DETERMINING CRITICAL FACTORS OF SIX SIGMA INITIATIVES: A STUDY OF THE AMERICAN SOCIETY FOR QUALITY REGION 12

By

Shawn W. Flynn

An Abstract
of a thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Industrial Management
to the School of Technology
University of Central Missouri
Warrensburg, Missouri

February, 2011

ABSTRACT

by

Shawn W. Flynn

Six Sigma is a popular quality and business improvement method that has received wide spread notoriety. There has not been a study to determine what are the key proportions of the Six Sigma universe, which contribute to success and failure in initiatives. The prevailing literature was examined to determine what critical factors are involved for success or failure in Six Sigma initiatives. The study measured whether or not organizational impact, financial effectiveness and success rates of initiatives are directly dependent on critical factors. An electronic survey was used, as the research instrument and distributed to American Society for Quality Region 12. The data was analyzed using the mean, the mode and multiple regression. The results of the sample's responses indicated positive upfront support for Six Sigma initiatives, poor follow through and sweeping bottom line gains were not apparent and the need for a larger study to draw more definitive conclusions.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
THE INTRODUCTION

The Case of Six Sigma

The use of quality and process improvement methods and tools change over time. Some of these techniques are called a repackaged tool or a fad (Stamatis, D., 2000). Most of these fads were developed and contain elements from long established practices. Because of their borrowed origins, they are not looked upon favorably or with respect as a new method and therefore do not receive a sustained and supporting effort, thus becoming a short-lived phenomenon. To some Six Sigma is another fad, one that has gone on for too long (Ramis, A., 2005).

Though Six Sigma has formally existed since the mid 1980's, its effectiveness is still in debate. Six Sigma has been regarded as both a positive and negative phenomenon. Many advocates and companies rave about the sweeping success and gains in quality, and bottom line results from using Six Sigma as an improvement methodology. It has been highly marketed (Lefcowitz, M., 2007; Stamatis, 2000; Burns, A., 2006) and thus reached epic proportions of popularity equal to or more than previous quality management initiatives such as Total Quality Management (TQM). This has been made evident by the number of practitioners, companies and institutions which have embraced Six Sigma, the constant positive publication in peer reviewed periodicals, the plethora of independent consultants offering Six Sigma as a primary consulting methodology and organizations offering certification (ISixSigma, 2009, July).

The major windfall in adulation or condemnation of Six Sigma is a lack of deterministic evidence (Lefcowitz, 2007). Publication efforts in either direction may be supporting a particular agenda and therefore may not accurately depict the whole picture. Advocates often depict the success stories while critics often tout the failures and denounce Six Sigma's impact. It has been referred to as a tool, subset, and extension of Total Quality Management (TQM) and reengineering efforts (Juran & Godfrey, 1999). According to Ramis (2005, pg. 2) it is, "...essentially a repacking of tools and methods going all the way back to Deming." In light of the both the positive and negative claims, clarification with deterministic evidence is needed.

What is clear is that two decades of Six Sigma have produced key or critical factors that lead to either success or failure during deployment. There is overlap and similarity between the success and failure factors. The major success factors include deployment strategy, resource allocation, data-driven decision making and organizational impact, while notable failure factors include deployment strategy, resource allocation, organizational impact, sub-optimization and alignment to business goals. The main upshot is that these 'critical factors' provide a starting place for measurement.

Problem Statement

There have been numerous studies on Six Sigma, DMAIC and successful project implementation. However, there was no definitive evidence of its overall success or failure and no comparison between TQM methodology and Six Sigma. Only certain views have been reported in the literature and released to the public. These views may harbor certain agendas and not be representative of what is actually happening in actual

Six Sigma practice and implementation. Furthermore, there were very few studies presenting the impact of critical factors on Six Sigma success and failure from the practicing quality professionals. This study aims to put some clarity on the issue.

Purpose of the Study

The purpose of this study was to provide some clarity, in light of the popularity and criticism, of the real contributing elements that determine underlying success or failure of Six Sigma initiatives. As Lefcowitz, put it, "Nowhere has any practitioner or institution attempted to statistically survey the universe of 6σ to discover what proportions are successful and what proportions are unsuccessful and for that matter-why or why not (2007, pg. 19)." The problem scope was large and complex, where approaches to the topic could entail its own detailed study. This study examined, as narrow measurement of the Six Sigma universe, the critical factors of initiatives and focuses on the elements of organizational impact, success rates and financial effectiveness. The results provide further enrichment, evidence, insight, and measurement on those aspects of Six Sigma.

Value and Need for the Study

The value of the study will help both current and future practitioners, skeptics alike have some tangible evidence about what proportions of Six Sigma are helpful to organizational improvement, and what proportions are barriers to improvement. There is a need for the study because of both positive and negative acclaim for Six Sigma with no definitive evidence of its overall success or failure. Only certain views are being reported. These views may be skewed by certain agendas or influence, such as promoting Six Sigma or only showing positive results. Such views do not depict an accurate representation of what is actually happening in the Six Sigma universe. This study can help bring some light and truth to the issue. It will help those considering use of Six Sigma as an improvement methodology; serve as a kind of roadmap or model of what elements constitute success and provide tangible evidence for those critical of Six Sigma to make an informed decision, instead of just charged and unsupported opinions.

Research Questions and Hypothesis Statements

Research Questions

1. What are critical success factors in Six Sigma initiatives?
2. What are critical failure factors or barriers in Six Sigma initiatives?
3. Is the organizational impact of Six Sigma initiatives dependent upon critical factors?
4. Are the financial results of Six Sigma initiatives dependent upon critical factors?
5. Is there a difference between Six Sigma and other similar methodologies such as Total Quality Management (TQM) and Information Technology (IT) projects?
6. Do Six Sigma initiatives share a similar success rate with other similarly structured methodologies such as Total Quality Management (TQM) and Information Technology (IT) projects?

Hypothesis Statements

H01. Critical factors have no statistically significant influence on organizational impact in Six Sigma initiatives.

HA1. Critical factors have a statistically significant influence on organizational impact in Six Sigma initiatives.

H02. Critical factors have no statistically significant influence on success rates in Six Sigma initiatives.

HA2. Critical factors have a statistically significant influence on success rates in Six Sigma initiatives.

H03. Critical factors have no statistically significant influence on financial effectiveness in Six Sigma initiatives.

HA3. Critical factors have a statistically significant influence on financial effectiveness in Six Sigma initiatives.

Definition of Terms

It is important to establish a viable definition, working knowledge, and understanding of terms and concepts related to this study. The most worthwhile approach is to use those definitions from the prevailing literature and by well-known experts.

American Society for Quality (ASQ): A professional, not-for profit association which promotes information, practices and technology related to the field of quality. ASQ serves over 100,000 individuals in 109 countries (Nelsen & Daniels, 2007, pp. 40).

Barriers: Something, which hinders or creates resistance to empowerment, improvement or operation, within an organization and may be tangible or intangible. Often related to the terms and concepts of bottle necks, constraints, hidden factory, organizational roadblocks and the Theory of Constraints (TOC) (Siebels, D., 2004, pp. 22).

Baseline Measurement: Initial measurement used as a point of reference or standard against which change is measured (Baker & Campbell, 2003, pp. 400; Nelsen & Daniels, 2007, pp.41).

Benchmarking: A continuous improvement technique used by individuals, groups, organizations, or part of an organization, which establishes a point of reference or standard to use as a comparative model or measurement of performance against better and best-in-class performers. Also used as a gap analysis to determine how better levels of performance were achieved and use that information to improve their own performance (Baker & Campbell, 2003, pp. 400; Baldridge National Quality Program (BNQP), 2008, pp. 56-7; Nelsen & Daniels, 2007, pp 41; Westcott, R., 2006, pp. 588 & 602).

Belt: Term borrowed from martial arts ranking systems used to describe a individual who has studied, been trained and tested or certified in the principles, practices and techniques of Six Sigma or a practitioner who is functioning at a standardized level of knowledge, skills and abilities within the Six Sigma Body of Knowledge. A “belt” may be earned, or bestowed, by demonstration of proficiency in the Six Sigma Body of Knowledge and or practical technique or project application most often through a certification or testing and review process. Six Sigma belt levels include white, yellow, green, blue, brown, black and Master Black Belt with Green, Black and Master Black Belt being the most commonly accepted and used (Pyzdek, 2003; Wortman, Richardson, Gee, Williams, Pearson, Bensley & et al, 2007).

Black Belt (BB): Full-time project manager responsible for implementing process improvement projects using structured methodologies such as the DMAIC process (define, measure, analyze, improve and control), Design for Six Sigma (DFSS), Lean and other business, project management and quality related tools and techniques to drive customer satisfaction through organizational process streamlining (Nelsen & Daniels, 2007, pp 41; Pyzdek, T., 2003; Wortman, et al, 2007).

Body of Knowledge (BOK): A prescribed system of knowledge or established criteria in a particular area, discipline or field of work. Often developed by renowned organizations or professional associations for a unified and common knowledge system and for criteria for certification or evaluation (Nelsen & Daniels, 2007, pp. 41-2).

Bottom Line: The essential or most important point. Often used in reference to financial reporting or results or something measurable (Nelsen & Daniels, 2007, pp. 41).

Business Process Reengineering (BPR): The rethinking and redesign of business processes and organizational structure for dramatic, often radical, performance improvement. Often used in reference to or interchangeably with the terms business process management or reengineering (Nelsen & Daniels, 2007, pp. 41; Siebels, 2004, pp. 31).

Cascading: The top down flow of information and training throughout an organization (Nelsen & Daniels, 2007, pp. 42). Also, see “deployment.”

Change Agent: An individual from within or outside an organization who facilitates change in the organization. Primarily the goals of change agents are to help people adopt new ways of thinking and behaving in relation to organizational culture and change, processes and standards. The term change agent is often used with roles where the individual has influence about the change management process such as leader, manager, process owner or direct Six Sigma related roles such as Champions, Green Belts, Black Belts, Master Black Belts or Sponsors (Nelsen & Daniels, 2007, pp. 42; Pyzdek, 2003, pp. 15-16).

Certification: Authoritative and documented act by an accrediting body, individual or organization; whereby, an individual, group or organization has met or complied with established criteria requirements to earn a specialized status of rights and privileges (Nelsen & Daniels, 2007, pp. 43; Siebels, 2004, pp. 38).

Critical Factor: An identified crucial or key characteristic, component, element, item, or root cause found to have significant influence or causality. Overarching, salient or top concept(s), main points or reason(s), from a group of identified concepts, points or reasons. The vital few.

Culture: Company, Corporate and Organizational: A common, yet unique, system of attitudes, behaviors, beliefs, customs, mannerisms, norms, perceptions and values accepted and shared by the individuals within an organization (Omdahl, T., 1997, pp. 28; Siebels, 2004, pp. 54 & 59).

Culture Change: A significant shifting in the behavioral, belief and operating principles and values of an organization and its employees (Siebels, 2004, pp. 59).

Deployment: The dispersion and dissemination process of communication, objectives and plans, downward and laterally, throughout an organization. Often used in reference to or interchangeably with “initiative(s)” (Nelsen, 2007, pp. 45; Westcott, 2006, pp. 597). Also, see “cascading” and “initiative”.

DMAIC: An acronym for define, measure, analyze, improve and control. The five phase logic gate process or project methodology of Six Sigma utilizing data driven information for process improvement. The central or primary structured problem solving methodology or framework of Six Sigma (Nelsen & Daniels, 2007, pp. 45).

Effective or Effectiveness: Producing a desired effect or result. Often characterized by financial measurements (Nelsen & Daniels, 2007, pp. 45).

Efficient of Efficiency: Performing the correct actions to produce a desired result, in a manner, which consumes the least amount of resources (labor, materials and time). Also, the ratio of the output to total inputs (Nelsen & Daniels, 2007, pp. 45).

Failure: The inability of something (item, person, project, etc.), whether a product or service, to perform or produce the desired functions and results (Nelsen & Daniels, 2007, pp. 46).

Failure Factor or Barrier: Something, which contributes to failure, undesirable results, and prohibits growth, desirable results or success, in relation to a deployment, initiative, project or undertaking. May be tangible or intangible. See "Critical Factor" and "Failure".

Green Belt (GB): An individual or employee who has been trained and possibly certified in a standardized part or level of the Six Sigma methodology and works in a part-time role on process improvement teams. May support a Black Belt or lead a project under the supervision of a Black Belt. The difference between Green and Black Belts are often the amount of training in advanced statistical and quality tools and administrative functions of managing a project (Nelsen & Daniels, 2007, pp 47; Pyzdek, 2003; Wortman, et al, 2007).

Initiative: A particular campaign dispersed or deployed throughout an organization or part of an organization. A planned course of action or series of operations for achieving an objective. Maybe a directive or mandate, a cultural shift, perception, or way of thinking, acting and behaving or a departmental or enterprise level project. Often used in reference to or interchangeably with "deployment" (Neufeldt, V., 1990, pp. 86 (campaign)). Also, see "deployment".

Key Performance Indicator (KPI): A measurement of organizational performance within a given critical or key area. Often used in reference to or interchangeably with the terms business metrics, dashboard metrics, key process output variable (KPOV) (Nelsen & Daniels, 2007, pp. 49).

Key Process: A major system level process supporting organizational or functional goals. May be a department or business unit (Nelsen & Daniels, 2007, pp.49).

Master Black Belt (MBB): A Six Sigma or quality expert responsible for strategic process improvement direction and execution within in an organization. Often leads a Six Sigma department and oversees Black Belts. A highly trained and skilled Six Sigma or quality expert who works as a process improvement consultant (Nelsen & Daniels, 2007, pp 50; Pyzdek, 2003; Wortman, et al, 2007).

Mean: The average of all the measures within a data set. A measure of central tendency (Nelsen & Daniels, 2007, pp 51).

Median: The middle or central value of a data set arranged in order from highest to lowest values. A measure of central tendency (Nelsen & Daniels, 2007, pp 51).

Measure: A numerical criteria, metric or means by which a comparison is made against. Second phase of the DMAIC process (Nelsen & Daniels, 2007, pp. 51).

Non-Value Added (NVA): A term that describes a process step or function that is not required for the direct achievement of process output. This step or function is identified and examined for potential elimination. Also, see "value added" (Nelsen & Daniels, 2007, pp. 51).

Organizational Impact (OI): The effect or degree of influence of something cultural, process or structurally oriented within an organization which is often measurable and may have an external affect on customers (Fredendall, Robbins, & Zu, 2006; Marx, M., 2006 & 2007).

Process: A set or sequence of value added inputs or interrelated work activities, operations or tasks that produce a specified set of goals, products, outputs, or services. Governed by a documented work procedure. An ongoing or continuous effort that has no end point (Nelsen & Daniels, 2007, pp. 53).

Process Owner: Person or office responsible for management and control of various functions and work activities at all levels of a process (Nelsen & Daniels, 2007, pp. 53; Omdahl, 1997, pp. 129).

Program: "A group of related projects in a coordinated way to obtain benefits and control not available from managing them individually. Programs may include elements of related work outside the scope of the discrete projects in the program." A prescribed set of activities that has an end point or is not an ongoing effort (Project Management Institute (PMI), 2004, pp. 368)

Project: "A temporary endeavor undertaken to create a unique product service or result" (PMI, 2004, pp. 368).

Project Management: "The application of knowledge, skills, tools and techniques to project activities to meet the project requirements." Overseeing all elements of a particular project (PMI, 2004, pp. 368).

Quality: Subjective term based on importance of requirements to a person or other entity such as an organization. Various definitions from quality experts reduce to two associated meanings: characteristics of a product or service to fulfill expected, implied or unexpected needs, performance or requirements and a product or service that is without deficiencies (Omdahl, 1997, pp. 192-3).

Return on Investment (ROI): "Return on investment (ROI) is an umbrella term for a variety of ratios measuring an organization's business performance and calculated by dividing some measure of return by a measure of investment and then multiplying by 100 to provide a percentage. In its most basic form, ROI indicates what remains from all money taken in after all expenses are paid". A measurement of performance effectiveness expressed financially through cost-benefit analysis measurements (Westcott, 2006, pp. 621; (Wortman, et al, 2007, Ch 3, pp. 21).

Savings, Hard: Tangible results that are measurable, observable and specific that directly impact an organization's key performance indicators or financial statement. Examples include cost reductions or revenue increase (ASQ, 2009, International Team Excellence Awards (ITEA); IsixSigma Staff, 2005, pp. 27).

Savings, Soft: Intangible results which may not be specific measures that indirectly impact an organization's key performance indicators or financial statement. Examples include productivity or customer satisfaction (ASQ, 2009, ITEA; IsixSigma Staff, 2005, pp. 27).

Sigma: "Sigma (σ) is the Greek letter used by statisticians to denote the standard deviation of a set of data. The standard deviation provides an estimate of the variation in a set of measured data. A stated sigma level, such as Six Sigma, is used to describe how well the process variation meets the customers requirements" (Keller, P., 2005, pg. 3).

Six Sigma (SS): "A method that provides an organization tools to improve the capability of their business processes. The increases in performance and decreases in process variation lead to defect reduction and improvement in profits, employee morale and quality of products or services. Six Sigma quality is a term generally used to indicate a process is well controlled (±6 s from the centerline in a control chart) (Nelsen, 2007, pp. 56)." " ... a business strategy and philosophy built around the concept that companies can gain competitive edge by reducing defects in their industrial and commercial processes (Harry & Schroeder, 2000)." Fredendall, Robbins, and Zu (2006) refer to Linderman, Schroeder, Zaheer, and Choo (2003) to define Six Sigma as, "an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates." Wortman defines "Six Sigma is a highly disciplined process that focuses on developing and delivering near-perfect products and services consistently. It is also a management strategy to use statistical tools and project work to achieve breakthrough profitability and quantum gains in quality (2007, Ch 2, pg. 2)."

Sub-optimization: "A condition in which gains made in one activity are offset by losses in another activity or activities that are caused by the same actions that created gains in the first activity (Nelsen & Daniels, 2007, pp. 56; Siebels, 2004, pp. 234)." "The principle of sub-optimization asserts that optimizing each subsystem dependently will not in general lead to a system optimum, or more strongly put: improvement of a particular subsystem may actually worsen the overall system. In other words, the whole is less than the sum of its parts. At the heart of the sub-optimization issue, therefore, are four paradigm blind spots: Ignoring the cumulative entropy created by the interaction of the various subsystems with one another. Confusing the maximization of the output of the various subsystems as being synonymous with maximizing the final output of the overall system. Assuming that the final outputs will achieve the targeted goals and/ or outcomes. Failing to validate that the targeted goals are actually moving toward the overall organizational vision (Lefcowitz, 2007, pp. 19-20)."

Success: The ability of something (item, person, project, etc.), whether a product or service, to perform or produce the desired functions and results. Often used in terms of measurable business, organizational or financial prosperity.

Success Factor: Something, which contributes to or enables desirable results, growth or success, in relation to a deployment, initiative, project or undertaking. May be tangible or intangible. See "Critical Factor" and "Success".

Top Management Commitment or Support: Participation of the highest-level officials in an organization. Participation may be active or passive in nature. It includes allocation of resources, behavior, involvement or presence, planning and recognition (Nelsen & Daniels, 2007, pp. 58).

Total Quality Control (TQC): A quality system, which integrates the quality development, maintenance and improvement of the parts of an organization for economical product and service delivery. Proposed by Armand Feignenbaum in 1956, in an article in Harvard Business Review. Similar concepts and foundational principles and practices for "Total Quality Management" (Omdahl, pp. 191). See "Total Quality Management".

Total Quality Management (TQM): A top down management approach to long term organizational success through customer satisfaction by involving all organizational members in a continuous cultural effort of improving processes, products and service. Similar to or an extension of "Total Quality Control" (Omdahl, pp. 191). See "Total Quality Control".

Value: Something of worth or usable output, to a customer (internal or external) (Nelsen, 2007, pp. 58).

Value Added (VA): Activities, which transform input factors into a usable, output factors or measures of worth for a customer (internal or external) (Nelsen & Daniels, 2007, pp. 58).

Variation: A change in data, characteristic or function caused by one of four factors: special causes, common causes, tampering or structural variation (Nelsen & Daniels, 2007, pp. 59).

Waste: Something, which consumes resources but adds no value (Nelsen & Daniels, 2007, pp. 59). See "Non Value Added", "Value" and "Value Added".

Assumptions

1. There is evidence available, whether through research previously done by others or new and original research, to make determinations about Six Sigma, irrespective of opinions and its worth as an improvement methodology.
2. It is necessary to evaluate Six Sigma on its own terms. This include the use of statistical measurement, getting to the root causes of why it is or why it is not successful and does it actually yield breakthrough gains in terms of bottom line results or not?

3. Critical factors demonstrate a correlation or influence on organizational impact, initiative success rates and financial effectiveness.

Limitations

The scope of this study was limited to examining only certain aspects of the Six Sigma universe. It focused in on aspects, which attempted to answer and measure the research questions and hypotheses as opposed to becoming overly expansive and exhaustive in scope. The study examined the available literature at the time of writing. The literature was limited at the time of writing due to possible protection of organizational interest and publication bias. The research survey was limited to those willing participants from a variety of industry sectors, so some sectors were better represented than others; thus limiting a generalized cross sectional view.

Six Sigma's Historical Foundations

In order to explore the Six Sigma universe for those key elements that depict its worth, it is important to gain an understanding of its origins by reviewing the quality movements that have contributed to its evolution. This is significant because Six Sigma is framework that was built upon the philosophies, practices, methods and tools from its predecessors. The following sections trace the roots of major historical movements and concepts in the field of quality from humble unconscious and ancient origins through the present day where Six Sigma has had two decades of application.

Ancient Origins

From the dawn of time, humanity has struggled with challenges of survival. These challenges have involved the quest for products, such as artifacts, dwellings, food, and trappings, and services, such as communicating, providing, sharing and trading various intangibles and tangibles. These products and services either satisfied or failed to satisfy survival requirements. This quest can be viewed as the pursuit of quality, since the products and services for survival must maintain and facilitate life.

Whether this pursuit of quality involves hunter-gatherer societies struggling for the basic elements to sustain existence or highly organized groups living in cities making commerce and culture, there remains an inimical drive to create improvements in life conditions. Hunter-gathers had to find better raw materials for defense and hunting and relied on self-sufficiency. Organized living groups or villages, towns and cities faced issues of commerce, division of labor and social organization. These achievements lead to a better quality of life, which demanded increasing improvement of products and services. This demand over time produced more formalized practices governing product and service assurance, measurement and specifications. The pursuit of quality practices can be found in the achievements of societies such as the Babylonians or Egyptians who utilized inspection, measurement and warranties (Juran, 1999).

Artisans, Craftsmanship and Guilds

With increasing levels of social organization and the division of labor, the need for increasing regulation of product and service requirements arose through the advent of trade unions. The livelihood and reputation of individual artisans and craftsmen greatly depended on the quality of the products or services they provided. An individual producer specialized in a particular product or service and was responsible for all related production and business aspects. For a weapon maker, this entailed obtaining raw materials either themselves or from a supplier and then making, marketing and selling their wares. For a trader, this involved obtaining goods, either by their own hands or through exchange and could involve great travel, and all the necessary business administration to barter, sell or trade such goods.

Organized unions known as guilds helped individual craftsmen prosper through specified codes of conduct, manufacturing practices and trade regulation. The guild system ensured specific levels of quality; as well as, consumer and craftsmen protection through specified planning and control. These same benefits also restricted further quality advancement due to tight governance, legislation and regulation. Guilds were the prevailing quality driver during the Medieval and Renaissance periods until the introduction of the factory system in the Industrial Revolution (Summers, D., 2006) (Juran, 1999).

The Industrial Revolution

The Industrial Revolution introduced interchangeable parts, powered machinery, mass production and the factory system in the eighteenth century. The factory system destroyed the hold of guilds by creating increased productivity through division of labor and reducing costs. During the age of guilds, productivity was limited to the individual output of craftsmen, since they were involved in all tasks to make an artifact. In the factory, artisans and craftsmen became workers or laborers who only performed a few tasks in the entire production process. Juran notes it took 18 separate steps to make a single pin, so the output of a individual craftsmen was dwarfed by comparison to the 4800 pins that 10 factory workers could turn out in a day (1999, Ch 2., pp. 12). The differences in productivity per person and cycle time are obvious. Equally as important to simplifying the production process through the division of labor, was the use of interchangeable or standard parts, which lead to the rise of mass production in the second half of the nineteenth and early twentieth centuries.

The Twentieth Century

Advances in quality increased exponentially during the twentieth century in comparison to previous centuries. This growth was due to increases in consumerism, government regulation, health and safety concerns, population, science, social structure and technology. The twentieth century went through various movements that build upon each other and lead to the birth of Six Sigma.

Inspection and Mass Production

Quality in early twentieth century, until the 1920's, was still characterized by methods from the late nineteenth century, namely Frederick W. Taylor's system of scientific management, Henry Ford's mass production in the automobile manufacturing, Sakichi Toyoda's use of automation in power looms and heavy reliance on inspection as the primary quality control driver (Wortman, et al, 2007). Taylor, Ford and Toyoda's methods also began the roots of both Six Sigma and Lean philosophies due to focus on process and product efficiency and reductions in labor and materials.

Inspection has been the primary method of quality assurance and control for much of human history and includes examining, measurement and testing of products, processes and services. Inspection gained greater use during the late Middle Ages and Industrial Revolution and gave rise to inspection departments. These departments became commonplace for factories in the very late nineteenth and early twentieth centuries. Inspection allowed the idea of defect prevention to develop until the birth of statistical process and quality control (BPIR.com Limited & Massey University, 2007).

Statistical Quality and Process Control

In the 1920's, Walter Shewart developed statistical application and control charts at Bell Telephone (Wortman, et al, 2007). This was a revolutionary differentiation from previous methods since it allowed for monitor and control of product and process quality and became known as statistical quality control (SQC) and statistical process control (SPC). Around the same time, Dodge and Roming developed acceptance sampling (Summers, 2006). These three methods dominated quality practices through World War II, though manufacturer's didn't fully embrace them until the late 1940's (BPIR.com Limited & Massey University, 2007) (BPIR). Reliability engineering techniques also developed during the War.

Quality in Japan and the Rise of Total Quality

During the War years, Japanese quality was poor in comparison to other countries. After the War, notable figures such as Juran, Deming and Feingenbaum were invited to Japan to teach managers and executives quality methods. The Japanese adopted their methods, which had a profound improvement on the quality of their products. Kaoru Ishikawa introduced quality methods to the Japanese Union of Scientists and Engineers (JUSE), which in turn would disseminate through Japanese manufacturing. He developed the cause and effect diagram, the concept of 'next operation as customer' and started quality circles in 1962 (Summers, 2006, pp. 53). Genichi Taguchi introduced the concept of the 'loss function' and is considered the 'father of quality engineering' for his methods. Taichi Ohno created the Toyota Production System (TPS) in the 1950's, which was influenced by Kiichiro Toyoda's mistake proofing and just-in-time concepts developed in the 1930's. Shigeo Shingo developed quick die change over in the 1950's and the single minute exchange of dies (SMED) concept was born in 1969 (Wortman, et al, 2007). All of these developments laid the foundation for the Lean framework that would come from Six Sigma in the 1990's.

Armand Feigenbaum developed the Total Quality Control concept in the 1940's and published the book Total Quality Control in 1951 (Summers, 2006; Wortman, et al, 2007). The concept took hold in Japan in the 1950's and became part of Japanese quality management practices. Ishikawa changed the ideology into company wide quality control (CWQC) in Japan (Wortman, et al, 2007). TQC went unnoticed in the USA until the encroachment of Japanese products gained market share in the 1960's and 70's. This allowed enough incubation time for TQC to integrate with other quality practices like quality circles, SQC, SPC, reliability and sampling to make a metamorphosis into Total Quality Management.

Total Quality Management

TQM was the phenomenon of the 1980's and 1990's that reinvigorated commitment to quality in the USA, due to Japanese success through loss of market share for USA made products. TQM swept the USA as quality did in Japan after World War II. TQM was characterized by four basic tenets: customer focus, employee involvement, continuous improvement and integration throughout the organization (BPIR, 2007). The down side to TQM is that any quality initiative became branded as TQM. Therefore, its intent and reputation were muddied and created confusion about exactly what TQM was trying to accomplish. TQM regained some clarity with the introduction of Six Sigma, and Business Excellence Models and Quality Awards, namely ISO9000 and the Malcolm

Baldridge National Quality Award, since these quality movements reframed TQM's methodology.

The Birth of Six Sigma and the Integration of Lean

Bill Smith and Mikel Harry birthed Six Sigma at Motorola in 1986. It was a combination of Smith's work on improving quality due to customer complaints and Harry's work from Arizona State University on a four stage 'logic filter' called MAIC for defect reduction. Smith adopted 'sigma' from capability studies as a measure of quality and 'six' from measuring defects in 'parts per million' as opposed to thousands, which proved to be too rigorous at the time.

Six Sigma became Motorola's in house brand for process improvement and gained public notoriety when Motorola won the Malcolm Baldridge National Quality Award in 1988. Motorola began certifying Black Belts in 1991. Other companies, such as Allied Signal and GE also began to adopt the Six Sigma methodology in the early 1990's and the phenomenon caught on as a management initiative over the next decade. It sparked a wave of consultants whose sole methodology was Six Sigma and a host of training products and certification entities.

Since it's meteoric rise in the 1990's, Six Sigma has consistently incorporated Lean, into its framework. Lean practices have been around for over a century but didn't gain significant attention until the book, *The Machine That Changed the World,* by Womack and Jones came out in 1990. Both Lean and Six Sigma have similar elements, though Lean focuses on system waste and Six Sigma on variation. From integration by various practitioners and companies, Lean Six Sigma has emerged and dominated in the quality arena between 2000 and 2010 (Chapman, 2009; Wortman, et al, 2007).

Summary

Six Sigma is a popular quality and business improvement method. It is an enigmatic paradigm with high marketability, cultural popularity, and structured hierarchy of highly trained individuals versed in a specialized rhetoric of improvement techniques and statistical tools (Burns, 2006), but exactly what is Six Sigma's impact? In order to discern that impact, this study investigated the Six Sigma universe and focused on whether or not organizational impact, financial effectiveness and success rates are directly dependent on critical factors present within Six Sigma initiatives.

The study is divided into five chapters. Chapter one, Introduction, provides the background case of Six Sigma, problem statement, purpose, value and need, research questions, hypothesis statements, definition of terms, assumptions, limitations, and historical foundations of the study. Chapter two, Review of the Literature, provides an overview of the three areas of investigation: organizational impact, critical factors and return on investment. The third chapter, Methodology, presents the investigation process and describes the research design including the research participants, variables, instruments, validity and reliability, data collection and data analysis. Chapter four, Results of Data Analysis, gives a detailed account of the statistical results. Chapter five, Summary, Discussion and Recommendations, provides a recap of the study and results, some discussion and observations from the author and recommendations for further study.

CHAPTER 2
REVIEW OF THE LITERATURE

The State and Nature of the Literature

The search for viable statistical evidence on Six Sigma success and failure rates yields sparse results (Lefcowitz, 2007; Burns, 2006). Having an existence spanning two decades, it would be expected that there is sufficient documentation to make a rational and supported conclusion, but this is not the case. It is easy to make claim about the success or failure of Six Sigma, but it is hard to back it up with facts. Six Sigma is data driven and it stands to reason it should be evaluated by this premise.

There is a multitude of literature on the subject across different mediums. This study reviewed print and electronic sources. The primary sources seem to be out numbered by the secondary and tertiary ones. The prevailing literature that is available comes from both experts and critics alike. To make a rational conclusion from the literature would be premature, since it is somewhat lacking in actual supporting data, especially from academic sources (Fredendall, Robbins & Zu, 2006), thus Six Sigma cultivates a certain amount of mystery surrounding itself.

The general scope of material is usually positive or negative in nature. The positive material doesn't have a huge base of overwhelming case studies to validate the lofty claims and hype. If there is a base of positive success stories, then it's not being reported openly, possibly because it is a generally accepted opinion that Six Sigma works and is effective. This is what Pyzdek (2006) calls “cargo cult” Six Sigma which,

"...misses what Six Sigma is and completely focuses on the visible aspects of Six Sigma." The material that was available with actual and usable data to verify Six Sigma success took was a gleaning process that required a lot of data mining to gather the information.

The negative responses are plentiful. The critics of Six Sigma convey a colorful picture of its incompetence and failures. Again, the data is far and few between to backup these claims. The general atmosphere of anti-Six Sigma material is often highly charged, opinionated and simply mockery (Burns, 2006; Pyzdek, 2006; Stamatis, 2000). Proponents on both sides come from a wide spectrum. Those who have long established experience and knowledge in the quality and business fields and those who are inexperienced or might simply be jumping on the band wagon of anecdotal mass consensus (Lefcowitz, 2007) and thereby give way to popular but unsupported opinion.

A decisive way to evaluate Six Sigma's overall effectiveness, is to measure success and failure rates and financial results. In order to come up with a base line metric for either of these proposed measures is a daunting task. It would require a study with large enough population and a finely focused survey of both success and failure case studies across multiple industries and most likely from different countries to get an accurate sampling of the Six Sigma universe. The results would need to be categorized by industry. The success and failure rates would need to be averaged to get a general base line, which would show whether Six Sigma is truly the sweeping panacea that the hype makes it out to be or simply confirm the vehement exhortations of its critics. But exactly what factors are important and essential for evaluating Six Sigma?

Organizational Impact

With an established basis of what Six Sigma is, it's important to gain an understanding of its organizational impact. The main purpose of Six Sigma is two fold. First to delight customers and secondly to improve a process through reduction in variation in order to gain value, usually financial. Six Sigma would not have the reputation of an iconic business improvement methodology if it were not turning out dramatic results, or would it?

Six Sigma has established roles and a framework, which motivates people to think differently about their work processes, and therefore can change an organization's culture. Its cultural phenomenon is best illustrated by a statement from former GE chairman John Welch, “Six Sigma has forever changed GE ®. Everyone...is a true believer in Six Sigma, the way this company now works (Wortman, 2007, Ch 2, pg. 1.).” This is but one example from main stream corporate America. The business world is well aware of the existence of Six Sigma and many other main stream companies have been equally as hooked on Six Sigma as GE ®. With this kind of deeply rooted enculturation, Six Sigma creates a sort of myth unto itself like, “...the quasi-religious atmosphere that accompanied TQM (Ramis, 2005).”

Six Sigma is often compared to TQM, in terms of its premise, methods, and cultural base in organizations, but the two are uniquely different on several levels. Six Sigma is a program while TQM is a process. A program has a finite endpoint, while a process is an ongoing effort. Six Sigma is project based and projects have an end. TQM is a company wide enterprise incorporating all employees. Six Sigma targets areas of improvement and uses teams to carry out solutions. TQM has an extensive plethora of

400 tools and techniques or more (Pyzdek, 2003, pg. 4) in comparison to Six Sigma's structured approach, the DMAIC problem solving structure or framework; use of highly trained change agents ranked into belts or levels and significantly fewer tools, about 30 to 40 according to Burns (2006). Keller (2005, pgs. 7-8) also notes that there are four differences between Six Sigma and TQM: project focus and duration, organizational support and infrastructure, clear and consistent methodology and top-down training. The simplest distinction between the two is that due to its integration and use of statistical tools, Lean concepts, and structured and targeted approach to bottom line results, “Six Sigma has been referred to as TQM on steroids (Wortman, et al, 2007).”

It is appropriate to define Six Sigma's architectural elements within an organization, to further demonstrate the differences between Six Sigma and TQM. Overall, TQM was implemented through existing organizational roles, primarily management, and in a rather seemingly amorphous fashion; where as, Six Sigma has a definite structure (Burns, 2006). Six Sigma has its own hierarchy or echelon of highly trained individuals who are ranked according to a belt system, which was borrowed from the martial arts (Harry & Schroeder, 2000). Earned through a certification process or bestowed, the belt ranking process signifies progressive levels of training and competency. The most common and widely used and accepted ranks are Green, Black, and Master Black Belts.

Like organized professions and religions, Six Sigma has it's own formalized knowledge structure or doctrine and is known as a Body of Knowledge (BOK) (ASQ, 2007). In comparison, TQM only had several basic tenants. The Six Sigma BOK is comprised of concepts from engineering, management, quality, project management, and statistics. Its central problem solving structure or tool is called DMAIC, which is an acronym for a 5 stage logic gate process of Define, Measure, Analyze, Improve, and Control (Keller, 2005; Wortman, et al, 2007). As times change, more tools, specialized tools and various subsets of tools emerge within Six Sigma's collection, such as critical parameter management, Design for Six Sigma (DFSS), DMADV, Lean, portfolio architecting and TRIZ (Wortman, et al, 2007). The depth and complexity of it's BOK allow practitioners to speak a specialized vernacular, not unlike religious doctrine or other highly trained professionals such as lawyers or medical practitioners. There is no central authority in the world today for Six Sigma's BOK, but there are several prominent organizations who's Six Sigma BOK material is accepted in common usage as a credible authority such as GE ®, Motorola, the Six Sigma Academy and the American Society for Quality. In addition to its penetration of major businesses and companies, there are several universities that have developed Six Sigma and Lean related courses, certificates, and certification programs such as Arizona State, Villinova, Kaplan, Southern Polytechnic State, California State University of Dominguez Hills, and the University of Michigan (personal communications, 2005-2007). With an established base of Six Sigma's cultural hype, organizational framework, link to TQM and societal penetration, where does its organizational impact fit in to have influence and value on initiatives?

Fredendall, Robbins, and Zu (2006), purport that group, developmental and rational culture orientations, as opposed to a hierarchical one, have significant importance in quality initiative implementation and are directly linked to identifiable quality practices or factors, while Marx's research explores the importance of Six

Sigma's organizational integration and role in influencing cultural changes (2006 and 2007). Marx indicates that 95% of organizations surveyed are pursuing cultural change; 31% indicate no presence of Six Sigma in cultural change efforts, only a scant 1% have achieved desired results, 47% are not within reasonable reach of cultural change, though 22% are moving in a desirable direction within a year (2007).

These numbers show the critics of Six Sigma may have a case since desired outcomes are less than 50%. It's clear that cultural change is important to organizations, though about 60% are utilizing Six Sigma for that change effort. Six Sigma's measurable organizational impact is not substantiated by it's hype and popularity, because it is not getting any where near the lofty claims of advocates from an cultural change standpoint. This however, does not count out the overall role Six Sigma plays in an organization or its effectiveness.

Six Sigma's effect within an organization plays a vital role in deployment of initiatives. It brings cultural change, which creates new levels of awareness, conduct and thinking, all of these leave an impact. This impact may be a short-lived project phenomenon for process improvement gains or become a long-term integration and part of the organization's structure. Six Sigma's architectural elements in terms of methodology, framework and defined roles play a much more formalized part in an organization than TQM's previously ambiguous existence. The research studies cited by Fredendall, Robbins, and Zu and Marx demonstrate that when Six Sigma was implemented in an organization, it has a definite presence and influence. These studies provide some tangible metrics and therefore evidence on Six Sigma's organizational impact, which often goes unmeasured because it is considered an intangible or soft saving. These studies also provide the necessary link to show that identifiable quality practices or factors have a direct influence on the success or failure of Six Sigma initiatives.

Critical Success Factors

The critical factors that make execution of initiatives run smoothly and therefore create positive Six Sigma deployment success comes from historical experience. Generally, these factors revolve around having proper planning and support of the Six Sigma program and have been developed from critical failure factors, which is the next topic. There is a multitude of sources that can be examined to derive what are critical success factors in Six Sigma initiatives. Since Six Sigma has a formal history of two decades and a much longer foundation rooted in quality and project management practices, it is rather easy to define what are critical success factors. For the purpose of this study, several sources were used to illustrate the main theme.

Goldstein (2001) recognizes thirteen factors as key input variables: 1. Deployment plan, 2. Active participation of the senior executives, 3. Project reviews, 4. Technical support, 5. Full-time vs. part time resources, 6. Training, 7. Communication, 8. Project selection, 9. Project tracking, 10. Incentive program, 11. Safe environment, 12. Supplier plan and 13. Customer "WOWS". Fredendall, Robbins, and Zu (2006) identify ten factors: 1. Top management support, 2. Customer relationship, 3. Supplier relationship, 4. Workforce management, 5. Quality information, 6. Product/service design, 7. Process management, 8. Six Sigma role structure, 9. Structured improvement procedure and 10. Focus on metrics. Keller, (2005, pgs. 9-19) lists only four factors: 1. Support and participation of top management, 2. Sufficient resource allocation to improvement teams, 3. Data-driven decision making and 4. Measurement and feedback of key characteristics. It is evident that there are common themes between these groups. Keller makes a good and concise synthesis, which touches on all elements from the other two lists.

The following tables list the main reasons for Six Sigma's high regard, popularity and success. These tables are the summation and synthesis of the examined authors' perspectives (ASQ, 2007; Burns, 2006; Fredendall, Robbins, & Zu, 2006; Goldstein, 2001; Harry & Schroeder, 2000; Keller, 2005; Lefcowitz, 2006 & 2007; Marx, 2006 & 2007; Pyzdek, 2003 & 2006; Ramis, 2005; Stamatis, 2000; Wortman, et al., 2007). They represent the common themes that keep surfacing as this topic was researched. Table 1, *Strengths of Six Sigma*, demonstrates the broad view by listing the general advantages and benefits to the Six Sigma methodology. Table 2, *Top 5 Success Factors*, depicts the core elements for good deployment, project success and organizational harmony. The top success factors may simply be seen the practice of efficiency and effectiveness or doing the right things and doing them correctly to achieve desired results.

Table 1

Strengths (Advantages and Benefits) of Six Sigma

1. Breakthrough process improvement
2. Root cause analysis
3. Integrates both human (cultural change, customer focus and belt infrastructure) and process elements (process management)
4. Statistical analysis of process data, measurement system analysis
5. Decision making based on data
6. Focus on achieving measurable and quantifiable results.
7. No project approval without bottom line impact
8. Statistical thinking provides practitioners with the means to view processes holistically
9. Helps understand the variation of the process and eliminate special causes
10. Design better products with less waste and at a lower cost.
11. Maximize customer satisfaction and minimize defects
12. Clearly denied & specific structured method
13. Focus on specific metrics- variation
14. Specialized changes agents with specialized training
15. Well defined organizational role structure
16. High return on investment
17. Long term value creation
18. Employs everyone for cultural change
19. Efficiency and effectiveness
20. Quick visible rewards
21. Literature available
22. Higher learning for managers

Table 2

Top 5 Success Factors

1. Support and deployment strategy (commitment from top management, process owners, customer focus and communication)
2. Resources (allocation of time, talent, equipment, training, technical support and the right people)
3. Data-driven decision making (statistical thinking and project selection)
4. Measurement and feedback, (KPM/KIVs, lessons learned and effective control plan)
5. Organizational impact (cultural acceptance, readiness and behavior toward change and workforce management)

Critical Failure Rates

The experience and wisdom from the past provide a succinct success model of what makes Six Sigma initiatives operate smoothly. The product of this recipe for success was built on the failures of the past in both Six Sigma executions and other similar problem solving and project methodologies. In reality, and more often than not, initiatives don't run smoothly or yield the desired results (Lefcowitz, 2007). Studying the critical failure factors is what is needed to get to the heart of what makes Six Sigma deployments truly successful and to define a real measurement of its effectiveness. As previously indicated, using Six Sigma metrics to make that determination is a possibility, but the first step is to take a brief look at the predecessors upon which Six Sigma is founded upon.

The available literature on the subject compares Six Sigma and effectiveness to business, quality, and project management related initiatives. The primary attention and comparisons were given to the TQM movement and business process reengineering (BPR) efforts (Government Executive, 1997; Pyzdek, 2006). All methods have been criticized as fads (Stamatis, 2000). Six Sigma carries the stereotype of failure along with these other initiatives. When examining the historical failure rates of these prior initiatives as benchmarks of their effectiveness, a range from 50 to 70 % or more is commonly reported (Government Executive, 1997; Lefcowitz, 2006 & 2007; Pyzdek, 2003; Stamatis, 2000). Most of the literature gives Six Sigma failure rate percentages that are often anecdotal, unsupported, and compared in context to TQM failure rates. The research for this paper only found evidence of two substantial case studies on this topic.

In their article, “Where Has All the Magic Gone?” Harder and Swayne (2003) write of the study done by Greenwhich Associates of Greenwich Connecticut, USA.

> The purpose of the Greenwich study was to determine the root causes of successful projects in organizations with Six Sigma programs and trained, full time Black Belts (BBs) and Master Black Belts (MBBs) and with management (the CEO or CEO’s direct reports) at least publicly supportive. In other words, given trained resources and management support, how do you develop and then maximize f(x) for our y of successful Six Sigma improvement projects? Greenwich Associates interviewed executives to establish a baseline of 13 high profile corporate users in the United States averaging three years of Six Sigma involvement. The users included 11 businesses in the Fortune 500. (Harder & Swayne, 2003, pg. 22)

The authors do not come to a definitive solution about the root cause of successful project implementation. Their article and the Greenwich study lays a foundation for further research based on actual data.

The other study by Lefcowitz and provides a clear and distinctive link between failure rates of Six Sigma projects to that of information technology (IT) projects.

> The 2004 Standish Group's "Chaos Report," a biannual study (to date) on surveys of more than 50,000 information technology (IT) projects, estimates that only 29 percent of all software projects succeed. Fifty-three percent of all projects fail to attain their specified cost, schedule, or performance goals. An additional 18 percent are canceled before completion or delivery and are never used. This results in a 71 percent failure rate. (2007, pgs. 19-20)

Lefcowitz further goes on to give three concise reasons for his hypothesis linking Six Sigma and IT projects:

> •In the absence of any other evidence, there is nothing to suggest that a 6σ project is any more complex or difficult than an IT project.
>
> •6σ projects frequently have a substantive IT component.
>
> •Both 6σ projects and IT projects exist within the same environmental and managerial milieu; if project failure is substantially a management failure issue, then the root causes of one should be substantially the same as the other (2007, pg. 20).

In light of this evidence, a link between Six Sigma and its founding methodologies of TQM and BPR can be made and that it is possible to put a failure rate on Six Sigma projects from extrapolated and data supported failure rates from IT projects. More direct research on Six Sigma project failure rates is needed, but exactly what are critical reasons why Six Sigma projects fail?

Critical Failure Factors

Process improvement initiatives help businesses to achieve excellence, though problems are often encountered during the improvement process that hinders those achievements. Like critical success factors, there are many sources for critical reasons why Six Sigma initiatives fail. It would prove dogmatic to list all the reasons. One might assume that success and failure factors would be polar opposites but this not the actual case. They tend to be more alike than dissimilar, since success had been bread out of failure. In this sense, the major reasons why initiatives fails mirrors the reasons why initiatives are successful.

Riley identifies 10 common problems organizations face when initiating projects. These problems are: 1. Lack of upper management support; 2. Failure to link project objectives with business goals; 3. Optimizing the part at the sub-optimization of the whole; 4. Hidden agendas; 5. Lack of process owner support; 6. Not letting the project determine what project type to use and who the team leader should be; 7. Not involving financial representative in project scoping; 8. Team make-up not including all relevant functions; 9. Not walking the process and involving the operators and 10. Failure to stabilize the process prior to embarking on improvement. Riley also offers the bonus pitfall of 'ineffective control plan', which stresses that to sustain any improvement gains; effective control tools must be put in place to maintain the new way of doing things. Riley also indicates that these pitfalls are usually inter-related, their effects can multiply and concludes that they are indicators of a need to improve your company's process improvement approach (Riley, P., 2008).

Motorola is a world recognized authority on Six Sigma. It is prudent to look at what the founders of Six Sigma identify as the most critical failure factors. Motorola University Web site lists six very concise reasons for Six Sigma failures. The first reason is a, “lack of visible senior leadership sponsor.” The second reason is a, “lack of alignment to clear organizational strategy.” The third reason is a, “lack of performance tracking and accountability.” The fourth reason is a, “failure to link projects to bottom line results.” The fifth reason is an, “insufficient or ineffective allocation of human resources.” The sixth and final reason is an, “over emphasis on rigid approach and technical tools (Motorola University, 2004).

Most sources had some degree of overlap with Motorola University's failure reasons, while others took divergent views or made large jumps in logic. Jay Arthur (2004) takes what might be seen as an offbeat, practical, and layman's approach to Motorola's concise view by listing, “The Top 10 Ways You Know You Need Six Sigma” (p.8) and “Barriers to Six Sigma” (pgs. 37-40). Arthur's “Top 10 Ways...” are: 1. Heroic efforts, 2. Customer complaints, 3. Supplier complaints, 4. Employee whining, 5. Blaming people, 6. Knee jerk fixes, 7. Margins are low, expenses are high, growth is stalled, 8. Failures in the field, 9. Too many inspectors and 10. Absenteeism and turnover. In addition to being possible reasons for needing Six Sigma, it can be inferred that these could be failure reasons, because they may be present even after Six Sigma implementation and are areas that fall within Motorola's six failure criteria.

Arthur's "Barriers..." are: 1. People don't like being measured, 2. Macho man, 3. Achievers vs. problem solvers, 4. Big picture vs. detail, 5. Evolutionaries vs. revolutionaries, 6. Hero worship, 7. Fix it fiefdoms, 8. Instincts vs. instruments and 9. Fear of looking stupid.

Carnell (2006) frames the subject of Six Sigma deployment failure in two main headings entitled "Master Black Belt (MBB), Black Belt (BB), and Green Belt (GB) Failures" and "Management and Company Failures" with 20 detailed reasons in the former and 33 detailed reasons in the latter. The first main heading or category puts the failure emphasis on the practitioners conducting the Six Sigma projects while the second category puts the failure emphasis on management and the company wide enterprise. Several notable reasons listed under the first category of "Master Black Belt... Failures" are: failing to appreciate the complexity of dealing with people, failing to recognize Control as the most difficult phase to implement effectively, not communicating effectively with management- they speak the language of money, avoiding resistance, not sharing credit for the solution with the team and not taking a roadblock to the Champion after they have tried themselves. Several notable reasons listed under the second category of "Management and Company Failures" are: no vision related to customer expectations, lack of alignment (horizontal or vertical), deploying Six Sigma with a goal but no plan on how to get there, abdicating the deployment plan to a consulting company, no rewards or recognition program, project selection process does not identify projects related to business objectives, no buy in at the process owner level, no consequences for suppliers sending bad material, believing a single initiative can/will solve all your problems and using BBs for fire-fighting.

Gilbert (2002) reviews Six Sigma as a dangerous trend because it has expanded from its original context by trying to reach into areas that are beyond its scope. Gilbert crystalizes his point by citing critic Larry Keeley, " ... the truism that once you master a hammer, everything starts to look like a nail." Besides comparing Six Sigma to a sick trend grown out of proportion, Gilbert lists 12 'TO-DONTS' OF SIX SIGMA which come from Mikel Harry's Six Sigma Academy & Hammer & Co. In addition to some over lap with previously cited authors, several of these key failure reasons are: having projects tied to insignificant criteria, setting incorrect targets perhaps based on the number of people trained and certified rather than on bottom line results, stretching the definition of Six Sigma is like stretching the definition of basketball to include baseball, don't oversell what Six Sigma can accomplish and don't apply it to all business problems.

Lefcotwiz (2007) draws upon both risk factors and traps in software reengineering and software metrics to support and illustrate Six Sigma project failures and presents the concept of sub-optimization as a primary reason why Six Sigma initiatives fail. In what seems to be a rather stretch approach, Lefcowitz (2006 & 2007, September and October) further extends the 71% failure rate concept from the Standish Group's 2004 "Chaos Report" by applying the ideology of the Pareto principle 80-20 rule to process improvement or Six Sigma. He also draws upon the work of Arthur (2004) to apply the 80-20 rule unto itself several times which leads to the conclusion that a very small percentage (1%) of company efforts lead to the vast majority (50 %) of its problems.

The following tables list the main reasons for Six Sigma's high failure rate and the factors that hinder its performance. These tables are the summation and synthesis of the examined authors' perspectives (Arthur, 2004; Burns, 2006; Carnell, 2006; Fredendall, Robbins, & Zu, 2006; Gilbert, 2002; Government Executive, 1997; Harder & Swayne, 2003; Harry & Schroeder, 2000; Keller, 2005; Lefcowitz, 2006 & 2007; Marx, 2006 & 2007; Motorola University, 2004; Pyzdek, 2003 & 2006; Ramis, 2005; Riley, 2008; Stamatis, 2000; Wortman, et al., 2007). They represent the common themes that keep surfacing as this topic was researched. Table 3, *Weaknesses of Six Sigma*, demonstrates the broad view by listing the general disadvantages and drawbacks to the Six Sigma methodology. Table 4, *Top 5 Failure Factors*, depicts the essence of the problem. The top failure factors may simply be seen as either a lack in either deployment method (strategy) or theory or in practical application of Six Sigma methodology.

Table 3

Weaknesses (Disadvantages and Drawbacks) of Six Sigma

1. Sub-optimization
2. Total change in management style
3. Creates time constraints for solving problems
4. Can't do partially/ not full commitment
5. Used as a fire fighting tactic
6. Easy to make mistakes
7. Requires full commitment of change and management commitment
8. Can be expensive
9. No standardization
10. Results are quick but complete transformation takes time. Lack of cultural integration for lasting change. No organizational change, only the process
11. Too many consultants and too few really good SS people available
12. Standardization of Six Sigma may inhibit new and creative processes and may actually stifle company growth
13. Using as a panacea or applying to every situation, when other tools or methods should and could be used

Table 4

Top 5 Failure Factors (Deployment Method vs. Six Sigma Methodology)

1. Support and deployment strategy
2. Resources
3. Organizational impact
4. Sub-optimization
5. Link to business goals and accountability

Return on Investment

The bottom line financial gain is often the definitive measure of Six Sigma's effectiveness, but is it really making that much of an impact or is the hype unsubstantiated from a financial view point? Large corporations report success stories and tout the glories of Six Sigma, but are they reporting the whole picture? Is what is disclosed to the public a true reflection? Might there be a different truth? A truth that is not so glorious. One that would undermine the pedestal upon which Six Sigma rests as a highly prized improvement approach and feeds all the skeptics of Six Sigma's real bottom line. To understand Six Sigma's effectiveness, a brief overview of its metrics is necessary to examine this issue.

Six Sigma metrics are a blend of long standing quality (statistical) and financial measurements. The metrics serve as an ongoing feedback mechanism over time. Typically, these may include critical to quality (CTQ), process capability (Cpk), defects per unit (DPU), defects per million opportunities (DPMO), first pass yield (FPY), rolled throughput yield (RTY), and other project risk measures (Breyfogle, 2003; Pyzdek, 2003; Wortman, et al, 2007). These metrics serve as both customer and business drivers and as benchmarks to make decisions about monitoring, adjusting and controlling processes. From a statistical standpoint, the hard metrics like Cpk, DPU and DPMO are approximations or averages of measurements on how a particular process is functioning. By taking, the hard metrics from a much higher-level view or satellite metrics as Breyfogle (2003) calls them, is a forward step in determining the effectiveness of Six Sigma initiatives. By extending the use of Six Sigma metrics and applying it to the Six Sigma methodology itself, it may be possible to come up with an overall success or failure rate for Six Sigma projects.

Examination of return on investment (ROI) provides a starting point for measuring Six Sigma initiatives, as mentioned by Carnell (2006) and Lefcowitz (2006 & 2007, September and October). Lefcotwitz provided a 71% failure rate for Six Sigma projects. He states that, “This failure rate is assumed a rough indicator of the industry's current effectiveness at producing results (2007, September).” Lefcowitz may have a valid point, but it requires data that are more precise gathered directly from Six Sigma initiatives across various spectrums. The ISixSigma staff conducted a fundamental survey entitled the “Black Belt Return on Investment Research Report” which provides hard evidence and data of Six Sigma project success and failure rates and return on investment. The report contends that median yield of hard financial savings for Black Belt projects are $187,000 with an average 12 month pay back period (2005). Marx, followed up with a “Project Failure” report, which explores the what, how, and why of project failure causes and puts a 68% project failure rate on Six Sigma initiatives (2008). Though these two research efforts clearly indicate that Six Sigma projects have at least a 50% failure rate, care must be taken before accusations can be made, since failure and success have different levels of meaning as indicated by Marx's research (2008). What these studies do is make it possible for formulating a bottom line failure rate and overall financial impact of Six Sigma's effectiveness.

One further measure of Six Sigma's effectiveness and worth was use of the the Standard's and Poor 500 (S & P 500) stock price index to evaluate performance of companies using Six Sigma. In particular, the study by Charles Holland of QualPro is often refereed to in the literature (Richardson, K., 2007). In general, its main point is that large companies like Ford, GE, Home Depot, Xerox and others implementing Six Sigma up until December, 2006 have under performed on the S & P 500. This is being used as an indicator that Six Sigma was not helping these organizations in the grand fashion it was made out to be. What was not often cited from the same study was that companies like Caterpillar, Target and Whirlpool have outperformed on the S & P 500 since their implementation of Six Sigma.

A caution for criticism of the S & P 500 measure is that it may not be a good indicator of Six Sigma's worth. The context of Six Sigma implementation must be considered. When implemented in these large companies, was Six Sigma used enterprise wide or only in certain segments of the company? In the case of Home Depot and GE it was over a large majority of the company if not enterprise wide for a long duration. In other companies it may have been on a smaller scale such as departmental and therefore not a good indicator. The S & P 500 may also be seen in the light of popular opinion, since Home Depot's shares went down 8.3% on the New York Stock Exchange with a 16% rise on the S&P 500 during it's Six Sigma implementation between July 2001 and

December 2006. More to the point is that its stock rose over 2% the day after Bob Nardelli's resignation as CEO in January 2007 (Richardson, 2007).

Summary

The literature review revealed a concise picture of what was available on Six Sigma in terms of critical factors, organizational impact, success and failure rates and ROI. There is a distinct gap between the plethora of criticism and adulation on Six Sigma and viable deterministic evidence from literature sources. The literature indicates that organizational impact has an influence on Six Sigma initiatives and provides a link to both historical quality initiatives like TQM and identifiable critical factors. Examination of critical factors demonstrates there are several key indicators attributable to initiative success or failure, which was substantiated by financial impact as characterized by ROI. Further research would provide additional support before conclusions can be reached about the hypothesis statements. A survey focusing on these proportions of the Six Sigma universe is needed for discernment. It would essentially evaluate Six Sigma on its own terms and whether or not it is really creating value.

CHAPTER 3
METHODOLOGY

Overview

In this chapter, the research participants, variables, instruments, validity and reliability, data collection and data analysis are defined. Participants include defining the population and the characteristics of the sample. The research instrument was a survey delivered electronically to measure the variables from the hypotheses statements. Data collection describes the steps followed in this study. Data analysis includes a description of the statistical techniques used to analyze the research findings.

The driving force for investigating Six Sigma initiatives was to determine what critical factors are involved which lead to ultimate success or failure of initiatives. As previously stated by Lefcowitz, "Nowhere has any practitioner or institution attempted to statistically survey the universe of 6σ to discover what proportions are successful and what proportions are unsuccessful and for that matter-why or why not (2007, pg. 19)." The researcher developed a survey to b delivered electronically which supplied data for descriptive result analysis using mean, mode and regression. The survey was developed from the research questions and hypothesis statements and measured whether or not organizational impact, financial effectiveness and success rates of initiatives were directly dependent on these critical factors.

Research Participants

The intended research subject audience consisted of ASQ Region 12 members. Figure 1, ASQ Region 12 Membership, shows that Region 12 includes Illinois, North

Western Indiana, Northern Iowa, North Dakota, North Eastern South Dakota, Minnesota and Wisconsin. The ideal target audience comprised professionals with direct Six Sigma initiative or project involvement from engineering, management and quality related areas. ASQ currently has over 100,000 members (ASQ, 2009) and there are approximately 8,357 ASQ members in Region 12 (Karen Posser (ASQ), personal communication, June 30th, 2010). Table 5, *ASQ Region 12 Membership Detail*, provides a breakdown of the membership classifications.

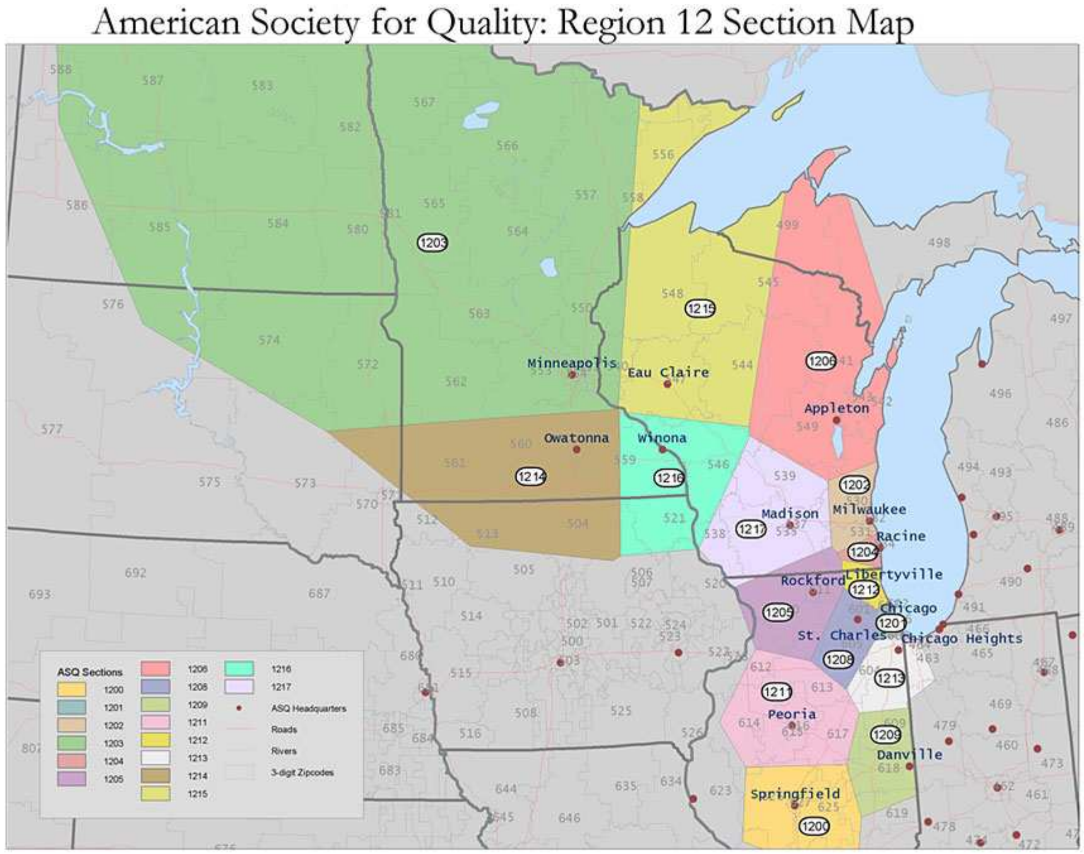

Figure 1. ASQ Region 12 Membership

Table 5

ASQ Region 12 Membership Detail

Member Type	Totals
Forum	15
Student	217
Associate	151
Regular	3923
Senior	3864
Fellow	62
Sustaining	65
Honorary	1
Organization	6
Organization Member	48
School	1
District	4
Total	8357

A letter of intent was sent to all ASQ section chairpersons in Region 12 via e-mail to assess support status in dissemination of the survey (see Appendix A). ASQ headquarters coordinated this effort. Support was gained from all section chairpersons (personal communications, 2010). An announcement of the survey was made via e-mail to Region 12 members and mentioned in regular electronic newsletters before release. The survey (see Appendix B) was distributed electronically in a single round fashion and responses were received and collated by the University of Central Missouri's server. The survey was available for approximately three weeks from August 1st to 21st, 2010.

Variables

The study includes four types of variables, controlled, dependent, extraneous and independent. The controlled and extraneous variables present information that remains either as a constant or is not theoretically interesting. Both help to clarify the relationship between the dependent and independent variables by giving it perspective. These variables were not measured since they are not the primary research interest. As subject matter, they could become a research topic for a different type of study related to a more holistic and satellite view of Six Sigma (Breyfogle, 2003).

For measurement purposes, only the dependent and independent variables will be analyzed. Independent variables may be thought of as items that can be changed by the organization, the cause to an effect or inputs. Dependent variables may be thought of those items that require influence, are expected to change and are the effect or output. Success rates are independent variables. They can be considered dependent variables only from the standpoint that they are expected to change contingent upon the critical factors. Statistical analysis of these variables will answer the primary research questions of this study. To restate, in a concise manner, this study was essentially trying to discern and measure the following:

1. There is a difference between implementing Six Sigma and other improvement initiatives such as Total Quality Management (TQM) and Information Technology (IT) projects.

2. Critical factors have a significant influence on organizational impact in Six Sigma initiatives.

3. Critical factors have a significant influence on success rates in Six Sigma initiatives.

4. Critical factors have a significant influence on financial effectiveness in Six Sigma initiatives.

The variables and their types consist of the following:

Controlled:

1. Do you believe that Six Sigma as a quality and management initiative over the last 20 yrs. has been successful?

2. Do you believe that the Six Sigma methodology has enough sustainability for a long-term future?

3. What constitutes project success: (ex. completion, meets targets/objectives, maintains improvement, meets financial goals, all projects considered successful, other).

4. What constitutes project failure: (ex. not completed, does not sustain improvement, does not meet targets/objectives, dose not meet financial goals, no project considered a failure and other.)

5. Estimate your Six Sigma project completion rate.

Extraneous:

1. Do you believe that Six Sigma as a quality and management initiative over the last 20 yrs. has been successful?

2. Do you believe that the Six Sigma methodology has enough sustainability for a long-term future?

Dependent:

1. Financial impact, project savings.
2. Organizational impact, aptitude toward cultural change.

Independent Variables:

1. Management commitment and support.
2. Critical Success Factors.
3. Critical Failure Factors.
4. Primary financial metric used.
5. Projects tied to business goals.
6. Length of time using Six Sigma, in years.
7. Project success rate before Six Sigma.
8. Project success rate after implementing Six Sigma.
9. Project failure rate before Six Sigma.
10. Project failure rate after implementing Six Sigma.
11. Opinion if there is a difference between Six Sigma and other project oriented improvement methods.

Instruments

An electronically delivered survey was developed by the researcher from the literature reviewed to gather data on critical factors of Six Sigma initiatives and the three focus categories of organizational impact, success rates and financial effectiveness (see Appendix B). The survey was reviewed in multiple rounds of refinement between the researcher, the survey design team and the thesis committee.

The first section of the survey contained the Demographic Information Section and questions one through nine. It was intended to gather information about the respondents type of industry, department, position, certifications, Six Sigma training and experience, education and their organization's size and sales. The second section contains the survey criteria and it was divided into the following five parts: Organizational Impact, Critical Factors, Success Rates, Effectiveness and Additional Comments.

The first part on Organizational Impact asked a total of five questions and included questions 10 through 14. A five point Likert scale was used (poor, fair, good, very good and excellent) for all questions. Questions 10 through 13 address organization attitude and behavior, while question 14 addresses organizational integration. Organizational Impact is important because it relates to the level of management commitment and support; the capacity for cultural change in terms of readiness acceptance and behavior; customer focus, including both internal and external customers and deployment strategy, which includes infrastructure, project selection, holistic view via statistical thinking and data-driven decision making, and the documentation, feedback and application of lessons learned.

The second part on Critical Factors asked thirteen questions and included questions 15 through 27. Question 15 through 22 and 25 through 27 used a five point Likert scale (poor, fair, good, very good and excellent), while question 23 asked respondents to rank critical factors in order of importance. Question 24 was an open ended fill in the blank, which asked respondents to list any other critical factors not covered by question 23 that may be important. Questions 15 through 22 covered the critical factors identified in the literature and questions 25 through 27 addresses the influence of the three focus areas and hypothesis statements.

The third part on Success Rates asked eight questions and included questions 28 through 37. Question 28 used a five point Likert scale (poor, fair, good, very good and excellent). Question 29 asked respondents to rank in order of importance the factors that constitute project success, while question 30 was an open ended fill in the blank to list any other project success factors not covered in question 29. Questions 31 and 32 asked to estimate Six Sigma project completion and project success rate from 0 to 100%, while question 33 was an open ended fill in the blank to list any other improvement methodologies used at the respondent's organization. Questions 34 through 36 used a dichotomous scale of “yes” or “no” to measure the respondents opinions about Six Sigma's success as a management initiative over the last 20 years, its sustainability for a long term future and if it is the most important improvement method used at the respondent's organization. Question 37 simply asked to list the most important improvement method used if the respondent answered 'no' in question 36, which indicates that Six Sigma was not the most important method uses at the respondent's organization.

The fourth part on Effectiveness included questions 38 through 43. Questions 38 and 39 asked for estimates of hard and soft savings from Six Sigma projects. Question 40 asked for the most important or effective project metric, while question 41 asked to specify any other important project metric used if the respondent answered 'other' in question 40. Question 42 asks for the most important or effective financial metric, while question 43 asked to specify any other important financial metric used if the respondent answered 'other' in question 42. The fifth part on Please Share Any Additional Comments allowed respondents the opportunity for further feedback.

Validity and Reliability

Validity and reliability of content were used to ensure that the survey questions measured the study's intended purpose. The instrument was reviewed by a Survey Design Team consisting of both ASQ and non-ASQ members with backgrounds related to the field of quality and academic research. The Team members familiarity with the subject helped to remove possible inherent bias with the survey questions.

The researcher with the help of the Survey Design Team reviewed and refined the instrument, then it was reviewed by the thesis committee members for an additional level; of refinement. Upon thesis committee approval, the researcher created the survey electronically on the University of Central Missouri's server using Simple Form and Survey Builder v2.1. The electronic version received a final review and approval from the thesis committee before release to ASQ headquarters, which in turn released it to Region 12 section chairs for final distribution to the section membership. This multiple round approach provided sufficient feedback for assurance of instrument reliability (Ulmer, 2008).

The survey review team included:

Jim Akers, Customer Quality Engineer/ Six Sigma Black Belt, Woodward Governor Company, Rockford, IL, USA.

Kam Gupta, Executive Coach and Management Consultant, Continuous Improvement Technologies, Buffalo Grove, IL, USA.

Tom Hall, Ph.D., CQE and CSSBB, Education Chair for ASQ Rockford (IL) Section, Quality Manager, MedPlast, Elkhorn, WI, USA.

Jerry Lassa, President's Action Council: Lincoln Foundation for Performance Excellence, Naperville, IL.

Duke Okes, Knowledge Architect, APLOMET/Applied Logical Methods, Blountville TN, USA.

Michael R. Whisman, Master Black Belt and Director of Quality for Business xcellence, Baxter Healthcare Corporation, Deerfield, IL, USA

Data Collection

The following steps entailed the survey development and data collection process.

1. The researcher contacted ASQ Section chairpersons to assess receptivity and assistance with survey distribution to ASQ members in Region 12.
2. The researcher selected ASQ members, which he had familiarity with, who would serve as a panel of quality experts known as the Survey Design Team to help develop and refine the survey.
3. Researcher developed the survey to answer research questions and hypotheses.
4. Survey distributed in multiple rounds of review, feedback and changes to the Survey Design Team and Thesis Committee.
5. Researcher developed the electronic survey on the University of Central Missouri's server using Simple Form and Survey Builder v2.1.
6. The Thesis Committee gave a final review and approval of the electronic version of survey.
7. Survey submitted and approved by the University of Central Missouri's Human Subject Committee.

8. The researcher contacted ASQ section chairs and ASQ headquarters to consolidate survey distribution in a single round.

9. Survey distributed to ASQ membership by electronic notification (e-mail and newsletters) from the sections.

10. ASQ members responded to the survey.

Data Analysis

The data gathered from the survey was correlated and coded using Microsoft Excel. Coding of the data was necessary for regression analysis of the research variables to test the hypotheses using the Statistical Package for Social Science (SPSS). Descriptive analysis of the data by two measures of central tendency, the mean and the mode, provided the average and frequency for the variables. These two measures generated an overall benchmark of critical factors identified in the literature. The power of a generalized benchmark provides relative clarity about Six Sigma's bottom line, as evident in a previously executed study on Black Belt return on investment by IsixSigma Magazine (2005).

Figure 2, Theoretical Framework, provides the statistical relationship of the variables to research hypotheses and the equations used in multiple regression. The multiple regression analysis with a confidence level of 95% determined if there was a statistical relationship between the variables, whether or not they were independent of each other and clarifies the relationship strength between the variables. These tests allowed for interaction of critical factors influence or lack thereof among the three criteria of organizational impact, success rates and financial effectiveness. A detailed explanation of the multiple regression equations is provided in the next chapter.

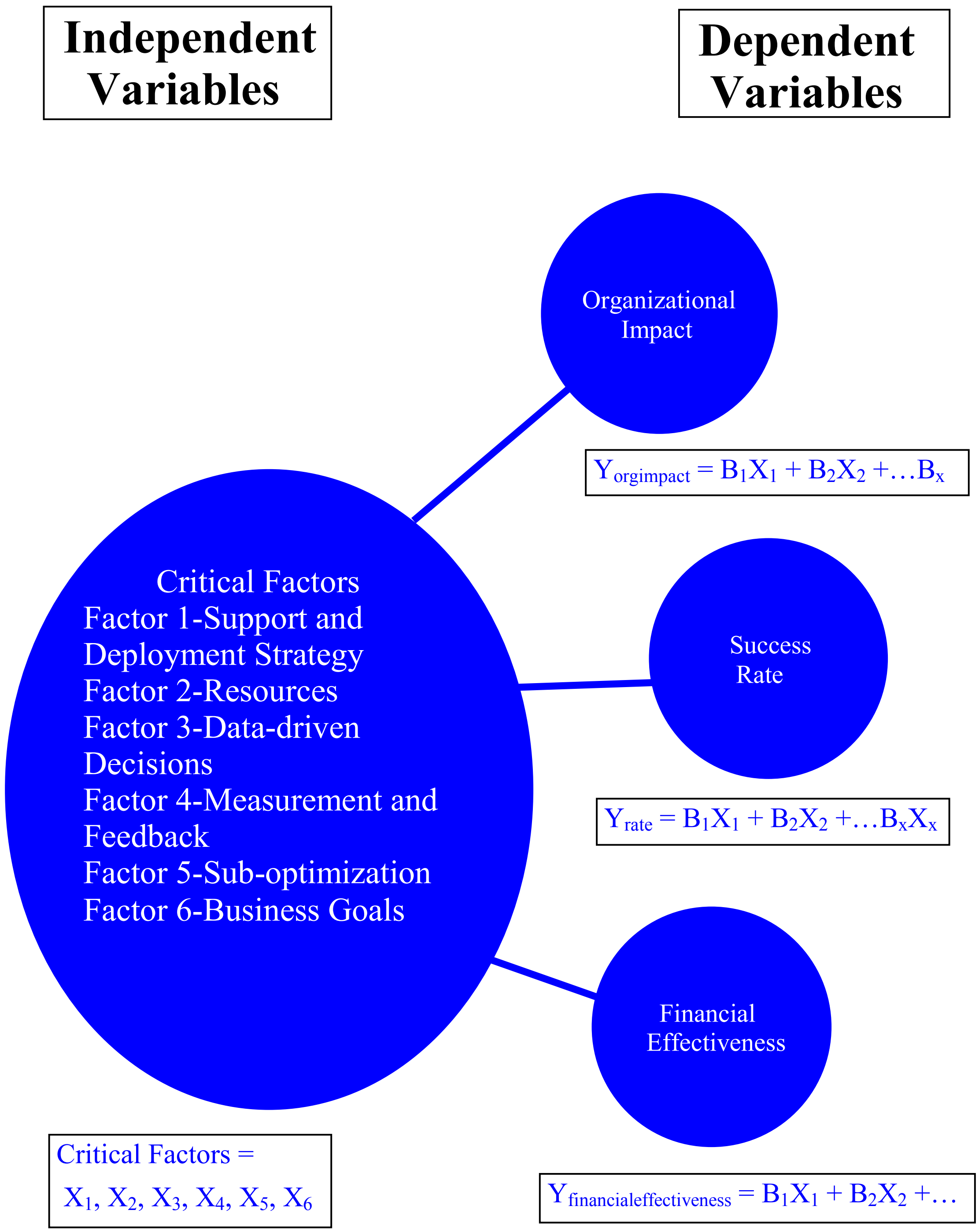

Figure 2. Theoretical Framework

Summary

This chapter described the methodology of investigation used for the study. It laid out the research participants, variables, instruments, validity and reliability, data collection and data analysis. The target research audience was a potential population of 8,357 ASQ members from Region 12. Support was gained from ASQ Region 12 chairpersons and ASQ headquarters to help distribute the survey electronically. The variables used to answer the research questions and measure the hypotheses were described and an overview of the survey was given. An expert panel was recruited and used to design the survey and provide validity and reliability. Data collection listed the formal sequence of steps followed for survey development and deployment, while the data analysis described the theoretical framework and statistical techniques used for analysis of research findings.

CHAPTER FOUR
RESULTS OF DATA ANALYSIS

Introduction

This chapter details the results from the electronic ASQ Six Sigma Survey distributed to ASQ members in Region 12. The survey population encompassed a potential of 8,357 respondents. The survey was available to the population for 21 days, from August 1st through 21st 2010, and yielded 36 total responses. The results are divided into two parts. Part 1 provided descriptive statistics for the survey results. Part 2 provided regression analysis of the hypotheses as they relate to specific questions in the survey.

Part 1: Survey Results

The survey was divided into two parts, a Demographic Information section and the Survey Questions. The demographic section covered information about the survey respondents that was not addressed directly by the research questions and covers survey questions 1 through 9. Descriptive survey data addressed the research questions in the second part of the survey. Research questions 1 and 2 address Critical Factors and covered survey questions 15 through 27. Research question 3 addressed Organizational Impact and covered survey questions 10 through 14. Research question 4 addressed Financial Effectiveness and covered survey questions 38 through 43. Research question 5 addresses the Six Sigma improvement methodology in comparison to other similar methods and research question 6 addresses Success Rates and covers survey questions 28 through 37. There was some overlap in the Critical Factor survey questions 25 through

27 with Organizational Impact, Success Rates and Financial Effectiveness respectively, since these questions were designed to answer the hypotheses.

The findings are divided into the major sections of the survey. A summary of significant highlights is given for each section followed by the data tables from the hypothesis question. The results are presented with descriptive statistical results of number of respondents or sample size, denoted by 'n', and frequency or percentage, denoted by '%', in a table format.

Research Questions:

1. What are critical success factors in Six Sigma initiatives?
2. What are critical failure factors or barriers in Six Sigma initiatives?
3. Is the organizational impact of Six Sigma initiatives dependent upon critical factors?
4. Are the financial results of Six Sigma initiatives dependent upon critical factors?
5. Is there a difference between Six Sigma and other similar methodologies such as Total Quality Management (TQM) and Information Technology (IT) projects?
6. Do Six Sigma initiatives share a similar success rate with other similarly structured methodologies such as Total Quality Management (TQM) and Information Technology (IT) projects?

Demographic Information Results

The Demographic Information section yielded some promising findings. There were only 36 responses in the sample of a potentially large population, so there was an overall return of less than one percent. Though the sample was small, the demographic results provide two important insights. It shows a reasonable cross section of quality professionals with Six Sigma exposure demonstrated by its breadth across industry sectors, which reinforces the sample's reliability and adds validity to the strength of the small sample.

In regard to the spread of respondents across industry sectors in question 1, there was about 70% in Business or manufacturing and 30% in non-manufacturing areas. Six Sigma was initially applied in manufacturing and has proliferated into through other industry sectors, so a 70 % majority was in line with its historical context. From question 2, the majority of respondents work in direct quality or management roles, with Quality Engineer at 33.3%, Management at 16.6% and Master Black Belts at 13.8%. From question 3, the most notable ASQ certifications were CQA and CQE both tied at 17.4% followed a second tie between CQM/OE and CSSBB at 14.5% and CSSGB with 10.1%. Question 4 on other certifications showed that 55.5% of respondents held no other certifications, while there was a tie between employer and other professional organization at 19.4%. Question 5 showed that most respondents Six Sigma training was a 27.8% tie between Black Belt trained or have little to no Six Sigma training and a second tie between Master Black Belt and Green Belt trained individuals with 22.8%. Question 6 showed most respondents Six Sigma experience of 50 % with 4 years or less, followed by 36 % for 5-9 years and only 13.9% with more than 10 years. Questions 7 showed most of the sample are Master's degree holders at 44.4% followed by Bachelor's degree holders at 38.9%. Question 8 showed that organizations of respondents with 1-5000 employees were the majority with 22.2% and organizations of 1-100, 5-10,000 and 10,000 or more were all tied at 19.4%. Questions 9 and 10 about total sales showed a dramatic shift upward compared to the number of employees with over $1 Billion taking the lead at 30.6%, $500 Million to $1Billion and $25 Million to 100 Million both tied at 19.4 % and

$1 to $25 Million at 13.9%. So overall, the sample provides a decent cross section of industry characterized by practitioners primarily from manufacturing companies, in direct quality or management roles, ASQ certified, with less than 5 years of Six Sigma experience, college educated, from smaller organizations of 1 to 5, 000 and sales in the millions if not in the billions.

Organizational Impact Results

The first section of the survey focused on organizational impact and covered in questions 10 through 14. Organizational attitude, question 10, was generally positive at 41.7%, while question 11 on aptitude ranged from good to fair at 36.3% and 33.3 %. Organizational behavior toward cultural change, question 12, was very positive at 47.2% but the deployment of Six Sigma, question 13 was generally fair at 31.4 % or either tied between poor and good at 22.9%. Integration of the organization's Six Sigma program, question 14, were generally at a maturing state of development with 31.4% or beginning at 25.7%. So the organization impact showed a positive receptivity to cultural change and Six Sigma but falls a little short on the actual deployment and most organizations are beginning or on their way using Six Sigma.

Critical Factors Results

The second section of the survey focused on critical factors that covered in questions 15 through 27. Questions 15, 16 and 17 were about support and deployment strategy. They showed that 34.3% of management had a good attitude toward Six Sigma in question 15, only a fair level of commitment at 37.1% in question 16 and a generally fair, ad hoc and informal approach of 31.4% to deploying Six Sigma throughout the organization in question 17. Questions 18-24 depicted the other identified critical factors.

Question 18 showed resource allocation was generally poor to fair at 28.6% for both. Question 19 had divergent results that data-driven decision-making ranged from fair or very good at 31.4% and 28.6%. Question 20 showed that measurement and feedback rank fairly at 37.1%. Question 21 showed sub-optimization ranged from fair to poor at 39.4% and 24.2%. This means that for most organizations in the sample, sub-optimization was quite prevalent. Question 22 showed that business goals receive fair consideration with 32.4%. Question 23 asked respondents to rank the critical factors in order of importance and Question 24 asked them to identify any other factors that are important but were not listed. From the responses, resource allocation and measurement and feedback ranked the highest at 22.1% each with data-driven decision making and organizational impact tying in second at 13.04% each. Of the 36 responses on other factors, 75% did not respond, but those who did, ranked gaining buy-in and trust as the most important at 8.3%. Questions 25, 26 and 27 rated the influence of the three main hypotheses in a very positive depiction with high rankings in very good and excellent. Organizational impact ranked 35.3% in excellent and 32.4 in very good; success rates ranked 33.3 %in very good and 27.3% in excellent and financial effectiveness ranked 42.2% in very good and 24.2% in excellent.

Overall, critical factors of Six Sigma initiatives rated a general trend toward fairly. The responses from the means and modes indicate that critical factors in most organizations were given positive intangible support, attitude and talk, while received mediocre attention in actual execution. The respondents considered resource allocation and measurement and feedback the most important. The perceived influence by the respondents of the three main hypotheses rated on the high end, which means a hopeful and positive attitude toward their importance in Six Sigma initiatives.

Success Rates Results

The third section of the survey questions focused on success rates and was covered in questions 28 through 37. Question 28 showed that overall Six Sigma program success was rather negative with a 36.4% in poor and 24.2% in fair categories. Question 29 showed that meets targets or objectives at 19.8% was the most important, while maintaining improvement and financial goals met come in a close second at 18.6% and 17.4%. Of the 13 who selected other, 10 responses were given in question 30 with an equal strength of 10% each. This other factors of project success were enhanced regulatory compliance, lessons learned, project selection/identification, buy-in or trust, quality impact of product or service, hidden factory, team selection/support, customer satisfaction index rises, data-driven decision making and alignment-nemawashi. Questions 31 and 32 showed that project completion and success rate was rather low at 34.4% and 35.5% in the 0-10 category for both. This was rather significant since it seemed to give credence to the critics. Question 33 asked respondents to indicate any other improvement methodologies used with Lean far out ranking the others at 32.4. Questions 34, 35 and 36 used a dichotomous scale of yes and no to relate respondents opinions of Six Sigma success over the last 20 years, if it has a sustainable and long term future and if it is the most important improvement method used in their organization. Question 34 shows 63.6% for yes and 36.4% for no. Question 35 shows 64.7% for yes and 35.3% for no. Question 36 shows 34.3% for yes and 65.7% for no. Question 37 asked the most important method used if no was answered in question 36. Of the 23 respondents who answered no in question 36, only 16 responded in question 37 with Lean at 31.3% and CAP-corrective action ranking the next highest at 12.5%. Overall, success rates of Six Sigma projects tend to be low according to the mean and the mode.

Financial Effectiveness Results

The fourth section of the survey questions focused on financial effectiveness and was covered in questions 38 through 43. Questions 38 and 39 provide hard and soft savings data from 2009 Six Sigma projects and both yielded $0-$25,000 at 33.3%. Question 40 identified the most important project metric as none or other with 18.8% for both. Question 41 asked to list the metric used if other was selected in question 40. Of the 6 responses for other in question 40, only five responses in question 41 of equal strength at 20% were given as loyalty survey, sales growth/cost savings, dollars saved, financial and do not used Six Sigma. Question 42 identified the most important financial metric as return on investment with an overwhelming 59.4%, while question 43 asked to list the metric used if other was selected in question 42. Of the four responses in question 42, only 3 responses in question 43 of equal strength at 33.3% were given as payback period, hard savings and do not use Six Sigma. Overall, the data from the mean and mode show that financial savings for Six Sigma projects were rather low and that return on investment was most important financial marker. The fifth and last section of the survey asked for any additional comments and of the eight responses given, none provided any reportable feedback.

Part 2. Regression Analysis

This section details the relationship of measured variables against the hypotheses statements used in SPSS multiple regression analysis. Questions 15 through 27 measured the critical factors identified from success and failure factors in Tables 1 through 4 and were coded for use in SPSS. These critical factors were statistically tested against the three hypotheses statements focusing on organizational impact, success rates and financial effectiveness. Full SPSS statistical results are in Appendix C, while the main points of the results in relation to the hypotheses are discussed and presented here.

Each hypothesis statement addresses multiple research questions. Every statement covers research questions 1 and 2 on critical factors and the respective question(s) relating to the particular hypothesis. Hypothesis statement 1 covers research questions 1 and 2 on critical factors and question 3 on organizational impact. Hypothesis statement 2 covers research questions 1 and 2 on critical factors and questions 5 and 6 on Six Sigma's similarity to other improvement methods and success rates respectively. Hypothesis statement 3 covers research questions 1 and 2 on critical factors and question 4 on financial effectiveness. The hypotheses are stated below and main results discussed afterward.

Hypothesis Statements:

H01. Critical factors have no statistically significant influence on organizational impact in Six Sigma initiatives.

HA1. Critical factors have a statistically significant influence on organizational impact in Six Sigma initiatives.

H02. Critical factors have no statistically significant influence on success rates in Six Sigma initiatives.

HA2. Critical factors have a statistically significant influence on success rates in Six Sigma initiatives.

H03. Critical factors have no statistically significant influence on financial effectiveness in Six Sigma initiatives.

HA3. Critical factors have a statistically significant influence on financial effectiveness in Six Sigma initiatives.

To test the hypotheses, the research variables were coded for use in SPSS. Table 6, *Regression Variables*, provides the coded variables for critical factors and the focus factor in the multiple regression equations. A detailed explanation of the multiple regression equations used to test each hypothesis and its data follows.

Table 6. *Regression Variables*

SPSS –Name	Question #	Full description
SDS_Atti	15	Support and Deployment Strategy - top management's attitude
SDS_comm	16	Support and Deployment Strategy- top management's level of support or commitment
SDS_depl	17	Support and Deployment Strategy - organization's Six Sigma deployment
Resource	18	Resources
Datadriv	19	Data-Driven Decision Making
Measure	20	Measurement and Feedback
Suboptim	21	Sub-optimization
Busigoal	22	Business Goals
Orgimpa	25	organizational impact
SuccesR	26	success rates
Fin_effect	27	financial effectiveness

Regression equations were formulated from the coded variables in Table 6 to illustrate the relationship between the dependent variable and the independent variables. The critical factors (support and deployment strategy-top management attitude, commitment and deployment; resources; data-driven decision making; measurement and feedback; sub-optimization and business goals) became the independent variables in each hypothesis and the focus factor became the dependent variable (organizational impact, success rates and financial effectiveness). A 95% confidence level (alpha = .05) was used and a standard multiple regression equation was used:

$$Y= B_1X_1 + B_2X_2 + B_3X_3 \ldots + B_iX_i + e_1$$

Where Y = the dependent variable, B_1 = independent variable coefficient 1 and X_1 = independent variable 1, B_2 = independent variable coefficient 2 and X_2 = independent variable 2, B_3 = independent variable coefficient 3 and X_3 = independent variable 3 and so on as B_i = independent variable coefficient i and X_i = independent variable i, and e_1 = error (Field, 2005, p. 157; Ulmer 2008, p. 116).

From Table 6, there are eight identified independent variables that form the critical factors and three dependent variables that form the test hypotheses. The independent variables remained the same for all three hypotheses; where as, the dependent variables changed. The format followed for hypothesis equations was:

$$Y_{\text{Org. Impact, Success Rates or Financial Effectiveness}} = B_1X_1 + B_2X_2 + B_3X_3 \ldots + B_iX_i + e_1$$

Where the independent variables used in each hypothesis equation are defined as: X_1 = SDS_Atti or Support and Deployment Strategy - top management's attitude; X_2 =SDS_comm or Support and Deployment Strategy- top management's level of support or commitment; X_3 = SDS_depl or Support and Deployment Strategy -organization's Six Sigma deployment; X_4 = Resource or Resources; X_5 = Datadriv or Data-Driven Decision Making; X_6 = Measure or Measurement and Feedback; X_7 = Suboptim or Sub-optimization and X_8 = Busigoal or Business Goals.

Where the dependent variables used in each hypothesis equation are defined as:

$Y_{Orgimpa}$ = Orgimpa or organizational impact; $Y_{SuccesR}$ = SuccesR or success rates and Y_{Fin_effect} = Fin_effect or financial effectiveness.

Hypothesis 1 measured the interaction between critical factors and organizational impact. Table 7, *Regression Results for Hypothesis 1 on Organizational Impact*, gives the model summary and the ANOVA and coefficient results. The model summary shows that R of .524, thus indicating a low correlation between the predictors or independent variables and the outcome or dependent variables. The R squared value of .275 provides the variance in outcome that the predictors account for or the percent of variation in the dependent variable. So critical factors account for 27.5 % of the variation in organizational impact. This means that for this model, 72.5% of the variation in organizational impact can't be explained by critical factors. The adjusted R squared value of .023 shows the loss of predictive power if the sample was derived from or generalized for the population. These values are not very close to each other, so the do not demonstrate well cross validity. If R squared and adjusted R squared are subtracted from 1 and those values are subtracted from each other, then the result is the percentage of less variance in the predictive power of the model if the outcome was applied to the population. So if 1 – R squared at .275 = .725 and 1- adjusted R squared = .977, then .725 -.977 = -.252, then the model would account for less than 0% variance in the outcome for a population (Field, 2005).

Table 7. *Regression Results for Hypothesis 1 on Organizational Impact. ANOVA and Coefficients.*

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.524[a]	.275	.023	1.286
a. Predictors: (Constant), Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_comm				

ANOVA b					
Model	Sum of Squares	Df	Mean Square	F	Sigma
Regression	14.43	8	1.8	1.09	.405a
Residual	38.04	23	1.65		
Total	52.47	31			
a. Predictors: (Constant), Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_Comm					
b. Dependent Variable: Orgimpa					

Coefficients a							
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sigma	95.00%	Coefficient Interval for B
	B	Std. Error	Beta				Upper Bound
(Constant)	3.34	0.7		4.79	0	1.9	4.78
SDS_Atti	-0.3	0.59	-0.3	-0.52	0.61	-1.52	0.9
SDS_comm	0.23	0.87	0.22	0.26	0.8	-1.58	2.03
SDS_depl	-0.93	0.65	-0.86	-1.43	0.17	-2.27	0.42

Coefficients a							
Resource	0.98	0.6	0.94	1.65	0.11	-0.25	2.22
Datadriv	0.19	0.54	0.17	0.35	0.73	-0.93	1.3
Measure	-0.5	0.53	-0.47	-0.96	0.35	-1.59	0.58
Suboptim	0.35	0.42	0.32	0.83	0.41	-0.52	1.212
Busigoal	0.33	0.41	0.31	0.8	0.43	-0.51	1.17
a. Dependent Variable: Orgimpa							

From the table, the final equation for Organizational Impact was:

$$Y_{Orgimpa} = 3.34 – 0.3X_1 + 0.23 X_2 – 0.93 X_3 + 0.98 X_4 + 0.19 X_5 - 0.5 X_6 + 0.35 X_7 + 0.33 X_8$$

The F-test value from the ANOVA and coefficient portion of Table 7 provided the most important information. The F ratio measures the difference in systematic to unsystematic variation and values greater than 1 mean that the effects of the experiment were above individual differences in variation. The F statistic was 1.09 with alpha at .05%, so it can be concluded that this model was a better predictor of organizational impact than using the mean and mode alone (Field, 2005). With F and sigma values above the .05% alpha value, the null hypothesis should not be rejected. This means for H01, critical factors have no statistically significant influence on organizational impact in Six Sigma initiatives.

Hypothesis 2 measured the interaction between critical factors and success rates. Table 8, *Regression Results for Hypothesis 2 on Success Rates*, gives the model summary and the ANOVA and coefficient results. The model summary shows that R of

.538, thus indicating a low correlation between the predictors or independent variables and the outcome or dependent variables. The R squared value of .29 shows that critical factors account for 29.0 % of the variation in success rates. This means that for this model, 71.0% of the variation in success rates can't be explained by critical factors. The adjusted R squared value is .043 and is not very close to R squared, so again cross validity is not good. If R squared and adjusted R squared are subtracted from 1 and those values are subtracted from each other, then a generalization about the loss in predictive power of the model can be made if the outcome was applied to population. If 1 – R squared at .29 = .71 and 1- adjusted R squared = .957, then .71-.957 = -.247, then the model accounts for less than 0% variance in the outcome for a population (Field, 2005).

Table 8. *Regression Results for Hypothesis 2 on Success Rates. ANOVA and Coefficients*

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.538[a]	.290	.043	1.266
a. Predictors: (Constant), Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_comm				

ANOVA b					
Model	Sum of Squares	Df	Mean Square	F	Sigma
Regression	15.03	8	1.88	1.17	.356a
Residual	36.84	23	1.6		
Total	51.88	31			
a. Predictors: (Constant), Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_Comm					
b. Dependent Variable: SuccesR					

Coefficients a							
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sigma	95.00%	Coefficient Interval for B
	B	Std. Error	Beta				Upper Bound
(Constant)	2.83	0.63		4.22	0	1.47	4.31
SDS_Atti	-0.24	0.57	-0.24	-0.42	0.67	-1.43	0.95
SDS_comm	0.12	0.86	0.12	0.15	0.89	-1.65	1.9
SDS_depl	-0.87	0.64	-0.81	-1.37	0.19	-2.2	0.45

Coefficients a							
Resource	0.9	0.58	0.87	1.55	0.14	-0.31	2.12
Datadriv	0.23	0.53	0.2	0.43	0.67	-0.87	1.32
Measure	-0.2	0.52	-0.19	-0.93	0.7	-1.27	0.87
Suboptim	0.39	0.41	0.36	0.95	0.36	-0.46	1.24
Busigoal	0.09	0.4	0.08	0.22	0.83	-0.74	0.91
a. Dependent Variable: SuccesR							

From the table, the final equation for Success Rates was:

$Y_{SuccessR} = 2.83 – 0.24\ X_1 + .12\ X_2 – 0.87\ X_3 + 0.9\ X_4 + 0.23\ X_5 - 0.2\ X_6 + 0.39\ X_7 + 0.09\ X_8$

The F-test value from the ANOVA and coefficient portion of Table 8 provided the most important information. The F ratio measures the difference in systematic to unsystematic variation and values greater than 1 mean that the effects of the experiment were above individual differences in variation. The F statistic was 1.173 with alpha at .05%, so it can be concluded that this model was a better predictor of organizational impact than using the mean and mode alone. With F and sigma values above the .05% alpha value, the null hypothesis should not be rejected (Field 2005). This means for H02, critical factors have no statistically significant influence on success rates in Six Sigma initiatives.

Hypothesis 3 measured the interaction between critical factors and financial effectiveness. Table 9, *Regression Results for Hypothesis 3 on Financial Effectiveness*, gives the model summary and the ANOVA and coefficient results. The model summary shows that R of .591, thus indicating a low correlation between the predictors or independent variables and the outcome or dependent variables. The R squared value of .349 provides the variance in outcome that the predictors account for or the percent of variation in the dependent variable. So critical factors account for 34.9 % of the variation in success rates. This means that for this model, 65.1% of the variation in financial effectiveness can't be explained by critical factors. The adjusted R squared value of .123 is not very close to R squared, so again cross validity is not good. If R squared and adjusted R squared are subtracted from 1 and those values are subtracted from each other, then a generalization about the loss in predictive power of the model can be made if it was applied to the population. If 1 – R squared at .349 = .651 and 1- adjusted R squared of .123 = ..877, then .651 -.877 = -.226, then the model accounts for less than 0% variance in the outcome for a population (Field, 2005).

Table 9. *Regression Results for Hypothesis 3 on Financial Effectiveness. ANOVA and Coefficients*

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.591[a]	.349	.123	1.134
a. Predictors: (Constant), Busigoal, SDS_depl, Suboptim, SDS_Atti, Measure, Datadriv, Resource, SDS_comm				

ANOVA b					
Model	Sum of Squares	Df	Mean Square	F	Sigma
Regression	15.9	8	1.99	1.54	.197a
Residual	29.6	23	1.29		
Total	45.5	31			
a. Predictors: (Constant), Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_Comm					
b. Dependent Variable: Fineffect					

Coefficients a							
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sigma	95.00 %	Coefficient Interval for B
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	2.83	0.63		4.52	0	1.54	4.13
SDS_Atti	-0.4	0.49	-0.4	-0.82	0.42	-1.4	0.6
SDS_comm	0.45	0.64	0.44	0.69	0.49	-0.87	1.76
SDS_depl	-0.96	0.49	-0.95	-1.94	0.06	-1.97	0.05

Coefficients a							
Resource	1	0.52	0.97	1.91	0.07	-0.08	2.09
Datadriv	0.25	0.43	0.22	0.57	0.57	-0.65	1.13
Measure	-0.45	0.46	-0.42	-0.97	0.34	-1.41	0.51
Suboptim	0.56	0.37	0.51	1.51	0.15	-0.21	1.34
Busigoal	0.09	0.34	0.08	0.25	0.8	-0.63	0.81
a. Dependent Variable: Fineffect							

From the table, the final equation for Financial Effectiveness was:

$Y_{SuccessR} = 2.83 – 0.4 X_1 + .45 X_2 – 0.96 X_3 + 1 X_4 + 0.25 X_5 -.45 X_6 + 0.56 X_7 + .09 X_8$

The F-test value from the ANOVA and coefficient portion of Table 9 provided the most important information. The F ratio measures the difference in systematic to unsystematic variation and values greater than 1 mean that the effects of the experiment are above individual differences in variation. The F statistic was 1.173 with alpha at .05%, it can be concluded that this model is a better predictor of organizational impact than using the mean and mode alone. With F and sigma values above the .05% alpha value, the null hypothesis should not be rejected (Field, 2005). This means for H03, critical factors have no statistically significant influence on financial effectiveness in Six Sigma initiatives.

Summary

The statistical results of the survey were provided using descriptive statistics and multiple regression to test the hypotheses. The demographic information showed even though the sample was small; it represented a good cross section of industry sectors with direct role quality professionals, thus providing validity to the sample. The survey gathered average and frequency data on organizational impact, critical factors, success rates and financial effectiveness. Overall, the data showed a positive inclination toward the soft side (attitudes and beliefs) of these areas while the hard side (execution and the bottom line) was rather negative. A detailed account of the results of multiple regression analysis against the hypotheses showed there was no statistical influence of critical factors on organizational impact, success rates and financial effectiveness.

CHAPTER FIVE
SUMMARY, DISCUSSION AND RECOMMENDATIONS

Summary of the Study and Results

Six Sigma, as a business and quality movement has lasted longer than its predecessors. It has been subject to both criticism and adulation. The purpose of this study was to provide some clarity on the underlying reality of Six Sigma's effectiveness. As Lefcowitz, put it, "Nowhere has any practitioner or institution attempted to statistically survey the universe of 6σ to discover what proportions are successful and what proportions are unsuccessful and for that matter-why or why not (2007, pg. 19)." It is important to understand its value and impact as testament of whether it really is a significant improvement methodology, a management fad or a framework that has its place and limits.

The study reviewed the literature to determine critical factors that contribute to success or failure in Six Sigma initiatives. Factors identified were support and deployment strategy, resource allocation, data-driven decision making, measurement and feedback, organizational impact, sub-optimization and business goals. To narrow the study's scope, three primary components for investigation into the Six Sigma universe were identified. These selected driving forces of initiatives were organizational impact, success rates and financial effectiveness.

Research questions and hypothesis statements were developed to statistically test whether or not the identified critical factors have an influence on the three driving forces of initiatives. These questions and statement are:

Research Questions:

1. What are critical success factors in Six Sigma initiatives?

2. What are critical failure factors or barriers in Six Sigma initiatives?

3. Is the organizational impact of Six Sigma initiatives dependent upon critical factors?

4. Are the financial results of Six Sigma initiatives dependent upon critical factors?

5. Is there a difference between Six Sigma and other similar methodologies such as Total Quality Management (TQM) and Information Technology (IT) projects?

6. Do Six Sigma initiatives share a similar success rate with other similarly structured methodologies such as Total Quality Management (TQM) and Information Technology (IT) projects?

Hypothesis Statements:

H01. Critical factors have no statistically significant influence on organizational impact in Six Sigma initiatives.

HA1. Critical factors have a statistically significant influence on organizational impact in Six Sigma initiatives.

H02. Critical factors have no statistically significant influence on success rates in Six Sigma initiatives.

HA2. Critical factors have a statistically significant influence on success rates in Six Sigma initiatives.

H03. Critical factors have no statistically significant influence on financial effectiveness in Six Sigma initiatives.

HA3. Critical factors have a statistically significant influence on financial effectiveness in Six Sigma initiatives.

The vehicle of measurement was a survey to be administered electronically to ASQ membership. An expert panel of quality experts was recruited to help design the survey. The 43 question survey was built around measuring critical factors, organizational impact, success rates and financial effectiveness. ASQ headquarters and Region 12 section chairpersons disseminated the survey to section membership with a overall population of 8,357 members. The survey was open for three weeks from August 1st to 21st, 2010. Only 36 responses were received. These results were analyzed using descriptive statistics of mean and mode and SPSS was used for inferential analysis by multiple regression.

The statistical results of the survey cast Six Sigma in a negative persuasion. The demographics showed a good cross section of industry sectors with quality professionals, primarily working in small to medium sized companies with rather large sales into the millions and billions in US dollars for 2009. The industry sector breakdown was about 70% in Business or manufacturing and 30% in non-manufacturing areas, and is in line with Six Sigma's historical context. Most respondents worked in direct quality or management roles. Quality Engineer was the highest at 33.3%, followed by Management at 16.6% and Master Black Belts at 13.8%. The most common ASQ certifications held were CQA and CQE both at 17.4% followed with a tie between CQM/OE and CSSBB at 14.5%. Respondents Six Sigma training was either Black Belt trained or have little to no Six Sigma training at 27.8%. A 22.8% tie followed this between Master Black Belt and Green Belt trained individuals. The majority of organizations employed 1-5000 people at 22.2% followed by a three-way tie between organizations of 1-100, 5-10,000 and over 10,000 all at 19.4%. Sales results were very high with over $1 Billion at 30.6%. This was followed by $500 Million to $1Billion and $25 Million to 100 Million both at 19.4 % and $1 to $25 Million at 13.9%. These results show that though the sample was small, it was robust and thus provides credibility to the overall results.

Organizational impact showed generally positive attitudes toward Six Sigma but actual behavior or execution was rather mediocre. Organizational attitude was 41.7%. Organizational aptitude ranged between good at 36.3% to fair at 33.3 %. Organizational behavior toward cultural change was at 47.2%, though actual deployment of Six Sigma was generally fair at 31.4 %. Integration of the Six Sigma program was at highest at a 31.4% maturing state of development followed by 25.7% in a beginning state. What the mean and the mode showed is that in general, organizational impact has a positive inclination toward cultural change with most being in a mature or beginning state, though actual deployment of Six Sigma was fair. Critical Factors showed some interesting results. For support and deployment strategy, 34.3% of management exhibited a good attitude toward Six Sigma with a fair level of commitment at 37.1% and organizations used a generally fair, ad hoc and informal approach of 31.4% for deployment. Resource allocation was poor to fair at 28.6% for both, while data-driven decision-making was fair at 31.4%. Measurement and feedback ranked fairly at 37.1% and business goals rated fairly at 32.4%. Sub-optimization ranged from fair to poor at 39.4% and 24.2% respectively, so it was generally present in organizations practicing Six Sigma. Resource allocation and measurement and feedback were identified as the two most important factors with 22.1% each, while gaining buy-in and trust were the most important factors not listed. The influence of the three hypotheses was positive since organizational impact ranked excellent at 35.3%, success rates was ranked very good at 33.3 % and financial effectiveness was ranked very good at 42.2%. Overall, the data showed critical factors of Six Sigma initiatives rated fairly. As with organizational impact, critical factors showed positive intangible support or attitude and talk, while actual support was of only mediocre action.

Success rate data showed project success was poor. Six Sigma program successes were generally poor at 36.4% and followed by fair at 24.2%. The most important factors ranked in order of importance that constituted project success were meets targets or objectives at 19.8%, while maintaining improvement gains and financial goals met were very close 18.6% and 17.4%. Project completion and success rated either low at 10% or less. Lean rated 32.4% and was the highest as other improvement methodology used. Respondents believed that Six Sigma over the last 20 yrs. has been successful with a very positive 63.6%, while 64.7% believed it exhibits enough sustainability for a long-term future. Six Sigma was not the most important improvement method used at organizations with a 65.7% negative response, though 31.3% of those identified Lean as the most important method.

Financial effectiveness showed savings from Six Sigma projects was rather low and return on investment was most important metric. Hard and soft savings from 2009 Six Sigma projects both rated $0-$25,000 at 33.3%. The most important project metric was none or other with both at 18.8%. The other important identified project metrics were loyalty survey, sales growth/cost savings, dollars saved, financial and do not used Six Sigma. Return on investment was identified as the most important financial metric at

59.4%, while payback period, hard savings and do not use Six Sigma were listed as other financial metrics used. Additionally, no reportable feedback was given in the comments section of the survey.

Regression analysis results showed critical factors have no statistical significant influence on organizational impact, success rates and financial effectiveness. Hypothesis 1 measured the relationship between critical factors and organizational impact with only a 27.5 % influence of critical factors on organizational impact and the F statistic was 1.09. Hypothesis 2 measured the relationship between critical factors and success rates with only a 29.0 % influence of critical factors on success rates and the F statistic was 1.173. Hypothesis 3 measured the relationship between critical factors and financial effectiveness with 34.9 % influence of critical factors on success rates and the F statistic was 1.173. Though the models were a better predictor of organizational impact, success rates and financial effectiveness than using the mean and mode alone, the F statistics above the .05% alpha critical value meant the null hypotheses were not to be rejected. Furthermore, the R and R squared values for each hypothesis indicated model accounted for less than 0% variance if applied to the population.

Discussion

The results of this study do not statistically provide the large-scale rationale about Six Sigma's overall effectiveness and worth, but it did give further insight into the Six Sigma universe. There are valuable lessons and considerations to be learned from the insights of this study. Three points to ponder are expected statistical results, the impact of the literature and considering the survey results as its own microcosm.

Firstly, two decades of Six Sigma have not yielded an expected body of statistical evidence from the literature that either confirms or denies the critics or proponents. The numbers are simply not readily available to make a concrete data based determination about Six Sigma. What's known is that due to the popularity and its practical trappings in society, there is prominent interest in the subject. This interest will continue to yield questions, which lead to further research and sharing of stories on the topic. This means that further documentation will continue to happen. This documentation in the form of continued research efforts and publications by organizations and individuals may over time yield enough substantial data to make an accurate decision.

Secondly, it showed that the literature provided key drivers for further research and investigation. The literature showed distinct factors that authors identified as contributing to success or failure in Six Sigma initiatives. Statistically provable or not, the literature represents and can be considered a mass social consciousness, thus depicting eminent issues. This study streamlined those factors into the most important drivers, as shown in tables 2 and 4. Those streamlined factors provided a simple body of knowledge and operational framework to be utilized, explored, refined and documented in Six Sigma and other related problem-solving project based methodologies.

Research conducted after the literature review for this study has shown statistical evidence to reflect those key drivers of Six Sigma initiatives. Crescenzi identified changing culture as the biggest challenge for Lean Six Sigma deployment leaders (2010). Hanson identified communication as a key driver of deployment and that most organizations use traditional methods of communication (face-to face, meetings, around the water cooler) about Six Sigma projects than technology enhanced ones (2010). Hsu identified cost reduction as the most often used metric to track Six Sigma project benefits (2010). These efforts reinforce the first and second points by depicting an albeit slowly emerging body of data based evidence and demonstrating the power of the literature to highlight key drives of the Six Sigma universe.

A third lesson is to simply consider the survey results as its own microcosm. From this approach, the critics would be correct that Six Sigma is another failed quality movement since its not living up to expectations. Based on the definition of management fad (Stamatis, 2000; Ramis, 2005), Six Sigma would seemingly fit the bill, if one did not consider the statistical results. The survey results show that in general, there was a lot of positive adulation and attitude toward Six Sigma, but when it comes to support, execution and bottom line results, organizations and programs fall short of the lofty and sweeping claims touted by popular literature and apostles of Six Sigma. By all accounts in this microcosm view, Six Sigma would be in line with the critics. Though given proper consideration, the critics have something to think about before so easily chalking Six Sigma up as another fad. They can't dismiss its long-term history and continued prevalent use as a standard business practice and method, even though it is not reaping the touted organizational benefits and lofty financial gains.

Observations

There were several unknown questions and factors about the research and the survey, which may have changed the results. It was unknown how many of the actual ASQ region 12 membership the survey reached. The population was rather large and the overall responses very low. The survey was released when ASQ sections do not meet regularly. The survey was open for three weeks. Though survey dissemination was a well-coordinated effort, there was no system or method built into dissemination to know how many members actually viewed or considered taking the survey but for whatever reasons did not. It's possible that maybe the timing was off, the survey was too long, took too much time to complete or longer availability to take the survey would have increased the quantity of responses. These unknowns provide the basis for better survey design and dissemination efforts should this study be revised, refined and done again.

Another development from the survey results concerns Lean. Respondents cited Lean most often as the method used in conjunction either with or in place of Six Sigma. Lean may be the next management fad or something, which will become part of standard business practices. This is both the story of Six Sigma and other historical quality and management initiatives that made it as an established practice or became an unsustainable fad.

As with Six Sigma, Lean has gained prominence and popularity in the literature. According to Bohan, the Lean idea and message has been sold as a tool set for cost cutting (2010). Cable showed Lean as the continuous improvement method that Detroit automakers, Chrysler, Ford and GM have integrated as a prerequisite for survival and flexibility (2009). Jusko made several points that seem to conjure up memories of Six Sigma in its early years (2010). These points include, “Companies' lean implementations frequently focus on singular aspects of the process rather than the whole...”, “Lean generates a lot of excitement and initial buy-in to the process and solution.” and “It has moved beyond the manufacturing industry as well, most notably into the health care industry (Jusko, 2010, pg. 34).”

These examples demonstrate that Lean has taken a similar path to Six Sigma and other historical quality and management methods. This may simply illustrate a new and evolving paradigm in management fads, one characterized by high popularity, specific usage, moderate sustainability and a deficiency in expectations. This may provoke a new definition of management fads; since these two movements have showed a differentiation in their ability survive by becoming entrenched with the operational framework of organizations. This may be the determining factor that makes Lean and Six Sigma programs or tool sets as opposed to fads. By comparison, the Baldridge Criteria has been evaluated and validated over its lifetime and thus shown to be sustainable. This is the main thing remaining for Lean and Six Sigma, to prove whether their management fads or truly the unique and viable ideologies and frameworks their labeled.

Recommendations for Further Study

In order to gain the deterministic evidence about Six Sigma's significant proportions, several approached can be taken. First recommendation would be to simply repeat the study with or without refinement to the survey to another population that elicits a higher response rate might demonstrate quantifiable evidence of Six Sigma's value. However, survey refinement is rather important due to considerations about length, time and data coding and analysis. The results of the sample in this study weighed in favor of the critics but also dismissed that critical factors in the literature don't contribute to its claimed gains.

The second recommendation is the specification. This includes survey refinement and goes a step further, to focus in on various aspects of identified critical factors and then do an isolated study. The filtering of the literature provided several main topics that could be considered a critical factors body of knowledge to choose areas within the Six Sigma universe to study. Tables 2 and 4 listed these facilitators and barriers, which can serve as a guide for organizations and practitioners use in Six Sigma applications. Specification would entail groups of similar factors like organizational impact or financial effectiveness, or simply target one specific area like success rates. This allows for significant examination of a single area with a microscopic view and highly detailed results as opposed to a general broad view. Over time, these complied results can yield a definitive body of evidence to make determinations about Six Sigma worth's. Time may be another component to allow further studies, broad or narrow to surface and add knowledge and results.

One cautionary concern about both survey replication and specification is multiculturalism. The cultural norms in one country may be different than in another and this of great importance to further Six Sigma studies. Schmidt and Woods examination of cultural differences showed varying degrees of what is important in Lean and Six Sigma application globally (2010). So surveys and studies deployed across multiple countries need to consider the cultural factors of geographic locality, otherwise risk errors in making generalized conclusions. The obvious upshot to these cultural differences is that these differences allow for benchmarking and improvement across countries where a deficiency may exist. For example, people deployment is a key driver in Asia; where as, productivity increases and saving money are more important in Europe and the U.S. (Schmidt, E. and Woods, R., 2010, p. 28). So researchers need to be aware of these cultural considerations, but they can also learn from them to find out what proportions of the Six Sigma universe work in different environments, why and possibly how to apply those successes in other environments where such factors are not successful.

A third recommendation is the holistic view. The research for this study showed Six Sigma programs often deployed in ad hoc, project, departmental or company wide fashion. Six Sigma has shown it's capable of being used in multiple areas on both small and large scales and as part or daily operations. To realize the gains of Six Sigma initiatives, organizations may need to embrace the holistic view of business improvement in their Six Sigma planning and execution (Snee & Hoerl, 2010, p.16). Such an approach is similar to the Baldridge Criteria, which has demonstrated over 20 years of sustainable success, though Lean and Six Sigma have no central agency or organization solely dedicated to administration, control and continuous improvement of their respective frameworks. As Snee and Hoerl point out, this approach reduces sub-optimization, an identified barrier for Six Sigma success (2010, p. 16). This shift in application may be a determinant for Six Sigma and Lean to move into validity.

To further the holistic view, Six Sigma may need to find ways to evolve and remain sustainable and innovative over time. Some of these have happened but Six Sigma must embrace the journey of continuous improvement to survive. Mader traces the first truly evolutionary leap Six Sigma made by integrating Lean (2009). This has shown to be a long-standing and successful merger; where as, off shoots of the main Six Sigma framework such as Design for Six Sigma have not merged either as a significant major tandem practice or into its own distinct framework. This may be in part due to Lean's wider range of application over other methods. Creasy, proposed combining the Theory of Constraints with Lean Six Sigma into 6TOC as another integration (Creasy, 2009). Reinke proposed 'Eco Belts' an innovative adaptation of Lean Six Sigma (2010). These Eco Belts would focus on green projects to discover hidden energy costs and applying Lean Six Sigma on the organizational scale to them.

A final consideration of Six Sigma embracing a holistic view is to be attentive to forces of change over time and become and adaptive framework. The examples and considerations above demonstrate some adaptability in the Six Sigma framework, though in order to transcend being a fad versus being a deeply integrated component of quality and management improvement methods, more is required. Conducted every five years, the ASQ Futures Study may provide the proper insights that Six Sigma needs to use as a springboard for sustainability. The 2008 study identified in order of importance globalization, social responsibility, new dimensions for quality, aging population, healthcare, environmental concerns and 21st century technology as the most salient drives (Sanders, S., 2010, P. 45). If organizations and practitioners embrace such forward thinking considerations within their Six Sigma efforts, the method may in fact achieve become the grand universal enigma it has been made out to be. Lack of adaptation to the framework over time will surely allow its obsolescence.

Though the study provided no statistical determination of critical factors impact on organizational effectiveness, success rates and financial effectiveness, it did however provide further insight into the Six Sigma universe by pointing the way for future studies to focus on critical factors in initiatives. The recommendations of repeated surveys, survey refinement and specification and the holistic view are dimensions that will further the conundrum about Six Sigma's worth encountered during this study. With these kinds of expansions to the Six Sigma methodology, a evidence based body of documentation and results may emerge and ensure its place in history as a bona fide methodology.

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APPENDIX A
SURVEY REQUEST LETTER FOR ASQ SECTION CHAIRPERSONS

The following letter was sent via e-mail to the chairpersons' of Region 12.

Dear ASQ Member,

There is going to be an electronic research survey on Six Sigma available August 1st -21st. The survey is research for a Master's degree thesis entitled *Determining Critical Factors of Six Sigma Initiatives: A Study of the American Society for Quality Region 12* by Rockford section member Shawn W. Flynn. The study measures whether or not critical factors of Six Sigma initiatives have a direct correlation on organizational impact, success rates and financial effectiveness. These criteria help build a foundation for evaluating Six Sigma's overall worth as an improvement methodology. Should you decide to participate, your participation will be anonymous, voluntary and confidential. It should take about 20 minutes to complete.

I will be sending the survey link in a separate email. You should receive this by the end of the month. I thank you in advance for sharing this with your membership.

Regards,

Shawn W. Flynn

Box 46, Compton, IL, 61318

815-497-2132

harlequinman1@aol.com

APPENDIX B
ASQ SIX SIGMA SURVEY

University of Central Missouri

School of Technology, Master of Science in Industrial Management

M.S. Research for Shawn W. Flynn

Determining Critical Factors of Six Sigma Initiatives:

A Study of the American Society for Quality

Region 12

Dear ASQ Member,

You are about to take the ASQ Six Sigma survey. The study measures whether or not critical factors of Six Sigma initiatives have a direct correlation on organizational impact, success rates and financial effectiveness. These criteria help build a foundation for evaluating Six Sigma's overall worth as an improvement methodology. Your participation is anonymous, voluntary and confidential. This survey has been approved by the Human Subject Committee of the University of Central Missouri . It should take about 20 minutes to complete. You may exit at any time until the survey is submitted. Thank you for helping with this research.

Sincerely,

Shawn W. Flynn

Six Sigma Survey
Section I: Demographic Information Section
Please select or write the most appropriate answer.

1. Please indicate your industry type:
____ Business/Industry
(including manufacturing and utility)
____ Education
____ Government
____ Healthcare
____ Service/Transactional
(including financial and consulting)

2. Position: Please mark the one that best describes your role, duties and responsibilities:
____ Accountant
____ Administrator: Coordinator, Director or Dispatcher
____ Analyst
____ Associate
____ Auditor
____ Black Belt
____ Chemist
____ Clinician
____ Consultant
____ Contractor
____ Counselor
____ Educator: Professor, Teacher or Trainer
____ Electrician
____ Engineer: (Computer, Electrical, Mechanical or etc...)
____ Executive: (CEO, CIO, General Manager, President or etc...)
____ Green Belt
____ Inspector
____ Laborer: Machinist, Operator or Worker
____ Management: Foreman, Manager or Supervisor
____ Master Black Belt
____ Mechanic
____ Nurse
____ Office Professional
____ Physician
____ Project Manager
____ Quality Engineer
____ Reliability or Safety Engineer
____ Retired
____ Researcher or Scientist
____ Specialist
____ Statistician
____ Student
____ Technician
____ Technology Professional: IT Analyst, Architect, Programmer or etc...
____ Unemployed
Other, please specify ____________________

3. ASQ certification(s): The word 'Certified' is not included next to the certifications. Please mark all that apply:
____ Biomedical Auditor (CBA)
____ Calibration Technician (CCT)
____ HACCP Auditor (CHA)
____ Manager of Quality/Organizational Excellence (CMQ/OE)
____ Pharmaceutical GMP Professional (CPGP)
____ Quality Auditor (CQA)
____ Quality Engineer (CQE)
____ Quality Improvement Associate (CQIA)
____ Quality Inspector (CQI)
____ Quality Process Analyst (CQPA)
____ Quality Technician (CQT)
____ Reliability Engineer (CRE)
____ Six Sigma Black Belt (CSSBB)
____ Six Sigma Green Belt (CSSGB)
____ Software Quality Engineer (CSQE)
____ I am not certified

4. Other certifications. This includes employer, other professional organizations and societies and college or universities. Please list the certification, such as Master Black Belt, and the granting institution.____.

5. Highest level of Six Sigma training (with or without certification). Please mark all that apply:

____ White Belt
____ Yellow Belt
____ Green Belt
____ Other Belt: Blue, Purple, Brown or Red
____ Black Belt
____ Master Black Belt
____Champion

6. Number of Years of Six Sigma experience:

____ 0 – 4 ____ 5 – 9 ____ 10+

7. Level of college education/ highest degree earned:

____ None
____ Certificate
____ Associate
____ Bachelor
____ Master
____ Doctorate

8. Company/organization’s size (total employees for all locations):

____ 1 – 100
____ 100-500
____ 500-1000
____ 1,000-5,000
____ 500-10,000
____ 10,000 +

9. Company/organization's sales (total for all locations):

____ less than $500, 000
____ $500,000 to $1 million
____ $1 to $25 million
____ $25 to 100 million
____ $100 to 500 million
____ $500 Million to 1 Billion
____ $1 Billion +

SECTION II. Survey Questions.
Please select or write the most appropriate answer.

PART 1. ORGANIZATIONAL IMPACT:

	Poor	Fair	Good	Very Good	Excellent

	Poor	Fair	Good	Very Good	Excellent
10. The general organizational attitude towards Six Sigma.					
11. Your company's overall organizational aptitude or state of readiness (attitude, receptiveness and orientation) toward cultural change.					
12. Your company's overall organizational behavior and actions toward cultural change.					
13. How well does your organization do what it says it is doing related to Six-Sigma?					

Organizational Integration:
14. Please indicate your organization's Six Sigma program is structure and maturity level.
This indicates formal level of development within the organization and how it is applied.
Poor (Dysfunctional, unorganized or not applied.) ____

Fair (Awakening or beginning or informal application.)____

Good (Developing. Formal application but no Six Sigma department.) ____

Very Good (Mature. Formal Six Sigma department.) ____

Excellent (Corporate, enterprise or global integration.) _____

PART 2. CRITICAL FACTORS:

Support and Deployment Strategy
15. Which of the following indicates top management's attitude toward Six Sigma at your company.
Poor _____, Fair _____, Good _____, Very Good _____, Excellent _____.

16. Which of the following indicates top management's level of support or commitment to Six Sigma deployment strategy at your company.
Poor _____, Fair _____, Good _____, Very Good _____, Excellent _____.

17. Please indicate the extent of your organization's Six Sigma deployment. This indicates overall organizational program application and entrenchment.
Poor (Not applied or unknown) ____
Fair (Ad hoc or informal) ____

Good (Departmental) ____
Vary Good (Business or functional unit or division) ____
Excellent (Corporate or enterprise-wide) ____

CRITICAL FACTORS	Poor	Fair	Good	Very Good	Excellent
18. Resources Please indicate the extent of resource allocation in your organization's Six Sigma deployments or projects. Resources include allocation of time, talent, equipment, training, technical support and the right people.					
19. Data-Driven Decision Making Please indicate the extent to which data-driven decision making or statistical thinking is utilized within Six Sigma projects (including project selection) at your organization.					
20. Measurement and Feedback Please indicate the extent of measurement and feedback that is utilized within Six Sigma projects at your organization. Measurement and feedback items include key metrics, lessons learned and effective control plans.					
21. Sub-optimization Please indicate the extent of sub-optimization present within Six Sigma projects at your organization. Sub-optimization means positive gains from actions in one area or subsystem have a negative effect on another area or subsystem.					
22. Business Goals Please indicate how closely Six Sigma deployments or initiatives and projects are tied to or aligned with business goals.					

Critical Factors
23. Please rank according to importance the identified critical factors of Six Sigma. Please rate the most important as 1 and least important as 8. The factors are: support and deployment strategy, resources, data-driven decision making, organizational impact,

measurement and feedback, sub-optimization, business goals or other (please specify in next question).

24. Please specify any other critical factors not listed in the previous question you think are important.____.

	Poor	Fair	Good	Very Go od	Excellent
25. Please rate how much you believe critical factors influence organizational impact in Six Sigma initiatives.					
26. Please rate how much you believe critical factors influence success rates in Six Sigma initiatives.					
27. Please rate how much you believe critical factors influence financial effectiveness in Six Sigma initiatives.					

PART 3. SUCCESS RATES:

28. Rate your organization's overall level of Six Sigma program success. Consider the alignment to business goals, management and workforce commitment, program effectiveness and results and organizational/enterprise integration and maturity.
Poor _____, Fair _____, Good _____, Very Good _____, Excellent _____.

29. What constitutes project success? Please rank from most important to least important. Rate the most important as 1 and least important as 6. Factors include completion, meets targets or objectives, maintains improvement gains, financial goals met, all projects considered successful or other (please specify in next question).

30. Please specify any other factors of project success, not listed in the previous question, you think are important.
____.

31. Estimate your Six Sigma project completion rate (use 0-100%). _____.

32. Estimate your project success rate (use 0-100%). _____.

33. What other additional improvement methodologies are used at your organization?
____.

SUCCESS RATES:	Yes	No
34. Do you believe Six Sigma as a quality and management initiative over the last 20 yrs. has been successful?		
35. Do you believe the Six Sigma methodology has enough sustainability for a long term future?		
36. Do you consider Six Sigma the most important or effective improvement method used at your organization?		

37. If answered no in the previous question, then what do you consider the most important or effective improvement method(s) used?______________________________.

PART 4. EFFECTIVENESS:

38. Estimate in U.S. dollars, hard savings from Six Sigma projects at your organization for 2009. Hard savings means tangible results that are measurable, observable and specific that directly impact an organization's key performance indicators or financial statement. These are value added activities such as cost/defect reduction.
$0-25,000 ____
$25-50,000 ____
$50-100,000 ____
$100,000-500,000 ____
$500,000- 1 Million ____
$1-50 Million ____
$50-100 Million ____
$100-500 Million ____
$500 Million-$1 Billion ____
$1 Billion + ____

39. Estimate in U.S. dollars, soft savings from Six Sigma projects at your organization for 2009. Soft savings are intangible results which may not be specific measures that indirectly impact an organization's key performance indicators or financial statement. These are non value added activities such as customer satisfaction and other intangible factors.
$0-25,000 ____
$25-50,000 ____
$50-100,000 ____
$100,000-500,000 ____

$500,000- 1 Million ____
$1-50 Million ____
$50-100 Million ____
$100-500 Million ____
$500 Million-$1 Billion ____
$1 Billion + ____

40. What is the primary, most important or most effective project metric used at your organization in Six Sigma initiatives or projects?
Critical To Quality (CTQ) _____
Defects Per Million Opportunities (DPMO) _____
Defects Per Unit (DPU)_____
First Pass Yield (FPY)_____
Parts Per Million (PPM) _____
Process Capability (Cpk) _____
Rolled Throughput Yield (RTY) _____
None is most important _____
Other, please specify in next
question____

41. If answered 'other' in the previous question, then please specify any other important project metric used at your organization in Six Sigma initiatives or projects?
____.

42. What is the primary, most important or most effective financial metric your organization uses to quantify the financial benefits from Six Sigma initiatives?
Internal rate of return (IRR) _____
Net Present Value (NPV) _____
Return On Investment (ROI) _____
None is most important _____
Other, please specify
____

43. If answered 'other' in the previous question, then please specify any other important financial metric(s) your organization uses to quantify the financial benefits from Six Sigma initiatives? ____.

PART 5. Please Share Any Additional Comments
The following message appears after survey completion:

Thank you for completing this survey. If you wish to receive an executive summary of the results, then please send and e-mail to me @ flynnsw@aol.com and include ASQ Six Sigma Survey Summary in the subject line.

APPENDIX C
SPSS REGRESSION ANAYLSIS RESULTS

95% level of confidence (alpha = 0.05).

Research hypotheses

Ho1: Critical factors have no statistically significant influence on organizational impact in Six Sigma initiatives.

Ho2: Critical factors have no statistically significant influence on success or failure rates in Six Sigma initiatives.

Ho3: Critical factors have no statistically significant influence on financial effectiveness in Six Sigma initiatives.

The variables are:

SPSS –Name	Question #	Full description
SDS_Atti	15	Support and Deployment Strategy - top management's attitude
SDS_comm	16	Support and Deployment Strategy- top management's level of support or commitment
SDS_depl	17	Support and Deployment Strategy - organization's Six Sigma deployment
Resource	18	Resources
Datadriv	19	Data-Driven Decision Making
Measure	20	Measurement and Feedback
Suboptim	21	Sub-optimization
Busigoal	22	Business Goals
Orgimpa	25	organizational impact

SuccesR	26	success rates
Fin_effect	27	financial effectiveness

Ho1: Critical factors have no statistically significant influence on organizational impact in Six Sigma initiative

Dependent variable: organization impact

Independent variables: critical factors (Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_comm.)

Regression

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_comm[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Orgimpa

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.524[a]	.275	.023	1.286

a. Predictors: (Constant), Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_comm

ANOVA b					
Model	Sum of Squares	Df	Mean Square	F	Sigma
Regression	14.43	8	1.8	1.09	.405a
Residual	38.04	23	1.65		
Total	52.47	31			
a. Predictors: (Constant), Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_Comm					
b. Dependent Variable: Orgimpa					

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	3.339	.697		4.791	.000	1.897	4.780
	SDS_Atti	-.304	.585	-.299	-.519	.609	-1.515	.907
	SDS_comm	.225	.872	.223	.258	.799	-1.578	2.028
	SDS_depl	-.928	.650	-.858	-1.429	.167	-2.272	.416
	Resource	.984	.596	.936	1.649	.113	-.250	2.217
	Datadriv	.186	.538	.166	.346	.732	-.926	1.298
	Measure	-.504	.525	-.469	-.961	.347	-1.590	.581
	Suboptim	.347	.418	.316	.831	.414	-.517	1.212
	Busigoal	.327	.406	.306	.804	.430	-.514	1.167

a. Dependent Variable: Orgimpa

Ho2: Critical factors have no statistically significant influence on success rates in Six Sigma initiative.

Dependent variable: success rates

Independent variables: critical factors (Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_comm.)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method

Variables Entered/Removed[b]			
1	Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_comm[a]	.	Enter

a. All requested variables entered.
b. Dependent Variable: SuccesR

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.538[a]	.290	.043	1.266

a. Predictors: (Constant), Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_comm

ANOVA b

Model	Sum of Squares	Df	Mean Square	F	Sigma
Regression	15.03	8	1.88	1.17	.356a
Residual	36.84	23	1.6		
Total	51.88	31			

a. Predictors: (Constant), Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_Comm

b. Dependent Variable: SuccesR

Coefficients[a]

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)	2.891	.686		4.216	.000	1.472	4.309
	SDS_Atti	-.242	.576	-.239	-.419	.679	-1.433	.950
	SDS_comm	.124	.858	.124	.145	.886	-1.650	1.898
	SDS_depl	-.873	.639	-.812	-1.365	.185	-2.195	.450
	Resource	.909	.587	.870	1.548	.135	-.305	2.123
	Datadriv	.227	.529	.204	.429	.672	-.867	1.321
	Measure	-.202	.516	-.189	-.391	.700	-1.270	.866
	Suboptim	.389	.411	.356	.945	.355	-.462	1.240
	Busigoal	.087	.400	.082	.217	.830	-.740	.914

a. Dependent Variable: SuccesR

Ho3: Critical factors have no statistically significant influence on financial effectiveness in Six Sigma initiative

Dependent variable: financial effectiveness

Independent variables: critical factors (Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_comm.)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Busigoal, SDS_depl, Suboptim, SDS_Atti, Measure, Datadriv, Resource, SDS_comm[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Fineffect

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.591[a]	.349	.123	1.134

Model Summary
a. Predictors: (Constant), Busigoal, SDS_depl, Suboptim, SDS_Atti, Measure, Datadriv, Resource, SDS_comm

ANOVA b					
Model	Sum of Squares	Df	Mean Square	F	Sigma
Regression	15.9	8	1.99	1.54	.197a
Residual	29.6	23	1.29		
Total	45.5	31			
a. Predictors: (Constant), Busigoal, SDS_Atti, Suboptim, SDS_depl, Measure, Datadriv, Resource, SDS_Comm					
b. Dependent Variable: Fineffect					

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.833	.627		4.518	.000	1.535	4.130
	SDS_Atti	-.396	.485	-.402	-.816	.423	-1.400	.608
	SDS_comm	.445	.639	.448	.697	.493	-.876	1.767
	SDS_depl	-.959	.492	-.953	-1.949	.064	-1.977	.059
	Resource	1.002	.526	.977	1.905	.069	-.086	2.091
	Datadriv	.245	.432	.221	.567	.576	-.649	1.138
	Measure	-.451	.464	-.422	-.970	.342	-1.412	.510
	Suboptim	.564	.374	.505	1.508	.145	-.210	1.338
	Busigoal	.088	.349	.082	.252	.803	-.634	.811

a. Dependent Variable: Fineffect