorola started the Six Sigma idea in the early 80s. According to Dennis Sester (2001), it was a high-quality objective of the company demanded by the chief executives. The research on process capacity and defects reduction by the chief research engineer, Bill Smith introduced the basics for the Six Sigma innovation. Through the leadership of the chief of technical staff, Motorola refined the strategy called Six Sigma. Companies like GE, Ford, Texas Instrument, and other organizations touted Six Sigma as a method used to improve processes. The Six Sigma activities and achievements are not just limited to large manufacturing operations, but also, many small businesses and service industries consider the method as one of the best in improving their processes to meet customer expectations. According to Henderson and Evans (2000), the reasons for its implementation are as follows:

- To focus on the customer
- To improve business profits

- To meet quality demands
- To focus on measurable outputs
- To qualify management and leadership needs of the organizing
- To solve problems using quality tools and techniques

In this section, the literature review comprises the history, definition, benefits, and implementation of Six Sigma and technics and principles of Total Quality Management.

Continuous Improvement Methods

A firm foundation lays the grounds for continuous improvement for organizations aspiring to meet world-class standards with continuous growth and development. Adopting Deming's PDCA Cycle for self-renovation improves organizational performances (Agrawal & Tiwari, 2014). The implementation of Six Sigma and culture provides day-to-day improvements through manufacturing defects elimination and improving product features leading to a continuous improvement environment. Managing problem solving or quality-improving teams that convert organizational weaknesses to strengths is part of the leadership's responsibility (Formby & Dave, 2016).

Strategic planning for quality purposes provides direction and guidance to operating performance and leadership (Madanhire & Mbohwa, 2016). A strategic quality plan represents the present state of the organization and guides on the organization's future or long-term objectives. According to Gonzalez, Muesada, Davis, and Mora-Monge (2015), the mission and vision of the organization have to be defined. The organizational value system constitutes the specified mission and vision that should be measurable, attainable, realistic, and time (SMART) effective. Part of the strategy is to identify customer requirements and customers, which enable organizations to meet their objectives. The strength, weaknesses, opportunities, and threats (SWOT) analysis also add value to the planning procedures.

Most organizations demand the involvement of all employees, management, suppliers, customers, and the community as a whole for guaranteed success. Sometimes it goes further than just employee engagements alone (Lari, & Asllani, 2013). The organization strives to meet the training needs of employed, wages, and job evaluations. Despite these arguments, employees should be very confident about organizational performance (Sharabi, 2013). The top management involves the head of operations and supervisors in the decision-making process.

Six Sigma and Total Quality Management

After a few decades of implementation, Six Sigma's success now spans from its vitality in quality improvement and efficiency in multidimensional approaches. While other researchers (McCarthy, Daniels, Bremer, & Gupta, 2005) describe it as a philosophy, most entrepreneurs today consider it a method of quality improvement. As a quality improvement method, many different theories and metric tools help to improve business processes, with results that lead to improved products and services. The Six Sigma metrics, which relate to six deviations, measures how much defective products and services deviate from the normal. These defects increase the costs of production.

Quality practitioners have ignored the integration of Six Sigma methodology into the TQM, although the literature survey explains the differences and similarities between both concepts and their effects on quality performance. Black and Revere (2006) believe TQM is the foundation of Six Sigma. Integrating Six Sigma tools in TQM helps in improving quality performance (Anvari & Moghimi, 2012). This part of the literature review concentrates on TQM and Six Sigma practices with the perspectives of using quality measurement techniques to ensure the best quality for the manufacturing and service industry. Identifying certain areas that have been lacking and relative gaps in recent studies is one of the research objectives. Why TQM? One of the revolutionary aspects of organization management duels on quality management because the approach creates a shift in a paradigm and amplifies organizational performance. It substitutes the control of management standards that includes very few aspects relating to continuous improvement.

Total Quality Management (TQM)

In recent years, quality is a significant issue plaguing most organizations. There has been a shift in quality control from the simple aspects of inspection to quality assurance, where the practices relate more to the regulations within a particular industry. Black and Revere (2006) discuss the origin of TQM as it aligns with the manufacturing sector in which quality control instruments address the reduction of product defects and cost reduction during the mid-80s. TQM evolved during the 90s, and many organizations used TQM as a paradigm in managing quality because it included the principles of quality leaders like Deming, Crosby, and Juran. Recently, the philosophy of TQM influences operation management (Anvari & Moghimi, 2012). The competitive nature of the global market has made many organizations to implement strategies that utilize quality improvement methods integrated into TQM.

The TQM paradigm is one of the concepts in which organizations attempt to implement better structures, procedures, customer satisfaction with an emphasis on quality improvement, reliability, and competitiveness. Performance measurement has become an integral element or factor in most management processes, as the organizations are always anxious to find measures of indicators like return on investment (Douglas, 2006). However, depending on financial indicators alone is not the only measure in TQM settings. Many researchers believe that ensuring the effective implementation of other quality improvement methods like Six Sigma provides direct quality measurements of organizational profitability and managers' ability to manage TQM programs (Antony, 2007).

The success of many organizational performances depends on good Total Quality Management. However, many practitioners have not understood the mechanisms through which TQM influences organizational performance. Incorporating organizational learning and its capabilities as part of TQM, goals, and objectives helps understand why TQM is contingent on many other factors (Andersson, Eriksson, & Torstensson, 2006). These contingencies are a group within the concept of organizational learning (Aboelmaged, 2010). Experts have explained the learning concept as a method of continuous improvement and organizational transformation. The learning concept articulates change in the form of continuous improvement (Shonhadji, 2017).

Meeting strategic goals set by stakeholders encourages employees to involve in training aspects of the organization (Green, 2012). Some organizations provide incentives to those who take part in some learning activities. These employees gain competence, expand knowledge, and change in behavior. TQM and organizational learning are interrelated concepts because they both focus on continuous improvement and competition (Green, 2012). More so, TQM advocates for organizational learning as one of the key mechanisms involved in the process of quality improvement. Implementing TQM philosophy in the organization provides a significant advantage to the employees. TQM gives voice to the people and enhances their morale to meet obligations. Any time employees are involved in the decision-making process, which leads to results provides them with a sense of the value of purpose (Douglas, 2006). The attitude of workers change, and the climate of the working environment is affected. TQM is cost-effective because the implemented processes are well studied. The process leaves out unnecessary steps, unnecessary repetition, and identifies errors in saving time and money. TQM encourages teamwork and cooperation amongst workers and between different departments. Accomplishments occur when management and operators work together (Green, 2012).

The benefits of TQM are long-term because time is required for achieved results to yield profits. Most companies seem compelled to implement TQM only after there is a massive loss in profit and the business brand (Cheng, 2008). Some companies such as Motorola and Xerox engaged in TQM after experiencing an increase in competition amongst companies in Japan. Since TQM lays more emphasis on the holistic concepts of quality management in an organization, continuous improvement is never-ending (Smyrlis, & Moschidis, 2015). That means the process has to be strategically managed and controlled. The biggest enemy of quality is variability. The expected design becomes successful when less variation occurs both on product and process. The goal is always to reduce the degree of variability (Choi, Choi, & Shin, 2013). Variation in the process may is sometimes as a result of natural causes and sometimes difficult to control because the characteristics of processes that occur at random other causes are related to assignable issues such as variations caused by differences in material, machines, workers, and other time factors.

Six Sigma History

Top executives of Motorola in the 1980s decided to hire new management to focus on new technology and design but using the same workforce (Eckes, 2001). During that period, companies in the United States competed with Japanese companies, but Motorola admitted that their products were of low quality in the market. Japanese companies had superior products in the market because innovation assisted in improving their product quality while the US-made products were obsolete in the market. Motorola decided to develop a method that could produce quality goods; else, they would lose business. Motorola developed a new improvement concept called "Six Sigma." A senior engineer of Motorola was the founder of the Six Sigma concept (Lucas, 2002).

The concept needed the full support of the CEO of Motorola at that time, Bob Galvin, made Motorola a Six Sigma organization. Motorola dedicated most of its resources to the Six Sigma way, with $170 million invested in education and training of its workers. Through hard work and dedication, Motorola became one of the winners of the Malcolm Baldrige National Quality Award. In the year 2000, a recall occurred due to wrong tires installed in one of Ford's model, called explorer (Muller, 2001). The recall costs Ford Company more than three billion dollars. Ford also had bottom-line issues with production delays. Ford finally implemented Six Sigma to help correct these errors, and its repair cost of warranty reduced. These changes occurred through the elimination of customer priority concerns and improving customer satisfaction.

Today most companies like Microsoft, Seagate, and Toyota use Six Sigma to accelerate production. The methodology of Six Sigma was developed from previous quality initiatives by quality gurus like Philip Crosby (Quality Management Principles), Edward Deming (Plan-Do-Study-Act), Walter Stewart, and Genchi Taguchi (Statistics, Robust and experimental design methods).

The Six Sigma Philosophy

The Six Sigma philosophy is defined by its ability to reduce product defects, cost of operation, and increase customer satisfaction. As a quality tool, Six Sigma eliminates the problems that cause defects and reduces the variations that occur in the process. The implementation of Six Sigma enhances process performance, improves the bottom- line and customer satisfaction by reaching the goal of 3.4 per million defects. The philosophy of Six Sigma helps to determine product and service conformances and the requirements to complete projects within a period to meet both organizational and customer demands (Knapp, 2015).

In general, quality programs require support from top management. Companies like Motorola and General Electric (GE) were successful because of the support from top management. Most companies have made Six Sigma training a pre-requisite for top managerial positions (Knapp, 2015). Salaries and compensations link senior executive commitment to Six Sigma and the successful projects accomplished. Some of the responsibilities aligning with top management include:

- Establishing initiatives that enhance the Six Sigma infrastructure
- Providing the necessary resources for Six Sigma projects
- Project review and training resources
- Creating a cross-functional team to manage projects
- Providing resources for both Six Sigma black belt training

Most managers believe that the success of Six Sigma comes from the disciplinary approach. The approach used is DMAIC (Define, Measure, Analyze, Improve, and Control) stages. The DMAIC process provides a workflow that links the various stages of Six Sigma. The process allows multiple processes to integrate valuable tools of business and quality improvement processes. The knowledge of Six Sigma has become a revolution in the production world, and many companies now use the Six Sigma methodology to improve their quality of goods and services.

What is Six Sigma?

Six Sigma has consistently suffered from different definitions. Some practitioners consider the statistical aspects as the central principle whole others choose the business aspect and its application as a better argument for its deployment. Despite such confusion, most researchers agree that the Six Sigma methodology may have different approaches, but the goals are relatively the same. Below are some Six Sigma definitions as suggested by some renowned practitioners:

- A more flexible system driven by the goals of sustaining and improving the business needs of an organization using statistical analysis (Pande & Holpp, 2002)
- Six Sigma is a concept applied to reduce variation by achieving the minimum standard deviation that could lead to zero defects (Eckes, 2001).
- The main idea of Six Sigma is creating a disciplined process dedicated to delivering customers with products of high quality and consistent services. The concept involves the use of statistical and managerial tools that help to improve business gains while reducing variations and preventing product defects (Harry, 1998)
- Six Sigma consists of the implementation of highly effective quality principles, management principles and uses statistical tools to reach error-free
- performances in the business, which lead to a reduction in the costs of quality and improved operations to meet customer expectations (Coronado & Anthony, 2002)
- Six Sigma represents 3.4 defects per million opportunities and variations that occur in a process based on statistical methods that aim at achieving fewer defects and boosting the quality of products and services (Pyzdek, 2003).
- Six Sigma is a systematic strategic improvement methodology used for new product development with the aid of statistical methods that help to reduce

variation and increase customer confidence (Linderman, Schroeder, Zaheer, & Choo, 2003)

- Six Sigma is a comprehensive, rigorous improvement methodology that uses the information and statistical measurements in identifying and preventing processes that might lead to defects in products from a three-sigma level to a Six Sigma level (Murphy, 1998)

These definitions provide a broad idea of the goals of Six Sigma implementation. The similarities between the definitions make Six Sigma, not just a strategic approach in which organizations use to manufactures goods through production lines and improve services, but it represents a methodology because of the role it plays in the quality system. For this dissertation, we define Six Sigma as a methodology that combines statistical analysis and organizational processes to reduce variation in products and services.

Six Sigma needs top management and leaders that guide performance at every level of the organization. Six Sigma does not only help in improving the quality of the system, but it also changes the culture of the organization (Pande & Holpp, 2002). In preparing to implement Six Sigma, measurements based on business performance are crucial in ensuring that an organization is effective in achieving established goals and sustaining the achieved results.

Six Sigma Methodology

The Six Sigma methodology is a problem-solving methodology based on the idea of the process and product improvement on Deming's PDCA model. Developing this new approach called Six Sigma realizes improvement quality assurance strategy and customer service improvements because the processes are data-driven and well managed. Six Sigma incorporates most of the techniques of business and statistical measures (Spilka et al., 2012). The continuous review of business processes is the goal of Six Sigma, whose abbreviated methodology (see figure 1) is DMAIC (define, measure, analyze, improve, and control). The fundamentals of Six Sigma is a breakthrough strategy involving rigorous data collection and analysis using statistical tools to identify causes and sources of defects and eliminating them (Czajkowska & Stasiak-Betlejewska, 2015).

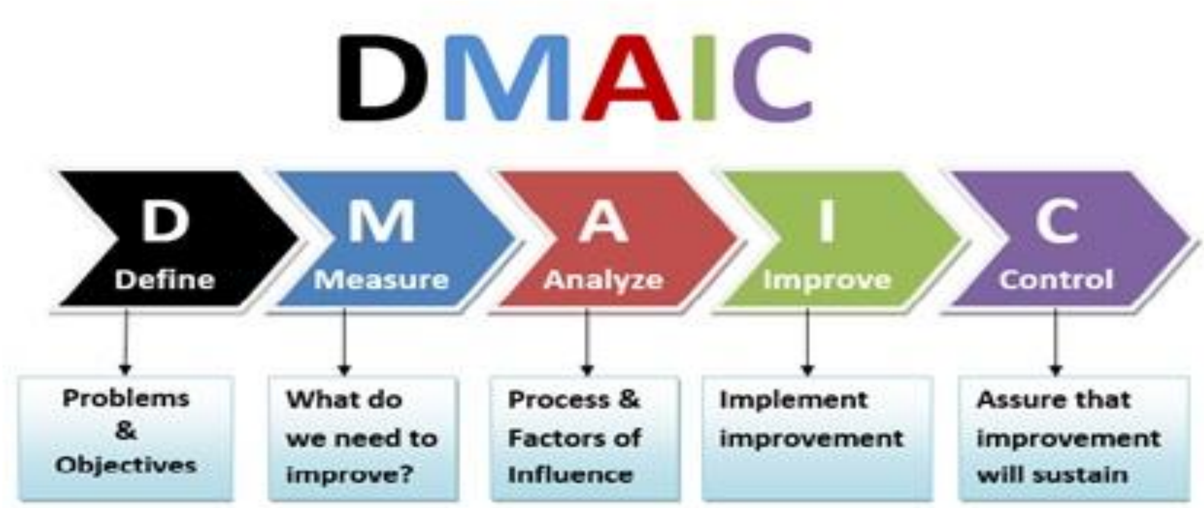

Figure 1. The DMAIC process Adapted from "Quality management in the enterprise using Six Sigma method." by Spilka et al., 2012, *Journal of Achievements in Materials and Manufacturing Engineering, 55* (2), 895-901.

To achieve quality based on the Six Sigma method, 3-4 defects per million opportunities or less produces the best rest results. Six Sigma's primary goal is to reduce costs substantially, sustain improvement, and enhance efficiencies. In most manufacturing companies, the main concerns relate to the cost of its products. That is why consumers prefer affordable prices for highly-valued products. Despite these challenges, the goal remains, sustaining the quality of products with a lower cost of goods and services.

Six Sigma tools are applied to reduce cycle time, determine waste, improve quality, and to sustain processes. According to Czajkowska and Stasiak-Betlejewska (2015), the Six Sigma method or approach improves workflow through quality and productivity. Most companies consider these aspects as a way of improving processes and products and also building a relationship where both people and processes contribute to business performance. Most Six Sigma projects relate to customer impact or bottom line. Well-defined projects complete between 2-6 months. Every Six Sigma tool application is different depending on the objectives of the project (Spilka et al., 2012). Another method of continuous improvement, which many companies have implemented, is the Kaizen system.

The critical difference between Six Sigma and other methods is the use of statistical analysis (Ramasubramanian, 2012). Six Sigma focuses on measurable and quantifying specific goals, which relate to solving the problems associated with product defects and inadequate services. Six Sigma methodology does not automatically fix all issues; meeting performance targets relies on accurate problem definition and diagnoses. Business leaders consider the voice of the customer, while Six Sigma leaders identify capability gaps (Wojtaszak & Baily, 2015). The project success relies on accurate information and specific identification within a timeframe that allows team leaders to focus on applying implementation strategies leading to improving process efficiency.

The DMAIC Stages

The DMAIC model consists of integrated activities, tasks, tools into the management platform that monitors and evaluates the projects. The DMAIC tool requires critical factors that are necessary to meet management procedures successfully. The DMAIC process includes five different stages: define, measure, analyze, identify, and control stages.

Define Stage (D). The define stage is the first step of the process. The stage is characterized by introducing the primary goals and tools needed for the project. Gryna (2001) described the objectives of the define stage as follows: Project identification and evaluation: identifying potential projects through screening and nomination based on available opportunities to increase customer value, reducing defects, and cost of poor quality (COPQ). This stage involves scope and benefits reviews. The problem and mission statement provide directions on planning and foreseeable outcomes. At this stage, selecting a project team and a charter defines the respective functions of team members (Hahn et al., 2001).

Measure Stage (M). The measuring stage aims at identifying the problem based on actual data obtained from the current process. (Pande & Holpp, 2002). The primary activity is to measure critical variables and factors that influence or affect the manufacturing process. The measurements involve practical data that influenced logical

arguments. In the measuring stage, the tasks and tools include; brainstorming, data collection plan, sample size determination, capability, and measurement indicators.
At the measuring stage, considering the critical needs of the customer is of priority. The stage establishes a relationship with the baseline performance and scope of the problem. The application involves statistical and management tools to access flow diagrams and map processes. Data collection relates to the symptoms and other qualifications of measurement systems available such as repeatability, reproducibility, and measuring the process capability.

Analyze Stage (A). The analyze stage involves data analyses (Eckes, 2001). Examining the variables and finding the root cause of defects using statistical analysis are the goals of this stage. Achieving such goals requires tools as cause and effect diagrams, five whys data analysis tools, and SPSS.

Improve Stage (I). The improve stage aimed at providing solutions to solve the identified problems. The main objective is to improve the process performance (Pande & Holpp, 2002). The tasks and tools involved during this stage are brainstorming, decision-making tools, Gantt chart, Implementation tools, capability (Cpk) diagrams, and Statistical software (SPSS) tools. At the improve stage, problem-solving takes place, including new remedies on improving the original issues. At this stage, optimization of process performance and using new variables to find alternative methods through exploratory experiments and possible simulations, including testing the effectiveness of the proposed remedy through pilot runs and other test processes.

Control Stage (C). In the last stage, all improvements are evaluated to ensure the achievements of all projected goals. For the evaluation of any project to be consistent, the control stage needs careful management. After applying and integrating the new system with new solutions, enhancement of the overall process takes place (Pande & Holpp, 2002). The tasks involve setting a control plan, new standard operating procedures, training of employees, and process capability maintenance.

Six Sigma focuses on the cause of problems, thereby enhancing the solutions to problems. The principle of Six Sigma applies to all departments of the same organization (Agrawal & Tiwari, 2014). Some of the benefits of Six Sigma can be only achievable by overcoming some of the barriers. The implementation of Six Sigma takes a long time to accomplish. The process needs trained practitioners for effective implementation. The implementation process makes some people lose their jobs, especially if the new process demands a new philosophy and spontaneous decision-making (Ahuja, 2012). The process needs much analysis, which turns to be frustrating as the data collection process is sometimes tedious and frustrating. More so, the decision-making process is not easy because the various teams need a consensus to reach the final decisions (Anvari & Moghimi, 2012). The process of getting qualified individuals is not easy because it is sometimes challenging to understand established quality mechanisms (Ahuja, 2012). Most practitioners are always reluctant to embrace Six Sigma because it needs support from top management and employees.

Quality improvement is no longer a slogan used by companies but has become a significant issue in today's global market. Those companies adopting best practices of quality management are experiencing a significant improvement in operational performance with successful employee relationships, productivity, customer satisfaction, and increase profits. While most companies have a unique opportunity in every unique environment, the features of quality management systems are virtually the same. These features consist of the focus on customer needs, leadership, employee empowerment, decision-making process, and cooperation with suppliers.

Continuous Improvement Tools

Understanding the techniques and methods of quality improvements demand the need to acquire knowledge of the tools required for effective quality management (Wandersman, Chien, & Katz, 2012). The application of these tools demands the use of trained individuals. These individuals commit to working through the process are get assurances from management. Managers need to show a degree of commitment and support to the implementation process. The role of statistics in six sigma projects needs to be addressed with the roles of project champions and managers. This section elaborates on seven statistical and planning tools.

Statistical Process Control (SPC) and Process Capability (Cpk)

The variation of the process can be measured using SPC to ensure the process meets specified requirements (Smyrlis, & Moschidis, 2015). SPC monitors a process and identifies the causes of process variations. These variations help as signals for corrective actions at an appropriate time (Choi et al., 2013). The process is then corrected and brought to control: that means the variances and process averages are constant with time. Figure 2 represents the control status of a process.

Most industrial managers consider the importance of the capability aspect of the process. This measurable process is called statistical quality control (Berenson & Rice, 2015), but Wandersman et al. (2012) believe that without the application of process capability methods, the customer requirements will hardly be realized. Hence, for a particular process to meet product specifications, the capability process must be measured to understand both input and output specification limits.

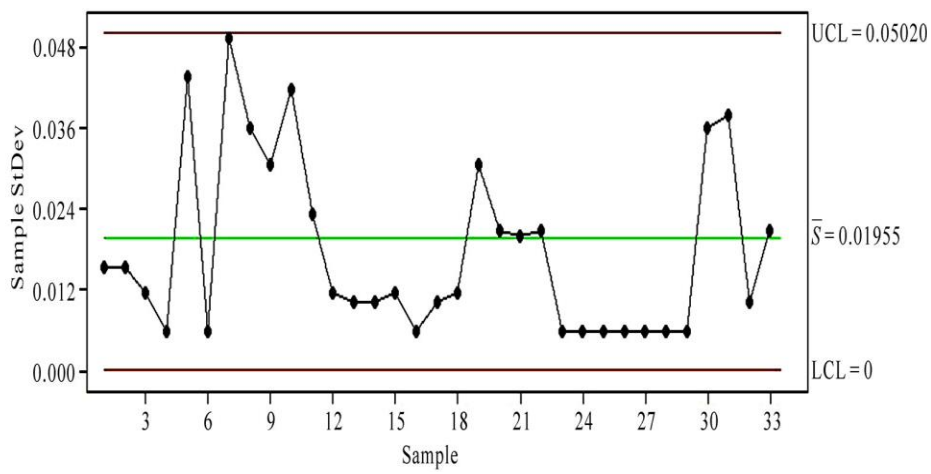

Figure 2. **S**tatistical process control (SPC). Adapted from "Six Sigma as a total quality management tool" (Odendaal & Claasen, 2002), *South African Journal of Industrial Engineering, 13*(1), 25-33.

Pareto Chart

The Pareto chart, also called the Pareto diagram, is one of the tools, which quality managers use to measure the cause and effect of variations that help in decision-making and understanding the overall effect.

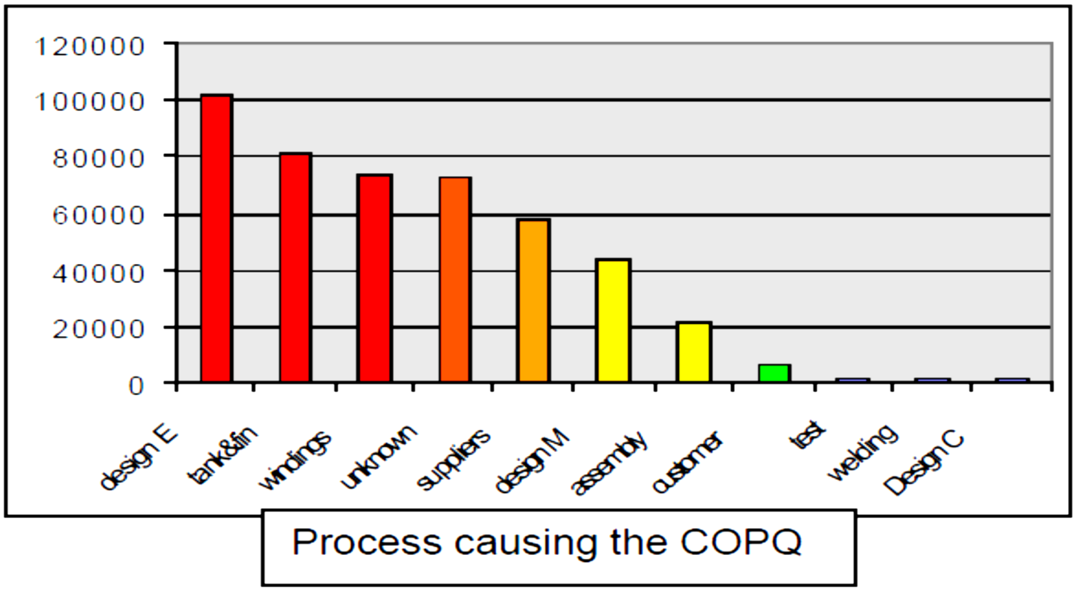

Figure 3. Pareto chart. Adapted "Six Sigma as a total quality management tool" Adapted from "Six Sigma as a total quality management tool" (Odendaal & Claasen, 2002), *South African Journal of Industrial Engineering, 13*(1), 25-33.

In quality control and Six Sigma, the Pareto chart helps everyone to concentrate on critical factors. The chart can provide answers relating to the frequency of occurrences, the cost incurred in production.

Cause and Effect Diagram

The diagram discovered by Kaoru Ishikawa is also called the Ishikawa diagram. The diagram identifies the effects and causes of problems. The diagram provides quality managers and team members an understanding of the level of problems and the structure of brainstorming to be established. The diagram helps in cause analysis through the categorical arrangements of levels based on variable relationships and events.

Check Sheet

The check sheet concentrates on defects and data collection for analysis. The tool helps in a wide variety of ways. The primary function is to present information in an efficient pattern, which distinguishes fact from opinion.

Check Sheet

<table>
<tr><th></th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th><th>Total</th></tr>
<tr><td>Daily Newspaper Ads</td><td>卌 ||</td><td>||||</td><td>卌</td><td>|||</td><td>卌</td><td>24</td></tr>
<tr><td>Weekly Newspaper Ads</td><td>|||</td><td></td><td>||</td><td>|</td><td>||</td><td>8</td></tr>
<tr><td>Website</td><td>|||</td><td>卌</td><td>卌 |</td><td>||||</td><td>||</td><td>20</td></tr>
<tr><td>Road Signage</td><td></td><td>||</td><td></td><td>|</td><td></td><td>3</td></tr>
<tr><td>Referral</td><td>|</td><td></td><td></td><td></td><td>|</td><td>2</td></tr>
<tr><td>Total</td><td>14</td><td>11</td><td>13</td><td>9</td><td>10</td><td>57</td></tr>
</table>

Figure 4. A check sheet. Adapted "Six Sigma as a total quality management tool" Adapted from "Six Sigma as a total quality management tool" (Odendaal & Claasen, 2002), *South African Journal of Industrial Engineering, 13*(1), 25-33.

Histogram

Histogram Data is a representation of simplified data through a graphical view. This graph is used to show the frequency of distribution. The histogram provides one of the simplest ways of a bar chart. The bar chart is mostly used to understand the level of requirements of a process and the output needed to meet both supplier and customer requirements.

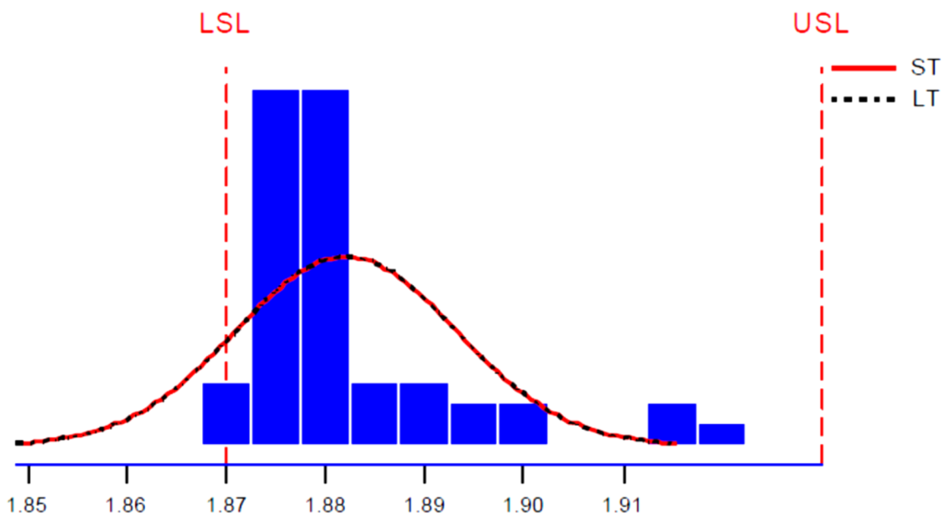

Figure 5. Histogram. Adapted "Six Sigma as a total quality management tool" Adapted from "Six Sigma as a total quality management tool" (Odendaal & Claasen, 2002), *South African Journal of Industrial Engineering*, *13*(1), 25-33.

Scatter Diagram

An x-y graph represents a scatter diagram. In quality, the tool displays the relationship between various variables. The lines or curves represent the correlation of variables cutting through the data points. For quality analysis, the data trends determine the directions and strength of the argument based on the points clustered around the line or curves.

Control Charts

The control charts are statistical process control tools. The tool indicates the variability that occurs in a process and helps quality operators to understand whether the process operates consistently or not. The tool detects changes in variances and process mean. Control charts help to measure operating performance, whether it is natural or assignable variances.

Graphs

Graphs are used depending on the purpose of analysis. Illustrating variations of a period requires the use of line graphs. Circle graphs are used to indicate values that are categorically broken down.

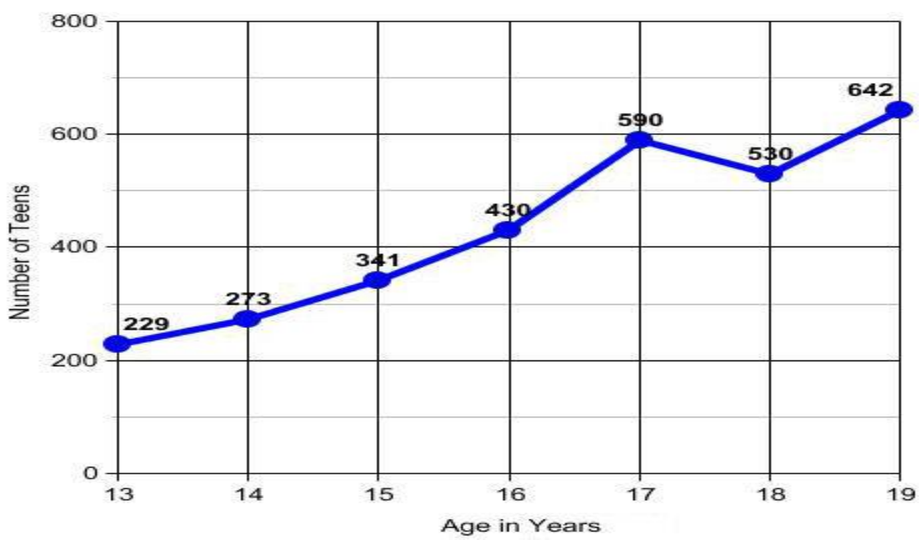

Figure 6. A Graph. Adapted from "Quality Management tools applying the strategy of logistics service quality improvement" (Czajkowska & Stasiak-Betlejewska, 2015). *Serbian Journal of Management, 10*(2), 225-234.

The Plan-Do-Check-Act (PDCA)

PDCA is a method popularized by Deming in Japan, which emphasizes on change or planning chance in a company. It encourages change in small scale through tests observation of effects and explains obtained results. According to Choi et al., 2013). Because new development takes a lengthy period, the methodology and approaches taken to meet better results need to be validated and tested. The challenges are enormous, and developing an optimal approach needs qualified tools and qualified management. The design may be accurate, but the approach used to ensure the quality of the final product and meet with customer requirements must be consistent.

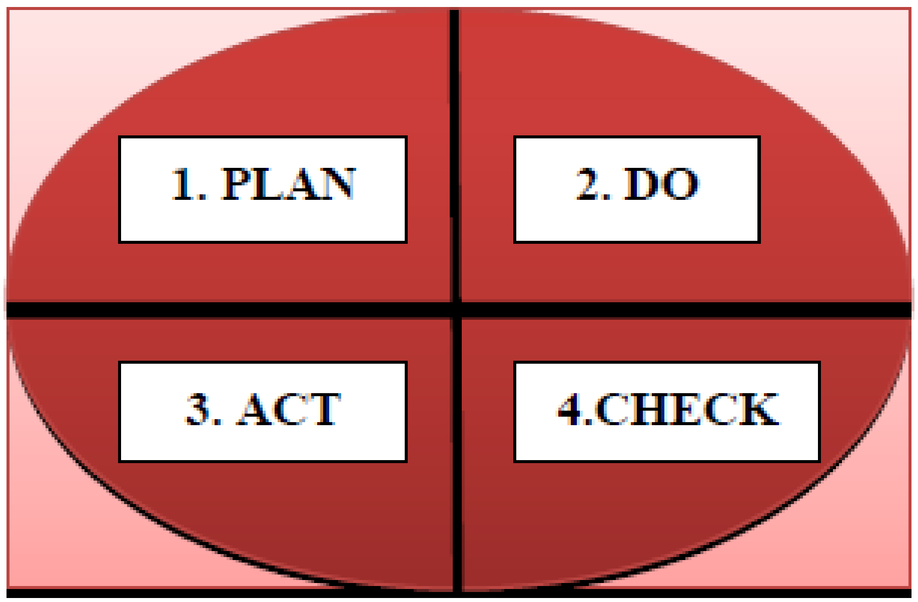

Figure 7. A PDCA cycle map. Adapted from "Quality management applied through QFD method," by R. Pakocs, 2014, *Scientific Research & Education in the Air Force - AFASES, 1*, 319-324. Copyright by Henri Coanda

Managing Six Sigma

The mistake most organizations commit is engaging in Six Sigma without building a stable structure. The organization only loses when this happens (Spilka et al., 2012). The common complaints remain not only being ISO 9000 certified and not meeting with quality requirements. We have Six Sigma; still, we are not meeting our goals on reducing the cost of quality. Pakocs (2014), explained that an organization with such problems do not last long. They might benefit from quick solutions but cannot sustain competition. Organizations with a strong foundation, organizational management, customer orientation, and focus will benefit in the global market (Miguel, Eduardo, Andrietta, & Calarge, 2012). These companies are believers of continuous improvement with proper strategic quality planning tools that guide their organization to grow continuously in the long-term with world-class performance.

Quality Cost Management

Managing quality cost requires the input of account managers, functional area managers, and process owners. Process owners calculate their quality cost based on performance measures of processes and employees (Lari & Asllani, 2013). The cost is the applied monetary value based on the data collected. After identifying a procedure to measure quality cost, a calculation system is implemented at all levels of management to ease monitoring and analytical methods, which will benefit the system (Lari & Asllani, 2013). The biggest challenge is the collection of related data from other departments. Ensuring all related data are filled on time and follows the right procedure, eliminating delays of performance evaluation.

Companies also have problems with how to assemble data for rework procedures. Part of the problem is that the right procedures, which guide rework instructions are lacking. Incoming goods inspection is also an area, which needs great attention because it is an area of high-quality cost. Most companies try to shift this cost to the supplier by requesting parts inspection at their respective sites, but many parts still have defects.

With no proper inspection in place, non-conforming parts go to production lines. These parts do not meet quality measures and in turn, the whole operations. Managers and operation inspectors must develop procedures and the right instructions for inspection to take place without production issues.

The research studies involve Six Sigma deployment and its integration into the Total Quality Management framework for project deployment. Furthermore, based on the results obtained, explaining the advantages of implementing a Six Sigma program and identifying the critical success factors, which enable a successful Six Sigma implementation, is one of the study objectives. The chapter involves sources of a literature review from academic and professional literature related to Six Sigma: a theoretical framework describing the basis on which the project. A cross-section of literature relates to the background and origin of Six Sigma and Total Quality Management.

Six Sigma Implementation and Challenges

Implementing Six Sigma requires guidance to inform experts who can design a roadmap that will provide help in achieving a successful execution (Setijono & Laureani, 2012). The Six Sigma process involves the DMAIC (Define, Measure, Analyze, Improve, and Control) methodology (Cheng, 2008). One of the most critical steps includes the following:

- Choice of the project leader (champion)
- formation of a cross-functional team
- Developing measurable goals

- Creating or developing a plan, which addresses issues such as training, data collection, maintenance, and coordinator.

The Six Sigma structure provides a clear understanding of the interconnection between business processes and customer value. The command of the decision-making process includes project selection relative to available data, validation of the benefits of such a project, achievable, and sustainable results.

Six Sigma Success/ Failures

The support from top management and deployment of Six Sigma tools are the basis of Six Sigma's successes. The application of these tools and data analysis affect the results of the project and provide direction in understanding the interpretation based on the voice of the Customer (Brook & Brook, 2010). Meeting such challenges, Practitioners need adequate training and education to understand the requirements and efficiency in meeting all quality improvement objectives (The Six Sigma approach entails training of Black Belts, Green Belts, and Champions of the various activities (Pande & Holpp, 2002). The training of these experts provides confidence to the project team and other support groups. While some researchers have spent time on the external factors that affect its implementation and application, the holistic nature of the method makes it difficult to address specific challenges that might cause Six Sigma to fail. The main issues affecting the Six Sigma projects include; team workload, technical difficulties, organizational culture, and top management commitment (Eckes, 2001). Most companies find it challenging to commit to Six Sigma in the long term due to insufficient resources. Chakravorty (2010) suggested that about 60% of Six Sigma projects fail because of the lack of ability to choose the right projects and commitment to train expects to run such projects. Generally, implementing Six Sigma projects takes between periods of 6-12 months.

The lack of support from top management or leadership is one of the critical drivers to fail. The deployment of Six Sigma projects also plays a pivotal role in its failure. When the strategy of deployment does not achieve organizational goals, the expected results and sustaining such commitment within the organization becomes challenging (Lucian, Liviu, & Ioana, 2010). Projects need alignment to avoid delays in decision making between stakeholders and top management. Such decisions involve time for deployment base on the scope of the projects.

Six Sigma Challenges

Most companies now invest in employee training and education to ensure quality improvement. Six Sigma implementation needs education and training. The training of Master Black Belts (MBB), Black Belt (BB), Green Belt (GB), and other training courses, including leadership skills, project management, data analysis, and quality improvement tools are necessary to support six sigma projects (Black & Revere, 2006). Because Six Sigma is a project-based program, the project leaders, who are black belts, identify and implement improvements needed to make product manufacture and services effectively. The success depends on the period used for project execution and the tangible benefits for the organization, and the customer and the project selection must not only be reflexive but should be inclusive (Andersson et al., 2006). The criteria for choosing such projects depend on the organizational needs and available resources, including the critical nature of the problem concerning the bottom line.

The budget is one of the aspects that associates with overall cost reduction and poor quality (Agrawal & Tiwari, 2014). The organizational budget includes technology, labor, and process transactions that are of great interest to the management. Leveraging the resources in place with the project cost gives the leaders an idea of strategizing towards project goals. That means repeated tasks are broken down and analyzed to provide an inside of the best way to improve performance. Narrowing the scope of the project within a reasonable period contributes to project success and completion. Projects should enable data collection and analyzes within a reasonable timeframe (Formby & Dave, 2016). It is always better to execute smaller projects that align with a big problem than trying to achieve all solutions within one project (Laureani & Antony, 2018).

Applying Six Sigma requires a good understanding of the current process performance, for example, collecting data relating to the input variables (X-variable) and not just focusing on the output variables(y-variables). The availability of data for both variables is an essential condition for selecting a Six Sigma project (Agrawal & Tiwari, 2014).

Defects Reduction

Results that are not desired by the organization and do not satisfy the customer are said to be defects. Six Sigma reduces these defects to less than 34 million defects per million opportunities. Six Sigma projects are mostly about minimizing anything that goes beyond customer requirements or specifications. The rate of defects is measured as a function of opportunity.

Reducing Cycle Time

Most successful projects reduce the time to complete workflow or process. Reducing the cycle time has a significant impact on the results. Sometimes reducing the cycle production time eliminates waste.

Customer Satisfaction

The interest of the customer is always part of every decision made by the Six Sigma project planners. Customer complaints provide opportunities for improvement. The first step is to consider the voice of the customer. Then, understanding the problem and its effects on the business. The voice of the customer helps in investigating the root cause and requires quantitative analysis.

Organizational Support

The systemic implementation of Six Sigma can only take place with the adequate support of the organization. That means some specific roles and operations are essential elements defined for the Six Sigma program. Top management takes the responsibility of providing sufficient support regarding resources and leadership, making it a top-down process. From the chief executives to senior managers who are champions and sponsors of the projects. The Master Black Belts are full-time consultants, and Black Belts play vital roles in the process. They take responsibility for the most critical areas of the project. The green belts participate on a part-time basis (Wasage, 2016). The contributions of Six Sigma projects are evident because of the realization of better management and operations practices.

Every result-oriented project involving technical knowledge and tools needs the support of management and resources to meet with the objectives of the project. One of the unique features of Six Sigma is the use of several practices related to human resources, specifically the use of full-time employees.

Limitations of Six Sigma

For a Six Sigma project to be successful, it requires active personnel and leaders who are ready to dedicate time, money, and talent to implement the project. The second problem is the rush by many organizations to deploy Six Sigma without having a firm grasp of the requirements of successful implementation (Saja et al., 2014). The companies can only overcome such obstacles by fully committing to the methodical process. Only then, can a project meet the core principles, which makes a difference in performance. Third, poor execution is also another problem. Even under the supervision of experts, Six Sigma projects can still be challenging to implement with poor execution (Saja et al., 2014). Anytime when the process improvement cannot align with the goals and objectives of the organization, the probability to fail increases. Although Six Sigma has been successful over the years, some companies have encountered failures using this methodology. One of the examples is the Whirlpool Company. Researchers believe that poor management and lack of use of experts in implementing Six Sigma led to failure (Saja et al., 2014).

Sometimes, one of the significant problems encountered stems from the management culture. Sustaining Six Sigma requires a supportive work environment and a culture that accepts Six Sigma experts such as MBB and BB to participate actively with the operational team, which includes most of the employees involved in the process or continuous improvement. Achieving such an environment is not a process. It comes with lots of resistance from employees at all levels (Laureani & Antony, 2018). The attention paid to reducing variation makes sponsors of the program forget about developing a more robust product, which can eliminate the variation reducing process simultaneously.

Another critic of Six Sigma is the change in organizational culture and the increase in Six Sigma bureaucracy. Organizational projects involving Six Sigma need approval from one management level to another. While these stages of approval are sometimes useful and structured, there are cases in which projects stifle with unnecessary burdens and bureaucratic issues. More so, with such rigid procedures, Six Sigma is sometimes seen to create roadblocks on many projects. For future studies, some areas of limitations might include:

- The challenge of data collection, especially in cases and processes in which no data is available at the start of the project.
- Prioritization of projects is one of the problems faced by many companies - prioritization subjects to judgment. There are very few tools to project forecast or judgment on prioritizing projects. Thus, future research should consider trust in such an initiative.

- The calculation of defects, which is 3.4 million defects per million opportunities, is a normality assumption. Non-Normal situations do not factor into calculations or address in present Six Sigma literature.
- Organizations must always consider current critical to quality (CTQ) characteristics because of the dynamic nature of the market because CTQ changes rapidly based on demands.

Constructs and Study Methodology

The constructs applied to similar studies will rely on the scope of the research as determined by the researcher (Black & Revere, 2006). Determining the factors that lead to failed Six Sigma implementation starts through the identification of critical characteristics of existing processes and potential parameters that affect quality improvements. As previously mentioned, data collected is used to determine the statistical significance of the parameters while attempting to develop a predictive model on the implementation of successful six sigma implementation, an initiative that has been ignored within the current literature. The research questions and the hypothesis suggest that a quantitative methodology is appropriate for the research study. The quantitative methods involve a survey that is used to validate all construct, such as processes, leadership commitment, and six sigma tools. These constructs are identified in other literature sources as constructs affecting Six Sigma quality improvement efforts.

After many attempts to explain the benefits of implementing Six Sigma but the reasons for its failure are discussed based on identifying the factors that prevent its successful implementation but lack the reasons for sustaining its implementation over a long period. According to (Glasgow, Caziewell, Jill, & Kaboli, 2010), the Six Sigma program fails because less attention is given to the CSF during its implementation. A review of most of the literature on Six Sigma implementation shows a limitation to the published factors that lead to Six Sigma failures (Duarte, Montgomery, Fowler, & Konopka, 2012). Therefore, this study aims at reducing the gaps that exist by exploring ways to understand the main critical failure factors of Six Sigma implementation.

Gaps in Literature

Several researchers have argued that Six Sigma implementation has failed many companies from achieving their desirable results (Antony, Krishan, Cullen, & Kumar, 2012). According to Pedersen and Huniche (2011), about 70% of companies that implemented Six Sigma never achieve considerable benefits. In a survey done by Chakravorty (2010), 70% of the respondent showed dissatisfaction with six sigma results. These failures do not lay too much blame on the methodology; they fail because less attention is given to the CSF during implementation. That is why the variables such as organizational management, Six Sigma statistical tools, management commitment, and scope of the projects need to be considered as critical factors during the implementation of Six Sigma.

Despite the extensive benefits of Six Sigma to companies, few researchers have provided a holistic view of the methodology. The absence of such endeavors has given chances for others to define the failures of Six Sigma implementation in vague terms. Reviewing the related literature on Six Sigma exposes gaps in the conclusive nature to which many researchers share their observations on Six Sigma implementation. Six Sigma is an agreed, logical approach used to manage the quality of products and services. Some researches consider Six Sigma to be a business concept without relating the Critical Failure Factors used to improve quality. Identifying the problem makes Six Sigma a methodology that relates to a project and gives practitioners the chance to apply the DMAIC approach and design while creating successful models in solving problems. When top management identifies the problem, implementing and managing the project becomes practically more accessible from the outset. A comprehensive and detailed study on the cause of six sigma implementation failures has not been explored.

The literature explains the ability of individuals to convince business leaders that Six Sigma does not work (AlSagheer, 2011). These opinions evolve through the lack of interest in looking at the Six Sigma approach that reigns through many organizations because the results obtain sometimes does not meet the project outcome. The literature falls short of discussing the critical factors that lead to most Six Sigma project failures. The study addresses gaps and unaddressed critical factors of these failures by most researchers. These gaps also provide understanding through the validation of the Six Sigma methodology.

Summary and Conclusions

This chapter covers the literature review of TQM and Six Sigma, describing the methodology, benefits, challenges, and history of the methodologies. Furthermore, Six Sigma statistically drives the aim of eliminating defects and reducing non-value-added approaches that affect the bottom line. Most of the articles reviewed did not explain the critical factors, which affect the implementation of Six Sigma. Six Sigma shares some similarities with TQM. The two methodologies focus on process improvement, management, teamwork, customers, and organizational culture. Their systematic and improvement strategies lead to a significant reduction in defects.

Past research and literature focused on the holistic nature of Six Sigma implementation. Unfortunately, less emphasis on CFF of implementation and the logical basis for predicting future outcomes. Within the scope of our study, we are focusing on the Critical Failure Factors (CFF) of Six Sigma methodology. The research studies involve Six Sigma deployment and its integration into the Total Quality Management framework for project deployment.

Based on the results obtained, the advantages of implementing a Six Sigma program and identifying the critical success factors, which enable a successful Six Sigma implementation, are explained. The chapter involves sources of the literature review from academic and professional literature related to Six Sigma: a theoretical framework describing the basis on which the project. A cross-section of literature relates to the background and origin of Six Sigma and Total Quality Management. Chapter 3 involves the choice of the research method (quantitative) and the selected design used for planning and conducting the research project. Furthermore, it describes the rationale behind the design strategy and methodology in which data collection occurs during the process, including the different data collection procedures, ethical procedures, and validation of the study

Chapter 3: Research Method

Chapter 3 includes the researched method used for the study. The research method includes an underlying philosophy and approach used in planning and conducting the research. Furthermore, it described the design strategy and methodology in which data collection occurs during the process, including the different data collection techniques.

The study involved two independent variables (CEFs) and a dependent variable (Failure variable). The independent variables are Six Sigma organizational management and Six Sigma statistical tools. The dependent variable (DV) is Six Sigma implementation failures. The research questions evolved from literature reviews that led to validation and statistical evidence of reliable data obtained from previous studies. Moreover, the quantitative method provided adequate techniques and enabled the researcher to develop a better understanding that could boost the positive effects of business organizations. The main areas of focus are research design, methodology, data collection procedures, ethical procedures, and validation of the study.

Research Design and Rationale

Quantitative research methods are methods that involve numerical data and measurable information within an investigation of a relationship or phenomena. The methods assist in explaining, predicting, and controlling relationships between measurable variables (Kapoor, 2016). In a quantitative study, the measurement steps are considered before data collection because the techniques of measurement and capturing the necessary data are sometimes complex depending on the source of information

(Kapoor, 2016). The results justify the data and statistical analysis. The quantitative research method typically starts with the process of the data collection, which is based on the theory and field practices, then continues with inferential or descriptive statistics (Agogo et al., 2016).

Quantitative research methods applied for the study involved the application of statistical methods to analyze data during findings. To validate the findings, empirical observation involved studies with rigorous verification, which constitute the chosen non-experimental research design. The hypothesis depends on the variable, which ascertained the laid down conditions. Hypothesis testing is one of the main techniques associated with quantitative method analysis (Creswell, 2014). Hypothesis testing involved the research questions and other variables. The study involved a quantitative research study, which investigated the critical factors that lead to Six Sigma implementation failures. Empirical evidence of both Critical Success Factors (CSF) and Critical Failure Factors (CFF) during implementation were used to attain study objectives. Three variables were considered: two independent variables (Critical Effective Factors) and a dependent variable (Six Sigma failures)

- Independent Variable A: Six Sigma organizational management. These are the roles and responsibilities involved in supporting Six Sigma implementation. A 5-point Likert scale was used to measure variables. The variable was used to assess a correlation between Six Sigma organization and Six Sigma implementation failures.

- Independent Variable B: Six Sigma statistical tools. These are problem-solving statistical tools used to support process and operation improvement technics of Six Sigma. A 5-point Likert scale was used to measure variables. The variable was used to assess a correlation between Six Sigma statistical tools and Six Sigma implementation failures.
- Dependent Variable: Six Sigma implementation failure. A Six Sigma implementation in which an insufficient return on investment (ROI) as primarily identified and approved is achieved (Albliwi et al., 2014). The dependent variable is the variable for investigation, which is measured based on the certainty of the answers provided for question 16 by survey participants. The hypothesis depends on this variable to ascertain the laid down conditions.

A relationship between the variables and the collected data was established. In general, quantitative research provides answers to questions based on the following observations:

- Evidence that a relationship between the variables exists. Understanding the relationship between the independent variables (Six Sigma organizational management and statistical tools) and the dependent variable (Six Sigma implementation failures) was established.
- The study involved a data sample from a survey involving Six Sigma practitioners who have participated in implementing the Six Sigma program in their respective companies and organizations. The correlational research design addressed the following questions:

Research Question 1: Does the lack of organizational management affect Six Sigma implementation failure?

$H_0 1$: Six Sigma implementation does not fail because of organizational management.

$H_1 1$: Six Sigma implementation fail because of organizational management

Research Question 2: Does the lack of Six Sigma statistical tools application affect Six Sigma implementation failures?

$H_0 2$ = Six Sigma statistical tools application are not the drivers of Six Sigma implementation failures.

$H_1 2$ = Six Sigma statistical tools application are the drivers of Six Sigma implementation failures.

In determining if the two independent variables (Critical Effective Factors) contribute to Six Sigma implementation failures (dependent variable) and predicting the settings of a successful Six Sigma Implementation., the research questions were answered using results of multiple regression model by testing the effects of the two independent variables on the dependent variable. A multiple linear regression analysis with the two independent variables X_1 and X_2 in predicting the dependent variable Y was conducted.

$$Y= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + e$$

The survey questions included multiple-choice to which objective responses were expected. The critical factor has rated using the Likert scale of 1 to 5 (1 = Strongly disagree, 2 =Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree). To advance our knowledge on Six Sigma implementation, participants were asked questions ranging from management, organizational management, Six Sigma tools, Six Sigma success, and failures. The data collection process met study goals despite the difficulty in recruiting many participants. These constraints were considered during planning deliberations. The research is a non-experimental study in which two or more variables are measured to assess the statistical relationship between the variables. A correlational research design approach was appropriate for the study. The correlational research design is preferred because the independent variables cannot be manipulated to force the presence of causality.

Methodology

A quantitative research method is appropriate for the study. The amount of information needed for such a business-related study reinforces the use of the quantitative methodology because seeking the understanding of the Six Sigma concept, and the correlation between variables based on related research questions needs the quantitative requirements. One of the main objectives of the quantitative method approach is maximizing replicability and generalization of research findings (Burns, 2014). Such generalization typically leads to new predictions. The key influences depend on instruments, which reduce bias such as the test and surveys used for data collection and the reliance on statistical analysis that relates to research questions (Seem, Nachmias, & Nachmias, 1988). The nature of the quantitative research design approach makes the inferences of the statistical test particular to the population, and the study is defined by the established sample characteristics (Burns, 2014).

The study involved a well-selected process and a representative sample, making it possible to generalize the findings. Data collection was consistent while also increasing the validity of the survey instruments. Most of the survey questions were firmly related to the research question. There was no evidence of interaction between the participants, thereby limiting the possibility of exhibiting bias.

Population

Because one of the main objectives of the study was to investigate the relationship between Six Sigma statistical tools and organizational management with respect to the critical factors that lead to Six Sigma implementation failures, the population of the study consist of Six Sigma practitioners who have participated in at least one Six Sigma project. These practitioners are individuals working for different companies, businesses, and organizations that make use of the Six Sigma (DMAIC) approach to solving quality-related issues. The ability to obtain Six Sigma reports and the results of its implementation from most companies are minimal; hence, it is difficult to provide the exact number of companies or businesses whose employees were involved in the study. For this study, the assumed estimated population of practitioners could be not envisaged because most organizations do not publish their Six Sigma implementation failure data to the public. These practitioners include Executives, Managers, Champions, Master Black Belts, and Black Belts.

Sampling and Sampling Procedures

The collection of data from selected individuals who are a representation of a group within a category is called sampling (Ravitch & Carl, 2016). To that effect, Six

Sigma (DMAIC) participants were selected in order to ensure that the sample reflects the key characteristics of the study population in order to reduce the margin of error. The sample constitutes Executives, Managers, Champions, Master Black Belts, and Black Belts, whose companies have implemented Six Sigma and have both failed and successful stories to share. For Consent Form (See Appendix D)

The Probability of getting accurate results depends on the sample that is a representation of part of the population. The sampling strategy of this study accurately represented the population in order to produce results that could be generalized to the entire population. For this study, random sampling was the best method because it reduced bias, and the results could be generalized. The right sample sizes for quantitative research should have a confidence level that ranges between 95% - 99%, and a probability of the unrepresented proportion of the total population of less than 1% (Adams, Khan, & Raeside, 2014). The inclusion and exclusion criteria of participants reflect a study sample of Six Sigma Practitioners who have participated in implementing Six Sigma DMAIC in their respective organizations or managed Six Sigma DMAIC projects.

A power analysis using the G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) program was conducted in determining the sample size. Considering the required α level, using two tails, estimated effect size, and power level, statistical power is being used to determine the required sample size (Cohen, 1992). The sample population was made of 223 participants. I considered 223 participants assuming a minimum sample size for a margin for error. To determine the minimum sample size, a statistical two-sample *t*-test was conducted with a power of 0.95, effect size of .80, and confidence of 95%. The results showed a minimum of 42 per tail side, equaling a minimum of 84 valid responses. Thus, a minimum response rate of 42% should accurately represent the population. The G*Power indicates a minimum sample size of 84 participants (Table 1)

Table 1

*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)	=	.95
Allocation ratio N2/N1	=	1
Output: Non-centrality parameter δ	=	3.6660606
Critical *t*	=	1.9893186
Df	=	82
Sample size Group 1	=	42
Sample size Group 2	=	42
Total sample size	=	84
Actual power	=	0.9518269

Procedures for Recruitment, Participation, and Data Collection (Primary Data)

The study participants were recruited for the study based on their participation in at least one Six Sigma project. The recruitment process occurred through two reputable social media organizations, LinkedIn and Survey Monkey. Through these media, Six Sigma practitioners were recruited to participate in the survey. The participants fulfilled at least one of the following conditions:

- Participant must be Six Sigma Master Black Belt, Black Belt certified
- Participant must have led a Six Sigma project
- Participant must have sponsored a Six Sigma project
- The participant must have been a manager of an organization that implements the Six Sigma program.
- Participant must be a Six Sigma trainer

The selection provided a rationale to obtain a broad view from practitioners of Six Sigma of many organizations. The data collection procedure began through the process of contacting and securing the participants for the survey. Data collection involves data assembling and measurements of obtained data with the specific objective of using the information to answer research questions and hypotheses (Ravitch & Carl, 2016).

The data collected was used to evaluate and predict future outcomes. Inaccurately collected data can lead to invalid results that could affect the study. The survey questionnaire includes questions of a questionnaire developed by Richard Sands (A Ph.D. graduate of Walden University). The quantitative survey questionnaire was developed using survey monkey and distributed to participants using an electronic distribution method. The questionnaire includes scale-type multiple-choice questions for respondents. The critical factors are rated using the Likert scale of 1 to 5.

The survey includes questions from validated literature, which constitutes material from salient areas related to successful and failed Six Sigma DMAIC projects. The survey was designed to provide specific answers concerning the research questions and other related material observed from the literature review. According to Fowler (2002), designing the questionnaire is critical because the responses depend on the way the questions are worded. The questioning format is closed-ended to enable quantifiable data collection and ensuring essential statistical analysis procedures. The questionnaire was developed using data from a comprehensive literature review by Six Sigma experts, and other suggested amendments were considered before carrying out a pilot study. Based on the comprehensive nature of the questions, the survey should take a maximum of 8-12 minutes.

All randomly selected 223 participants were contacted social media. The SurveyMonkey weblink to the approved consent and open-ended questions was sent to each participant via email. All participants received the approved consent and completed the acceptance and signing process before gaining access to respond to survey questions. Once all questions were answered and submitted, the SurveyMonkey software stored the tabulated data. The collected data was transferred into Microsoft excel and saved into my document’s accounts.

Instrumentation and Operationalization of Constructs

Quantitative data are reliable when validated instruments are used during data collection. The validated survey measures the dimensions related to survey questions aligning with organizational culture, Six Sigma statistical tools, organizational management, leadership, and organization performance.

The name of the questionnaire developer is Richard Sands, who is a graduate of Walden University. Dr. Sands's dissertation is titled "When does Six Sigma reduce defects and increase deficiencies" (Sands, 2015). Sands (2015) created a questionnaire for a survey that examined what leads to Six Sigma project failures and the implications to the service industry (The permission letter is in appendix A). The study explored factors contributing to Six Sigma project failures by comparing responses of Six Sigma practitioners who both failed and succeeded in conducting Six Sigma projects. The results from the survey were quantified and analyzed, and conclusions were made on the reasons for Six Sigma project failures. The findings underscored the need for more investigations within the organizational management contexts and other critical factors influencing Six Sigma implementation. The questionnaire was used for the study to determine the critical failure factors and predicting the failures during the Six Sigma implementation. The collected survey data were analyzed to understand failure variables and their effects on Six Sigma implementation within the scope of the study.

The SurveyMonkey tool is a self-administered online tool used to collect data. SurveyMonkey represents a hosting and internet site that researchers use to survey through the internet. The web-based tool used for the study provides the researcher with the ability to introduce the purpose of the research with emphasis on the confidentiality of the participants, and the willingness to voluntary participate. A test was conducted in comparing the means and testing the independence of the instrument using the chi-square test. All participants followed survey instructions by providing answers using a 5-point Likert scale to the questions relating to the study.

Data Analysis Plan

A systematic approach in cleaning, inspecting, and modeling the data was used to discover new information from the survey responses. After collecting all data, the survey data was transformed into a compatible SPSS. The data screening procedures involved proofreading on collected data for accuracy, checking randomly missing and duplicated data, detecting and determining outliers. During data screening, only completed surveys were considered. Internal consistency was measured using Cronbach's alpha reliability test. All obtained data were analyzed using SPSS statistical software.

The study addressed the following questions:

The research questions are as follows:

Research Question 1: Does the lack of organizational management affect Six Sigma implementation failure?

$H_0$1: Six Sigma implementation does not fail because of organizational management.

$H_1$1: Six Sigma implementation fail because of organizational management

Research Question 2: Does the lack of Six Sigma statistical tools application affect Six Sigma implementation failures?

$H_0$2 = Six Sigma statistical tools application are not the drivers of Six Sigma implementation failures.

$H_1 2$ = Six Sigma statistical tools application are the drivers of Six Sigma implementation failures.

In determining if the two independent variables (Critical Effective Factors) contributed to Six Sigma implementation failures (dependent variable), Two inferential techniques (Pearson correlation coefficients and multiple regression analysis) are employed. To answer the research questions, both descriptive statistics and multiple regressions were used to analyze each independent variable and the dependent variable. A Kolmogorov-Smirnov test is considered in order to examine the normality of the dependent variable.

The Pearson correlations (ρ) between the dependent variable and the two independent variables are examined to measure their level of statistical significance in considering the null hypothesis. Multiple regression analysis is used in predicting the dependent variable from the independent variables. The test also provides information that relates to the impact of the two independent variables on Six Sigma failures. Thus, conducting a multiple regression analysis with the two independent variables X_1 and X_2 in predicting the outcome of the dependent variable Y, $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + e$. The questions are analyzed using descriptive statistics. That means the statistical analysis of the data is interpreted based on the mean, percentage total, and standard deviation. The values would determine the central tendency of the data and variations between the mean concerning the available answers of the survey.

Understanding the critical failure factors helps Six Sigma practitioners and executives in making better decisions and developing effective ways of preventing process variations and reducing defects in product manufacturing and other applicable areas (Raja, Gopikumar, Smitha, Ayon, & Jiju, 2018).

Threats to Validity

In this study, much emphasis was laid on the importance of both internal and external validity. The consistency in presenting a validated data through a well-structured questionnaire to participants and the reliability of the instruments used were considered. The questionnaire developer used data from an extensive literature review to develop the online survey questionnaire. All obtained data were analyzed using SPSS statistical software. Internal consistency was measured using Cronbach's alpha reliability test for the corresponding scale. Table 2 below represents the Reliability Statistics Table with the Cronbach alpha value .805. The value indicates a high level of internal consistency.

Table 2

Reliability Statistical Output

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.805	0.81	18

External Validity

According to Fei and Wang (2013), the notion that the results of quantitative research are always inherently accurate is misleading. Thus, acquiring data through survey methods and applying correlational study designs needs a high level of consciousness concerning the validity and reliability of the instruments of data collection (Fei & Wang, 2013). Researchers are bound to check the validity of data obtained because there is a possibility of a lack of control during data collection. Data obtained from the survey were validated to avoid wrong analysis. The measurement of data was based on the sample characteristic and not just the sample size. Research data validity, reliability, and generalizability are key concepts considered during our quantitative data measurements.

Internal Validity

Internal validity refers to the measurements or steps taken to ensure the existence of the study purpose (Almomani, Avi-Itzhak, Demeter, Josman, & Al-Momani, 2018). Internal validity is more related to theoretical knowledge and improves the researchers' is knowledge through survey questions and other instruments. The reliability of data depends on the degree of measurement errors. Internal validity can be measured through repeated measures to check consistency and similarity of the results. In quantitative research, the generalization of results from a sample of the population is a common practice. The probability that obtained results from a sample of less than 5% in error is called statistical significance (Marti, 2016). Testing the significance is sometimes confusing, but significant level estimates, and confidence level interval lead to generalization.

This quantitative study determined if there was an existing relationship between the variables. A strong causality established that internal validity was strong. How the survey relates to data collection instruments and the demonstrated relationships between variables determines its reliability. The surveymonkey.com tool has been extensively validated from previous research (Almomani et al., 2018). Surveymonkey.com relates to the internal consistencies that are reliable based on the validation analysis of its components.

Construct Validity

The test of statistical significance was used to test assumptions and search for data patterns or distribution on the collected data. In dealing with construct validity, the issue relating to convergent validity was eliminated such that the measurements remain the same for the survey. The independent variables (Six Sigma statistical tools and organizational management) do not depend on each other. As such, construct validity did not present any threat to the study. SPSS Statistical Software was used to test for construct validity threats.

Ethical Procedures

The rules and necessary ethical conduct required to meet with the study were implemented. The ethical codes for the study to meet all guidelines were as follows:

- Honesty: The consent of all participants was considered during the process of data collection, publishing of results of the survey, and other approved procedures.
- Objectivity: The study was impartially conducted with apparent objectivity in data analysis, interpretations, and peer review standards.
- Integrity: The integrity of all participants was highly considered during the study.
- Respect: All permissions needed for publishing data and the use of the approved method was considered in adherence to intellectual property.

- Confidentiality: The identity of all other relevant communication related to research remains confidential and shall only be released based on the participant's permission.

The study and related information remain protected from the public according to Walden University's protection guidelines

Summary

Chapter 3 elaborated on the choice of the research method (quantitative) and the selected design used for planning and conducting the research project. The chapter explained the underlying approach, philosophy of planning, and execution. The Six Sigma approach seeks to identify, measure, and evaluate the improvement process, and at the same time, data are collected to establish causal relationships between different variables of the related study. To answer the research questions, the quantitative research choice aligns with other previous research studies.

The collected data from the survey is analyzed using SPSS software. The choice relates to the objective approach of data collection and numerical data analyzation using statistical methods. The individuals received the questionnaire by electronic mailings. The survey includes questions relating to implementation, project costs, management support, organizational impact, Six Sigma tools, business types, and customer satisfaction. Chapter 4 involves data analysis interpretation, implementation of research findings.

Chapter 4: Results

Chapter 4 involved data collection procedures and analysis of the process. The data collection process constitutes a collection of responses from survey participants' and instruments. After collecting all data, the survey data were transformed into a compatible SPSS. The data screening procedures involved proofreading, checking randomly missing and duplicated data, detecting and determining outliers.

The purpose of this quantitative study was to determine and develop knowledge of the critical factors that lead to Six Sigma implementation failures. The research involves a survey that further examines the relationship between failed Six Sigma implementation projects and critical factors that cause these failures. The proposed framework focuses on understanding the various reasons behind the failures of Six Sigma implementation. Testing the framework involves considering a proposed research hypothesis on the relationship between failures of Six Sigma implementation and the sigma tools. Three variables considered are two independent variables (Critical Effective Factors) and a dependent variable (Six Sigma implementation failures).

The research questions are as follows:

Research Question 1: Does the lack of organizational management affect Six Sigma implementation failure?

$H_0 1$: Six Sigma implementation does not fail because of organizational management.

$H_1 1$: Six Sigma implementation fail because of organizational management

Research Question 2: Does the lack of Six Sigma statistical tools application affect Six Sigma implementation failures?

$H_0 2$ = Six Sigma statistical tools application are not the drivers of Six Sigma implementation failures.

$H_1 2$ = Six Sigma statistical tools application are the drivers of Six Sigma implementation failures.

Demographics

Electronic data were collected data through an anonymous survey using a 5-point Likert scale. The survey was administered through SurveyMonkey.com, focusing more on the reasons behind Sigma DMAIC (define, measure, analyze, improve, and control) projects failures. The survey questions did not demand personal information. Therefore, no adverse events were anticipated to occur during the answering process. The criteria inclusion was related to those who had participated in at least one Six Sigma DMAIC project.

Data Collection

An anonymous survey, which included Six Sigma practitioners, was conducted. Below are steps of development and data collection for the study.

1. The developed survey questionnaire was reviewed and approved by the dissertation committee
2. The electronic survey was developed for distribution in Surveymonkey.com
3. Participants for the survey were recruited through

4. The survey link was distributed to participants by email, including other social media professional social media groups in LinkedIn and SurveyMonkey.
5. Participants responded to the survey.
6. Survey data were screened and uploaded in SPSS software

The data collection process included Six Sigma DMAIC participants who had participated in at least one Six Sigma project. All participants were in the United States. In total, 223 Six Sigma practitioners were contacted through social media (LinkedIn six sigma professional social groups and SurveyMonkey Six Sigma expert collectors) to request survey participants. The approved consent by the university was included through SurveyMonkey.com.

Data collection was launched and collected between October 8, 2019, and October 28, 2019. The participants were able to launch the survey by clicking to the provided SurveyMonkey.com web link. After answering all the questions, the survey was then submitted using the submit button. The collected data were processed and stored in the SurveyMonkey software. The survey was anonymously conducted. Participants could not be identified and were allowed the option to either voluntary complete or leave the survey uncompleted. Amongst the 223 Six Sigma practitioners that were contacted, 115 accepted to participate in the survey, resulting in a response rate of 51.5%. The response rate of 51.5% is satisfactorily more than the projected response rate of 42% earlier indicated. All participants answered the questions using the 5-point Likert scale. The collected data was transferred into Microsoft excel and saved into a Dropbox account. The Data was later transferred into the SPSS software to ease quantification, analysis, and regeneration of results. The raw data is stored in a secured Microsoft account for a minimum of 5 years.

Study Results

This section involves data analysis and approaches or statistical techniques employed to obtained answers to research questions. The survey respondents answered specific questions on the main factors that contributed to successful and failed Six Sigma DMAIC implementation on which they had the opportunity to participate. The results of the 18-question anonymous survey were tallied for "Agree and Disagree," as shown in Appendix C. In this section, the survey response data is being used to analyze the response questions and hypotheses to the related study.

Research Question 1 - Does organizational management affect Six Sigma implementation failure?

As shown in Table 3, the respondents were asked if the Six Sigma DMAIC project was supported by management. The modal class of the variable is "Agree," which means that most respondents agree that their project was supported by the management (33.9%). 27.8 % of the respondents strongly agreed with the statement that management supported the project. Overall the higher percentage said that their projects were supported by management (61.7% Agree and strongly agree). The results support the general assertion that support from management is vital to Six Sigma implementation. Nevertheless, even if this component was fulfilled, the project still failed for different reasons.

Table 3

Descriptive Statistics for Survey Question 1

Was your Six Sigma DMAIC* project supported by management?		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	3	2.6	2.6	2.6
	Disagree	8	7.0	7.0	9.6
	Neither agree nor disagree	33	28.7	28.7	38.3
	Agree	39	39.0	33.9	72.2
	Strongly agree	32	27.8	27.8	100.0
	Total	115	100.0	100.0	

Another finding related to RQ1 was, "Did management in your Six Sigma DMAIC project hierarchy understand Six Sigma?" The modal class of the variable is "Neither agree nor disagree," which means that most respondents remain neutral about the statement that the management of their DMAIC project hierarchy understands Six Sigma (33%). 17.4 % of the respondents Disagree with the statement that their DMAIC project hierarchy understands Six Sigma. 5.2% strongly disagree, 28.7% agreed, while 15.7% strongly agree. Overall the higher percentage said that the management of their DMAIC project hierarchy understood Six Sigma (44.1 % strongly agree and agree).

The different stages involved in a Six Sigma project requires the project manager and top management executives to understand the requirements of Six Sigma. The organizational management's active involvement of top management is needed in supporting the quality improvement method in enabling the success of Six Sigma projects (Eckes, 2001). The data obtained for this study supports Six Sigma projects, but the projects might fail due to other reasons. Therefore, the research findings can be used to close the gap established that Six Sigma fails because of inadequate support from management. Factors beyond organization management support can contribute to failures during implementation.

Table 4

Descriptive Statistics for Survey Question 12

Did management in your Six Sigma DMAIC* project hierarchy understand Six Sigma?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	6	5.2	5.2	5.2
	Disagree	20	17.4	17.4	22.6
	Neither agree nor disagree	38	33.0	33.0	55.7
	Agree	33	28.7	28.7	84.3
	Strongly agree	18	15.7	15.7	100.0
	Total	115	100.0	100.0	

RQ2 - Does Six Sigma statistical tools application affect Six Sigma implementation failures?

The results from respondents on the project champion's level of understanding the statistics behind Six Sigma projects are shown in table 5. The modal class of the variable is "Agree." That means, most respondents agree that their project Champion understood the statistics behind their Six Sigma project (36.5%). 17.4% of the respondents strongly agreed that their project Champion understood the statistics behind their Six Sigma project. 31.3% were neutral about the topic, 13.9% disagreed, while 0.9% strongly disagree. Overall the higher percentage said that their project Champion understood the statistics behind the Six Sigma project (53.9% Agree and strongly agree)

Table 5

Descriptive Statistics for Survey Question 14

Did your Six Sigma DMAIC* project Champion understand the statistics behind your Six Sigma Project?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	0.9	0.9	0.9
	Disagree	16	13.9	13.9	14.8
	Neither agree nor disagree	36	31.3	31.3	46.1
	Agree	42	36.5	36.5	82.6
	Strongly agree	20	17.4	17.4	100.0
	Total	115	100.0	100.0	

Because Six Sigma is a data-driven approach that relies on statistics and data analysis, some individuals who manage projects should understand the statistical needs during the problem-solving process. At every of the Six Sigma DMAIC process, statistical techniques are needed. Therefore, project champions must not just understand the manipulation of statistical tools but also need to understand the statistics behind six sigma (Smyrlis & Moschidis, 2015). According to the results, about half of the respondents believed that the project champions (53.9 % Agree and strongly agree) understood the statistics behind the Six Sigma project. That means analyzing the data obtained at various stages could be very challenging for some project managers.

Null Hypothesis Test

The Chi-square statistical test was performed to determine which statement supports the collected data. The statements relate to the null hypothesis and the alternative hypotheses. The Chi-square statistical test compares the survey data with expected data by measuring the variation between the observed counts and expected counts. The results of the tests are shown in table 6 below

Hypothesis 1

$H_0 1$: There is no association between Six Sigma organizational management and Six Sigma implementation failure.

$H_1 1$: There is an association between Six Sigma organizational management and Six Sigma implementation failure.

A chi-square test of association was used to test the above association (Table 6). There are 64% cells with an expected count less than 5. Fisher exact test will be interpreted for that reason the test is significant at a 5% level of significance (Fisher's exact statistic =30.940, P = 0.002). Therefore, the null hypothesis is rejected. There is sufficient evidence from this sample data an association exists between Six Sigma organizational management and Six Sigma implementation failure.

Table 6

A Chi-Square test of association /Cross tabulation hypothesis 1

Was your Six Sigma DMAIC* project supported by management? * Was your organization affected when your Six Sigma DMAIC* project failed? Cross tabulation

	Was your organization affected when your Six Sigma DMAIC* project failed?					Total
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	
Strongly disagree	0	1.0	1.0	1.0	0.0	3.0
Disagree	0	2.0	3.0	2.0	1.0	8.0
Neither agree nor disagree	0	5.0	24.0	2.0	2.0	33.0
Agree	4	3.0	20.0	9.0	3.0	39.0
Strongly agree	8	9.0	7.0	6.0	2.0	32.0
Total	12	20.0	55.0	20.0	8.0	115.0

Chi- Square

	Value	df	Asymptotic	Monte Carlo sig. (2-sided)			Monte Carlo sig. (2-sided)		
			Significance	Significance	99% Confidence Interval		Significance	99% Confidence Interval	
			(2-sided)		Lower Bound	Upper Bound		Lower Bound	Upper Bound
Pearson Chi-Square	29.873a	16	0.019	.019b	0.016	0.023			
Likelihood Ratio	34.077	16	0.005	.006b	0.004	0.008			
Fisher's Exact Test	30.940			.002b	0.001	0.003			
Linear-by-Linear Association	3.843c	1	0.050	.052b	0.046	0.058	.027b	0.022	0.031
N of Valid Cases	115								

a. 16 cells (64.0%) have expected count less than 5. The minimum expected count is .21.

b. Based on 10000 sampled tables with starting seed 2000000.

c. The standardized statistic is -1.960.

Hypothesis 2

$H_0 2$: There is no association between Six Sigma statistical tools and Six Sigma implementation failure

$H_1 2$: There is an association between Six Sigma statistical tools and Six Sigma implementation failure

A chi-square test was conducted for the hypothesis. There are 68% of cells with expected counts. Fisher exact test shall be interpreted, showing that the test is significant at a 5% level of significance (Fishers exact statistic =33.035, P =0.002). Therefore, we reject the null hypothesis. There is enough evidence from this sample data showing that there is a relationship between **Six Sigma statistical tools** and **Six Sigma implementation failure.** The test is carried using a Monte Carlo simulation, so the p-value comes with a 99% confidence interval. (0.00, 0.002) this interval is below 0.05, which means that we are 99% confident that there is a relationship (at 0.05 level of significance).

Table 7

A chi-square test of association /Cross tabulation hypothesis 2

Did your Six Sigma DMAIC* project Champion understand the statistics behind your Six Sigma project? * Was your organization affected when your Six Sigma DMAIC* project failed? Cross tabulation

Count

		Was your organization affected when your Six Sigma DMAIC* project failed?					Total
		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	
Did your Six Sigma DMAIC* project Champion understand the statistics behind your Six Sigma project?	Strongly disagree	0.0	0.0	0.0	1.0	0.0	1.0
	Disagree	2.0	7.0	4.0	2.0	1.0	16.0
	Neither agree nor disagree	0.0	5.0	26.0	3.0	2.0	36.0
	Agree	5.0	7.0	19.0	9.0	2.0	42.0
	Strongly agree	5.0	1.0	6.0	5.0	3.0	20.0
	Total	12	20.0	55.0	20.0	8.0	115.0

Chi- Square

	Value	df	Asymptotic	Monte Carlo sig. (2-sided)			Monte Carlo sig. (2-sided)		
			Significance (2-sided)	Significance	99% Confidence Interval Lower Bound	Upper Bound	Significance	99% Confidence Interval Lower Bound	Upper Bound
Pearson Chi-Square	34.002[a]	16	0.005	.006[b]	0.004	0.023			
Likelihood Ratio	34.019	16	0.005	.004[b]	0.003	0.008			
Fisher's Exact Test	33.035			.002[b]	0.001	0.003			
Linear-by-Linear Association	.267[c]	1	0.606	.634[b]	0.646	0.058	.325[b]	0.022	0.031
N of Valid Cases	115								

a. 17 cells (68.0%) have expected count less than 5. The minimum expected count is .07.

b. Based on 10000 sampled tables with starting seed 624387341.

c. The standardized statistic is .516

Non-Six Sigma Methodology Related Failures

Finally, the respondents were asked if the Six Sigma DMAIC project failed for reasons other than the Six Sigma methodology. The modal class of the variable is Neither agree nor disagree, which means that most respondents are neutral about the statement that their Six Sigma DMAIC project failed for reasons other than Six Sigma methodology (35.7%). 15.7 % of the respondents Disagree with the statement that their Six Sigma DMAIC* project failed for reasons other than Six Sigma methodology, 10.4% strongly disagree, 24.3% agreed while 13.9% strongly agree. Overall the higher percentage said that their Six Sigma DMAIC* project failed for reasons other than Six Sigma methodology (38.2 % strongly agree and agree).

Table 8

Descriptive Statistics for survey question 18

Did your Six Sigma DMAIC* project fail for reason(s) other than Six Sigma methodology?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	12	10.4	10.4	10.4
	Disagree	18	15.7	15.7	26.1
	Neither agree nor disagree	41	35.7	35.7	61.7
	Agree	28	24.3	24.3	86.1
	Strongly agree	16	13.9	13.9	100.0
	Total	115	100.0	100.0	

Regression Analysis

This section provides details on the relationships that exist between the measured variables and the hypothesis. The assumptions (linearity, normality, Multi-collinearity, Homoscedasticity) of multiple linear regression were considered. A multiple linear regression analysis was conducted to predict the dependent variable from the independent variables. The independent variables X_1 and X_2 (predictors) were used to predict the outcome of the dependent variable Y: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + e$. Where β_0, β_1, and β_2 are the respective independent variable coefficients. The test also provided information that relates to the impact of the two independent variables on Six Sigma implementation failure.

Multiple regression can be used to assess the moderating effects of the variable. Three variables considered are two independent variables (Critical Effective Factors) and a dependent variable (Six Sigma implementation failures). Question 1 and 14 (Was your Six Sigma DMAIC* project supported by management and did your Six Sigma DMAIC* project Champion understand the statistics behind your Six Sigma project?) are questions, which measure the Critical Effective Factors that were identified as both success and failure factors. Question 16 (Was your organization affected when your Six Sigma DMAIC* project failed?) measures the outcome or dependent variable. A test was conducted to statistically test the Critical Effective Factors against the hypothesis statements relating to Six Sigma implementation failures. The main SPSS results that relate to interactions and the hypotheses are shown in the model summary, ANOVA, and Coefficient table below. The hypothesis also addresses the research questions.

Variables

- Independent Variable A: Six Sigma organizational management
- Independent Variable B: Six Sigma statistical tools application
- Dependent Variable : Six Sigma implementation failure

Hypothesis

H_0 = The Critical Effective Factors have no statistically significant effect on Six sigma implementation failures

H_1 = The Critical Effective Factors have a statistically significant effect on Six sigma implementation failures

Assumptions The following assumptions (linearity, normality, Multi-collinearity, Homoscedasticity) of multiple linear regression were considered.

Normality

A histogram of the regression residuals is approximately symmetric, which indicates that the normality condition is approximately met.

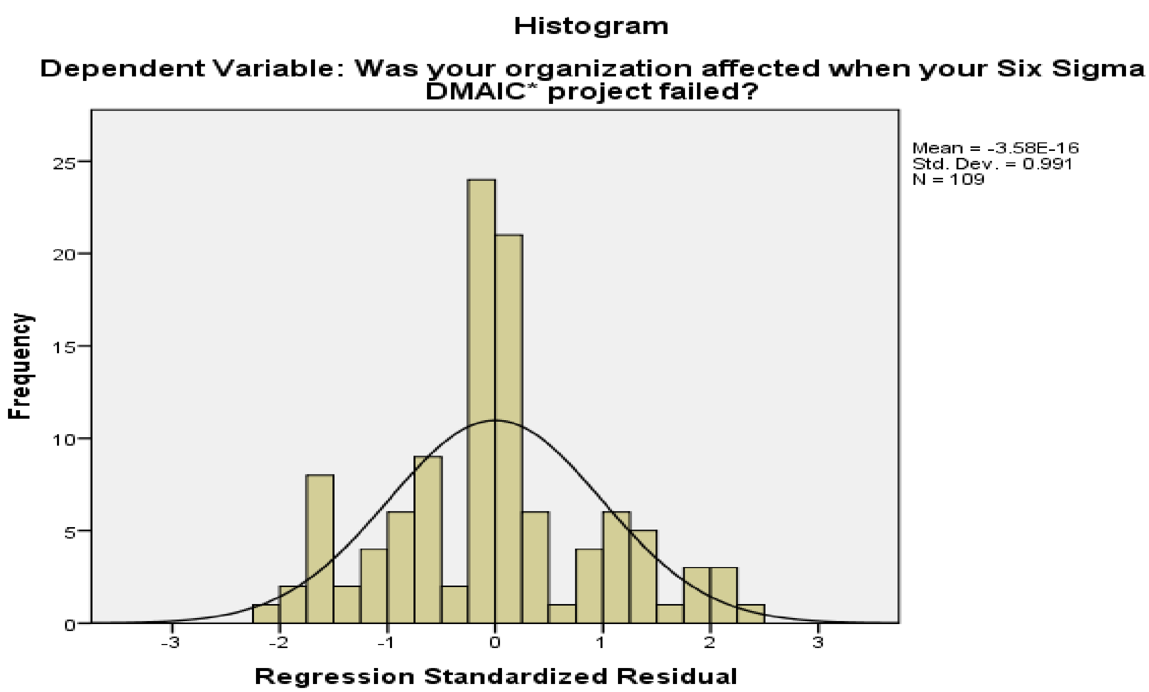

Figure 8. A histogram of the regression residuals.

Homoscedasticity

A scatter graph of standardized residuals against standardized predicted values shows a random pattern, which indicates that error variance is constant. The condition is, therefore, met.

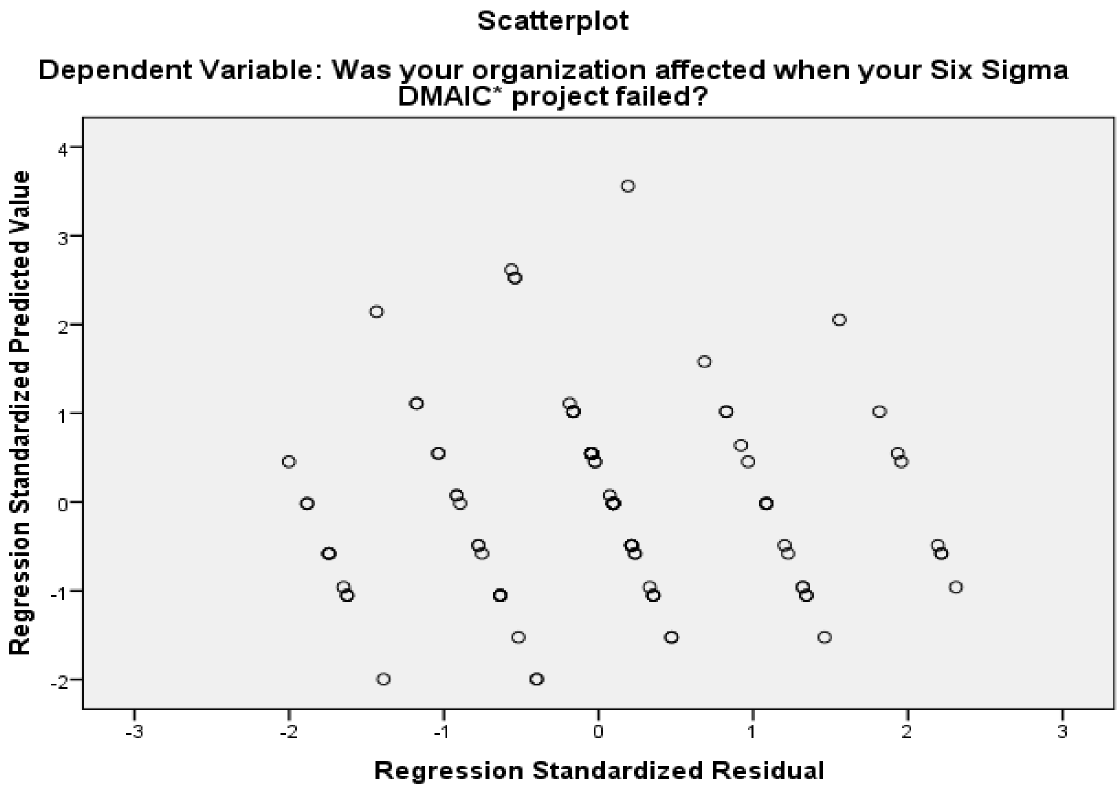

Figure 9. A scatter graph of standardized residuals.

Independence

The sample used for this analysis is gathered by is simple random sampling technique. Independence of observations can be reasonably assumed to be met.

Outliers

Casewise diagnostic did not return any case with a standardized residual higher than ±3, which indicates an absence of extreme values. For Mahalanobis distance, only one case was a significant outlier

Table 9

Descriptive Statistics for outliers

Outliers					
		Frequency	Percent	Valid Percent	Cumulative Percent
Casewise diagnostics	Not outliers	115	99.1	99.1	99.1
Mahalanobis distance	Not outliers	109	94	100	100

Linearity

From a scatter matrix, there is no strong linear relationship between the two independent variable variables, the dependent variable; the assumption is, therefore, not adequately met.

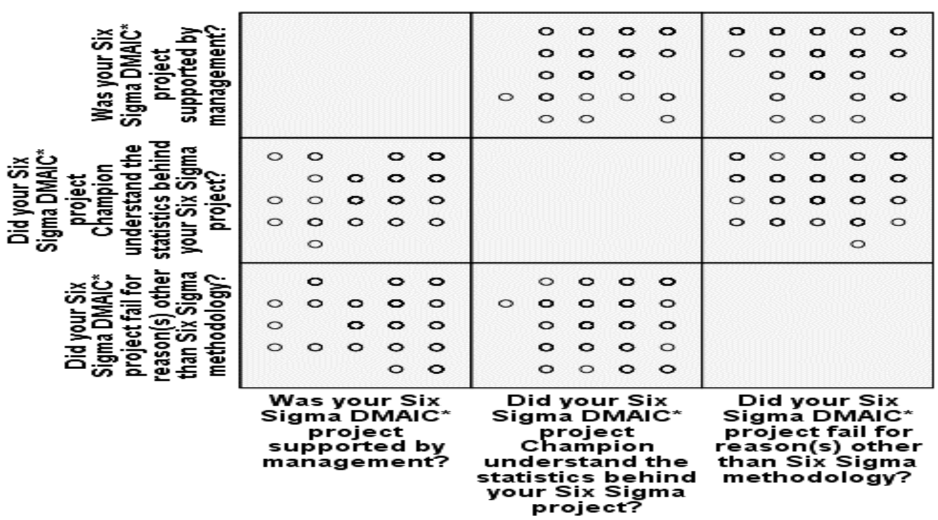

Figure 10. Linear relationship amongst variables.

Multicollinearity

The variance inflation factors are 1.002 for both variables, which is within the acceptable range of less than 5.

Regression Model

In the model summary, the R-value is 0.221, indicating a low correlation between the Critical Effective Factors and Six Sigma implementation failure. The R-Square value of 0.049 defines the percentage of variation of Critical Effective Factors to Six Sigma implementation failure. The independent variables account for 22.1% variation in the dependent variable leaving 77.9% with no tangible explanation. The Adjusted R-Square value of 0.032 indicates a low predictive power of the Critical Effective Factors.

The regression equation for Six Sigma implementation failure:

$$Y_{\text{Six Sigma implementation failure}} = 3.31 - 0.23X_1 + 0.14X_2$$

The difference in variation based on systematic to unsystematic changes were measured using the F-test. The F-test indicates the fitness of different linear models. The F-statistic of the regression is 2.87. The F-statistic is greater than 1, which means the model seems to be a better predictor of Six Sigma implementation failures. The p-value of the regression ANOVA is 0.061. A regression ANOVA test is significant at $P > 0.05$ level of significance ($F=2.87$, $P = 0.061$). One of Sigma values of the coefficients for the independent variable (Six Sigma statistical tools) is above the 0.05 (alpha value), the null hypothesis should not be rejected. Six Sigma organizational management was found to be significant at 5% level of significant

(B= -.23, P = 0.021). That means, on average, Six Sigma implementation failure decreases by 0.23 units for each unit increase in Six Sigma organizational management support.

Table 10

Regression Model output

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	.221[a]	.049	.032	1.007	.049	2.875	2	112	.061

a. Predictors: (Constant), Did your Six Sigma DMAIC* project Champion understand the statistics behind your Six Sigma project? Was your Six Sigma DMAIC* project supported by management?

Table 11

Regression ANOVA output

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.832	2	2.916	2.875	.061[b]
	Residual	113.612	112	1.014		
	Total	119.443	114			

a. Dependent Variable: Was your organization affected when your Six Sigma DMAIC* project failed?

b. Predictors: (Constant), Did your Six Sigma DMAIC* project Champion understand the statistics behind your Six Sigma project? Was your Six Sigma DMAIC* project supported by management?

Table 13

Regression Coefficients output

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	95.0% Confidence Interval for B Upper Bound
1	(Constant)	3.311	.433		7.650	.000	2.453	4.169
	Was your Six Sigma DMAIC* project supported by management?	-.232	.099	-.231	-2.340	.021	-.429	-.036
	Did your Six Sigma DMAIC* project Champion understand the statistics behind your Six Sigma project?	.140	.105	.132	1.334	.185	-.068	.347

Coefficients[a]

a. Dependent Variable: Was your organization affected when your Six Sigma DMAIC* project failed?

Summary

Data collection procedures were discussed, and the results obtained from the survey were presented using descriptive statistics and multiple regression analysis. The obtained data was a representation of six sigma practitioners from a cross-section of both manufacturing and service industries in the United States of America. The survey data included both identified success and failure factors of Six Sigma implementation. In an attempt to answer the two research questions, the collected data was analyzed based on the answers provided by the respondents to related questions of the survey.

For research question one (RQ1), to investigate the effect of organizational management on Six Sigma implementation failure, the answers provided to question 1 and 12 of the survey were considered. The answers provided by the respondents confirmed that without support from top management of the organization, six sigma projects are bound to fail. The results supported the assertion that organizational management support is key to running a successful Six Sigma operation. In addition, rejecting the null hypothesis associated with the research question was sufficient evidence that a relationship exists between Six Sigma organizational management and Six Sigma implementation failure.

For research question two (RQ2), to investigate the effect of Six Sigma statistical tools application on Six Sigma implementation failure, the answers provided to question 14 of the survey were considered. Most of the respondents agreed that their various Six Sigma champions understood the statistics behind the Six Sigma methodology. Using the Chi-square test, the null hypothesis was rejected because enough evidence from the data indicated that a relationship between Six Sigma statistical tools and Six Sigma implementation failure exists.

Multiple linear regression analysis was conducted to test the possibility of predicting Six Sigma implementation failures. The independent variable variables are considered to the Critical Effective Factors of Six Sigma implementation. Although the F- statistics of the interaction indicated a good fit in the linear model, the null hypothesis was not rejected because, based on the individual p-values of the regression and predictor variables, Six Sigma organizational management was found to be significant, but Six Sigma statistical tools application were insignificant in the relationship.

The next chapter shall involve the detail interpretation of the findings, discussions, recommendations, and conclusion of the study.

Chapter 5: Discussion, Conclusions, and Recommendations

Six Sigma, as a continuous improvement tool, has been in use for more than three decades and is still subject to adulation from many practitioners. One of the reasons why Six Sigma remains popular is because of the human aspects of knowledge involved when implementing Six Sigma projects. The purpose of this quantitative study was to add some understanding to the underlying issues that relate to its implementation failures. That means the study was conducted to determine and develop knowledge on the critical factors that lead to Six Sigma implementation failures. The research involved a survey that further examined the relationship between failed Six Sigma implementation projects and critical factors that cause these failures.

As part of the quantitative approach, the correlational research design was considered for the research because the independent variables cannot be manipulated to prove the presence of causality. The factors that affect both failures and successes of Six Sigma implementation and their outcomes were examined. Besides, problems related to organizational, implementation processes, and practices that result in quality improvements and failures when measuring performance in both process capability and management were analyzed. The effect of organizational management and statistical tools on Six Sigma implementation failure was investigated. The answers provided by the respondents confirmed that without support from top management of the organization, six sigma projects are bound to fail. There was sufficient evidence from the data that indicated a relationship between Six Sigma statistical tools and Six Sigma implementation failure. In testing the possibility of predicting Six Sigma implementation failures. Six Sigma organizational management had a significant effect, but the effects of Six Sigma statistical tools applications effect was insignificant on Six Sigma implementation failure.

Interpretation of Findings

Some of the existing challenges or gaps were to realize that organizational management and Six Sigma statistical tools should be considered as critical factors during the implementation of Six Sigma. The gap in both practice and theory made it valuable to consider the CFF of Six Sigma implementation. When top management identifies a problem, implementing and managing the project should become practically accessible from the outset. The reviewed literature discussed in chapter two contributed to identifying both the success and failure factors of Six Sigma implementation. The identified factors include organizational management, statistical tools, financial resources, organizational infrastructure, project scope, and training. The scope of this study led to the selection and investigation of two Critical Effective Factors, which could affect Six Sigma implementation failure.

For research question one (RQ1), to investigate the effect of organizational management on Six Sigma implementation failure, the answers provided by the respondents confirmed that top management support of the organization was vital to prevent Six Sigma implementation failure. Overall the higher percentage said that their projects were supported by management (61.7% Agree and strongly agree). The results supported the assertion that organizational management support is key to running a successful Six Sigma operation. Besides, rejecting the null hypothesis associated with the research question was sufficient evidence that a relationship exists between Six Sigma organizational management and Six Sigma implementation failure. Nevertheless, even if this component was fulfilled, the project could still fail for different reasons.

Another finding related to RQ1 was if the management of the Six Sigma DMAIC project hierarchy understood Six Sigma. Overall, a higher percentage said that the management of their DMAIC project hierarchy understood Six Sigma (44.1 % strongly agree and agree).

For Research Question 2 (RQ2), to investigate the effect of Six Sigma statistical tools application on Six Sigma implementation failure. Because Six Sigma is a data-driven approach that relies on statistics and data analysis, some individuals who manage projects are intimidated by the statistical needs during the problem-solving process. Most stages of the Six Sigma DMAIC process involve statistical techniques, which play a vital role in reaching the final results. Therefore, project champions must not just understand the manipulation of statistical tools but also need to understand the statistics behind six sigma (Smyrlis & Moschidis, 2015). According to the results, about half of the respondents believed that the project champions (53.1% Agree and strongly agree) understood the statistics behind the Six Sigma project. That means analyzing the data obtained at various stages could be very challenging for some project managers. The null hypothesis was rejected because sufficient evidence from the data indicated that a relationship between Six Sigma statistical tools and Six Sigma implementation failure exists.

Multiple linear regression analysis was conducted to test the possibility of predicting Six Sigma implementation failures. The independent variable variables are considered to the Critical Effective Factors of Six Sigma implementation. Although the F- statistics and P-value results of the interaction indicated a good fit in the linear model, the null hypothesis was not rejected because, based on the individual p-values of the predictor variables, Six Sigma organizational management was found to be significant, but Six Sigma statistical tools were insignificant in the relationship.

From the literature, most companies consider Six Sigma to be a business concept without considering the Critical Failure Factors used to improve quality. Identifying the problem makes Six Sigma a methodology that gives practitioners the chance to apply the DMAIC approach while creating successful models in solving problems. The findings now confirm why most companies make Six Sigma training a condition in order to gain a managerial position. Some even link Six Sigma projects to salary increases and compensations (Knapp, 2015). The findings suggest that Six Sigma implementation failure cannot be based on enough on financial resources available alone, but other factors outside management can lead to those failures.

Furthermore, the collected data illustrates the role of statistics in Six Sigma, as discussed in the literature (Berenson & Rice, 2015). In terms of its application to problem-solving, specifically to variations during quality control, Six Sigma Champions need to understand principles and the utilization of statistical tools. The data components interaction was less significant, but the fact that a relationship was established in the model should not be underestimated. Therefore, it should be safe to say that some of the factors, which lead to Six Sigma failure, may as well lead to its success if well employed.

After decades of practice, the theoretical foundation of Six Sigma still needs to be improved because the approach leaves many assertions with less scientific evidence. Predicting the failures of Six Sigma Implementation from the data needs a massive yield of statistical evidence, as proponents are not ready to supply data of failed projects. Finally, when the respondents were asked if Six Sigma DMAIC projects fail for reasons other than Six Sigma methodology, the difference between those who were neutral (36.6%) and those who strongly agreed and agreed (37.5%) was insignificant.

Limitations of the Study

The certification of Six Sigma practitioners involved a wide range of institutions with different criteria. The wide range of tools needed for Six Sigma deployment is not the same for every project. Therefore, the choice of tools provides different experiences for each participant. Consequently, careful considerations were made during results interpretations. Furthermore, measuring organizational management has some challenges because obverting the characteristics of management varies from each participant.

The research project is constrained because only the identified critical factors were considered in the investigation. Recruiting individuals to participate in the survey was not an easy task due to the inclusion criteria. The research was a cross-sectional study; the time range to conduct the investigation was limited, thereby constraining the scope to focus on aspects related explicitly to the research questions and hypothesis. The survey was limited to participants in the USA and those subscribed to social media. Some areas could not be represented, limiting a level generalization.

Recommendations

After more than three decades of Six Sigma, introduction proponents and critics still lack adequate data to show concrete justification of what factors shall lead to both success and failure factors of its implementation method continuous to draw many organizations to its interest, thereby, leading to further research. The literature acknowledges that the key factors need further investigation with more consciousness. On a cautionary note, replicating the survey within a particular culture or one country provides makes it difficult to highlight benchmarks on areas in which deficiencies exist. Consideration of cultural differences should be considered.

Second, the use of a large sample is necessary to ease the generalization and avoid threats to the sample validity. Although the sample used was above the sample threshold, a large sample could yield better results. More time should be provided for data collection, and the recruitment of participants might encourage many individuals to the participant. The research findings provide some opportunities for improvement. The recommendations are as follows:

- Top management should be more engaged in the process of recruiting team players, and communicating the goals and objectives of the process should be of less importance if the right principles and right experts are hired to manage the project. Six Sigma fits into both small and large companies. The Six Sigma program needs to be established within the organizational culture.

- An organizational infrastructure should be established. The Master Black belts, Black Belts need to take responsibility for enforcing and facilitating training and other organizational processes that are involved in Six Sigma application.
- The choice of projects should be based on the effect of cost reduction. The cost of production is reduced when defects are eliminated. The should be a set criterion to select projects based on the impact on the customer and the organization.

Implications

The rise in cost and the soaring demand for better products has increased the search for better information from manufacturing companies, therefore, from the consumer point of view, empowering individuals in using new tools to manage projects is cost-effective. Socioeconomic and cultural changes are global and involve a level of synthesis about social change, methodological, theoretical, and empirical implications.

Implications for Social Change

The study advances the need for organizations to satisfy customer demands. The adaptation to new development involves variables like economic, professional, and social behaviors. The financial constraints of every project lead to dissatisfaction, which extends to virtually all other aspects of sociocultural development within the organization and society. The changes brought about by a successful Six Sigma implementation explores human development with respect to a socioeconomic and cultural change in the organization. Cultural change involves contextual dynamics and adaptation. Adapting to a development pattern involves variables like economic, professional, and social behaviors. The financial constraints of every company are partially caused by low ROI, leading to economic dissatisfaction, which extends to virtually all other aspects of sociocultural development. Implementing the Six Sigma methodology creates a phenomenon of positive social change as a result of available opportunities for both human and economic development. Positive social change leads to a transformation of existing features in the industry.

Furthermore, enhancing personal development influences change within not only the organization but also the employees become aware of the challenges and pressure they faced from the competitors. Six Sigma implementation is conceptual, involving different spheres of management techniques. Socioeconomic and cultural changes are global and involve a level of synthesis, which is based on newly created management applications. Six Sigma implementation is conceptual, involving different spheres of management techniques. Such changes require validated suggestions that apply to research and other applications. Such validations are necessary because, from a cultural standpoint, events do not remain static or unique.

Methodological, Theoretical, and/or Empirical implications

The Six Sigma methodology has been promising in improving goods and services to consumers by reducing the variation of goods and services at the supplier, process, product, and service levels for decades. Many companies today continue to implement Six Sigma programs as a method of intervening with the lack of professional skills found in many organizations. Successful implementation reduces customer claims and increases the financial benefits for the company and the employees, respectively. Six Sigma as an improvement methodology makes it comprehensive and meaningful to every company, thus laying a solid foundation for future research on Six Sigma.

Theoretically, through this study, the theoretical principles and facets of quality management theory could be strengthened as Six Sigma is implemented in institutions, communities, and economies, the theoretical concepts of quality improvement changes. These changes vary in the process and sometimes due to other variations, which exist in workplaces. Furthermore, this study builds on the theoretical tenets of individual and team development, such as teambuilding processes and training programs, which help to improve interpersonal relationships between individuals, groups, departments, peers, and managers. Improvements in Six Sigma methodology and quality management have led to an increase in learning while reducing the cost of transactions and training (Antony, 2007).

Methodologically and empirical data using reserved qualitative methods to obtain information obtained from survey respondents could help to inform Six Sigma practitioners about the necessary changes that positively affect the company. Service providers use such information to improve the cycle times in which services are provided to customers. This research study provides a level of understanding of how organizations can improve their quality level through the identification of CFF and CSF of Six Sigma. The role of organizational culture in Six Sigma implementation can be examined, including the key factors that lead to improved customer services, provide insights on how to reduce cycle times in production and service delivery. The emergence of new quality improvement techniques could influence the application in many companies. Most companies may overcome the challenge faced in improving quality with increasing demands and cost reduction through this study. Furthermore, through improvements in Six Sigma, efficiencies in quality management increase, learning of new techniques while reducing the cost of transaction and training is observed.

Conclusions

Reducing defects and improving the quality of goods and services has a profound impact on the manufacturing and service industry. Results of the survey showed that the Critical Effective Factors of Six Sigma implementation projects could sometime lead to implementation failures because a relationship exists between Critical Effective Factors and the failure variable. Therefore, the Six Sigma project will fail if the CEF is not efficiently employed. These findings justify the assertion that there is no specific factor that influences Six Sigma projects to fail. The factors that lead to Six Sigma implementation failure could be both internal and external factors. Despite the low correlation power between CEF and Six Sigma implementation failure, the results of this results study cannot be ignored.

Six Sigma is a methodology that will continue to evolve; determining the factors that lead to its failure should not be limited to organizational management and statistical tools application. The reviewed literature establishes a path in combining TQM and Six Sigma initiatives as continuous improvement quality programs in the organization. Statistically predicting the cause of Six Sigma failures from the CEF still needs further investigations. However, the study provided the first step in investigating other critical factors that will lead to further development in Six Sigma implementation and evidence on critical failure determination.

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Appendix A: Sample Survey Request E-mail

Adopting instruments for dissertation

From: Eyong Eyongebot < eyong.eyongebot@waldenu.edu>

To: Dr. Richard J. Sands, MBA, CSSLBB <rsands@drrichardsands.com>

Re: Adopting instruments for dissertation

Dear Dr. Sands,

I hereby request that you permit me to use your instruments (questionnaire) as these instruments have already been validated. What will it take me to acquire your permission? I really need your help.

Sincerely,

Eyong

Re: Adopting instruments for dissertation

From: Dr. Richard J. Sands, MBA, CSSLBB <drrichardsands@gmail.com>

Yesterday, 9:08 AM

Eyong Eyongebot < eyong.eyongebot@waldenu.edu>

July 1, 2019

Eyong,

You have my approval to use my questionnaire from my approved Dissertation.

Appendix B
Survey/Questionnaire

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.

Appendix C:
Survey/Questionnaire Results

#	Extraneous variables	Disagree	Agree
1.	Was your Six Sigma DMAIC* project supported by management?	11	71
2.	Was your Six Sigma DMAIC* project financially based?	23	63
3.	Was your Six Sigma DMAIC* project solution implemented?	11	68
4.	Was your Six Sigma DMAIC* project supported with good baseline data?	11	72
5.	Was your Six Sigma DMAIC* project scope too large for the DMAIC format?	46	30
6.	Was your Six Sigma DMAIC* project too small for the DMAIC format?	56	19
7.	Are you properly trained in the Six Sigma DMAIC* process?	24	66
8.	Was your organization ready for a Six Sigma DMAIC* project?	21	59
9.	Was your Six Sigma DMAIC* project properly resourced?	15	67
10.	Was there enough time allotted to complete your Six Sigma DMAIC* project?	23	56
11.	Was your Six Sigma DMAIC* project properly selected?	16	66
12.	Did management in your Six Sigma DMAIC* project hierarchy understand Six Sigma?	26	51
13.	Was your Six Sigma DMAIC* project too complex to solve?	48	25
14.	Did your Six Sigma DMAIC* project Champion understand the statistics behind your Six Sigma project?	17	62

15.	Was your Six Sigma DMAIC* project negatively affected by company politics?	44	36
16.	Was your organization affected when your Six Sigma DMAIC* project failed?	32	28
17	Did your Six Sigma DMAIC* project fail because of Six Sigma methodology?	51	21
18	Did your Six Sigma DMAIC* project fail for reason(s) other than Six Sigma methodology?	30	44

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