A Taxonomy Of Lean Six Sigma Success Factors For Service Organizations

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A TAXONOMY OF LEAN SIX SIGMA SUCCESS FACTORS

FOR SERVICE ORGANIZATIONS

by

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ABSTRACT

Six Sigma is a business improvement strategy that aims to improve process performance using a structured methodology that identifies and removes the causes of defects in manufacturing and business processes, while implementing the lean concepts attempts to remove wasteful activities from those processes. In practice, the Six Sigma strategy and the Lean philosophy are combined and often viewed as one integrated philosophy, where the philosophy of Lean Six Sigma simultaneously removes wasteful activities from a process and reduces the variability of that process.

This thesis research reviews the concepts and implementation of Lean thinking, Six Sigma strategy, and the integrated concept of Lean Six Sigma, with emphasis in service organizations. Most importantly, this thesis summarizes the critical success factors for implementing Lean Six Sigma within a service business environment and categorizes them within a proposed multi-level taxonomy that can be used by service business units and service providers to improve the .success of Lean Six Sigma implementation.

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CHAPTER 1:
INTRODUCTION

1.1. The Perspectives of Quality

Quality can be defined primarily from two perspectives. The first perspective and, perhaps, the most common perspective is functional (or objective) quality. Functional quality is the ability of the product or service to fulfill its intended purpose and this ability is measurable. This quality perspective is most commonly used in manufacturing settings where a physical product is produced adhering to a set of criteria or specifications and then delivered for customer use or consumption. Functional quality is often measured and verified using a Pass/Fail inspection process based on the set of criteria or specifications with the goal of defect, deficiency and variation reduction. Advancements in information and database technologies over the past three decades have made real-time online inspection data collection, storage, mining, retrieval, analysis and reporting quite efficient in today's manufacturing organizations. Although functional quality is the primary focus in manufacturing settings, it is also considered, monitored and measured in service settings; however, it is difficult to measure due to the nature of performing service activities for customers. Furthermore, technological advancements in functional quality data collection, analysis and reporting within service settings have not kept pace with that of those in manufacturing settings. Therefore, quality performance is not monitored in real-time and is usually tracked by obtaining follow-up feedback from the recipient of the service, usually via a survey instrument or an interview.

The second perspective of quality is perceived (or subjective) quality. Perceived quality is based on a set of attributes or characteristics of a product or service that are observed and interpreted. The level of perceived quality may be approximated; however, it cannot be, or it is difficult, to measure. For instance, the aesthetics, tactility and taste of a product can influence the perceived quality of a product, but the level of quality is relative to the customer and is based on his/her knowledge and past experiences. In addition, the reputation of a particular provider can influence the perceived quality of a product or service. Therefore, perceived quality is usually monitored and measured by obtaining written and/or oral feedback from the recipient and user of the product or service.

1.2. Challenge of Measuring Quality in Service Organizations

Not all service organizations have been successful in establishing formal, successful quality control procedures, as quality measurement in service settings is difficult. High variability inherent in the general demand behavior provides a challenge in service settings. Another concept that increases the difficulty of such measurements is that the primary means of assessing the quality of providing a service is via written and/or oral customer feedback after the completion of that service.

1.3. Lean Six Sigma in Service Organizations

The realization of quality improvement needs started with TQM and defect reduction. The effects of Lean Six Sigma in manufacturing and service have been better than expected. The

following are examples of successful Lean Six Sigma implementations within service organizations.

1) The Mayo Clinic's Rochester, Minnesota Transplant Center reduced the cycle time from when a new patient made initial contact to setting up an appointment from 45 days to 3 days (iSixSigma.com, 2010).
2) Mercy Medical Center reduced in-hospital mortality rates from 6.7% to 3.5%, a 47.8% reduction (Medical News Today, 2010).

As can be seen, the effects of Lean Six Sigma in service organizations range from cycle time reduction and profit enhancement.

The current state provides a guide for the transformation methodology of any organization. However, the current state of the research does not study the attributes or characteristics of successful Lean Six Sigma implementations and transformations. The concept of Lean Six Sigma is traditionally a manufacturing-based concept. However, its implementation in service settings has a significant impact. It is the attempt of this thesis to understand Lean Six Sigma and its success.

1.4. Expected Contributions of This Research Investigation

The expected contributions of this research investigation are the following. The first contribution is a list of the factors that influence Lean Six Sigma implementation success within service organizations. The second contribution of this investigation is a proposed taxonomy of the success factors, which will facilitate the understanding of the contribution of these factors and their relative importance to each other.

1.5. Overview of the Remainder of This Thesis Document

The remainder of this thesis document is as follows. Chapter 2 explains the concepts of the Six Sigma methodology and the Lean philosophy in detail. Chapter 3 briefly reviews the existing research related to Lean Six Sigma. Chapter 4 presents the proposed taxonomy of success factors for Lean Six Sigma implementations within service organizations. Finally, Chapter 5 provides a summary of this research followed by a summary of the directions for future research.

CHAPTER 2: OVERVIEW OF THE SIX SIGMA METHODOLOGY

2.1. Introduction

Six Sigma is a disciplined methodology that uses data and statistical analysis to measure and improve a company's operational performance by identifying and eliminating defects. The methodology is a data-driven quality management strategy for improving manufacturing and service process capabilities and has received considerable attention in research and in industry, in particular. This chapter gives an overview of the Six Sigma methodology and its sub-methodologies. Readers who are familiar with the Six Sigma methodology are advised to proceed directly to Chapter 4, where a set of proposed success factors are presented as well as the proposed list and taxonomy of the success factors.

2.2. The DMAIC Methodology

There are two traditional Six Sigma methodologies based on the needs of the customer – DMADV (Define, Measure, Analyze, Design, and Verify), which has practical use for the design of new systems and processes to meet specific customer needs and DMAIC (Define, Measure, Analyze, Improve, Control), which has practical use for existing systems or processed in need of improvements (Harrison, Voehl, & Gupta, 2009). For a detailed discussion of the DMADV and DMAIC methodologies, the reader is directed to the work of Gross (2001), Snee (2004) and Snee & Hoerl (2005). An overview of the statistical theory that underlie the Six Sigma improvement strategy is now discussed.

2.3. Overview of Statistical Six Sigma

Six Sigma serves as a means to reduce cost while simultaneously providing a systematic method of assessing the performance of the organization in terms of potential unsatisfied customers.

Six Sigma is the lowest defect or erroneous rate in process. Its basis is the calculation method employed in process capability studies, which measure the number of standard deviations between the process mean and the nearest specification limit in sigma units.

The process capability is measured using the statistical measure called the process capability index, which quantifies the ability of a process to produce output within computed specification limits. The two main process capability indices are C_p and C_{pk}. The C_p is estimated as $\hat{C}_p$ and is computed as

$$\hat{C}_p = \frac{USL - LSL}{6\hat{\sigma}}, \tag{2.1}$$

where $\hat{C}_p$ is the estimated process capability, *USL* and *LSL* are the upper and lower specification limits, respectively, and $\hat{\sigma}$ is the estimated variability of the process (expressed as a standard deviation, which is estimated using the sample standard deviation). Eq. 1 means that the measure of process capability is the amount of the observed process variation covered by the process specifications. In this case, the process variation is measured by six standard deviations (6σ), i.e., ± 3σ on each side of the mean. Note that the process capability for specifications that consist of only an upper limit and only a lower limit is computed as

$$\hat{C}_{p,\,\text{Upper}} = \frac{USL - \hat{\mu}}{3\hat{\sigma}}. \tag{2.2}$$

and

$$\hat{C}_{p,\,\text{Lower}} = \frac{\hat{\mu} - LSL}{3\hat{\sigma}}, \text{ respectively.} \tag{2.3}$$

It follows that, if C_p > 1.0, then the process specification covers almost all of the process observations. It is important to note here that Eqs. 1-3 assume that the output from the observed process is approximately normally distributed. The implication is that $\hat{C}_p$ corresponds to sigma level, which that corresponds into the defect or error rate.

For a non mean-centered process, the process capability index is

$$\hat{C}_{pk} = \min\left[\frac{USL - \hat{\mu}}{3\hat{\sigma}}, \frac{\hat{\mu} - LSL}{3\hat{\sigma}}\right]. \tag{2.4}$$

$\hat{C}_{pk}$ estimates what the process is capable of producing if the process target is centered between the specification limits. If process mean is none-centered, $\hat{C}_{pk}$ overestimates process capability. If $\hat{C}_{pk}$ < 0, the process mean falls outside of the specification limits. One important note is that the process capability index assumes that the process output is approximately normally-distributed. The calculated values from the C_p and C_{pk} calculation correspond to Table 2.1.

Table 2.1. Sigma levels and defect rates

Defect Per Million Opportunities (DPMO)	Sigma Level	C_{pk}
933200	0.000	0.000
691500	1.000	0.333
308500	2.000	0.667
66800	3.000	1.000
6200	4.000	1.333
230	5.000	1.667
3.4	6.000	2.000

2.4. Traditional Lean Manufacturing

Lean Manufacturing as defined by The National Institute of Standards and Technology (NIST) is a systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection. There are eight categories of waste in manufacturing, which are the following:

1) Overproduction
2) Waiting For Logistical Supplies
3) Transportation
4) Non-Value Added Processing
5) Excess Inventory
6) Excess Motion
7) Under Utilization of Skills
8) Defects

According to Lisa Norcross, there are two aspects of managing a change organization. The first is the acquisition and development of the skills of the front-line people, the shop floor staff, and their team leaders and managers. The other aspect is the capability to accomplish mini Lean projects (Pullin, 2005). Pullin (2005) suggests that leadership, experience, and training are most important in Lean transformation. The main requirement for Lean transformation is for key

people to acquire people skills in the industry (Pullin, 2005). Lean Manufacturing has five basic principles. It starts with customer's definition of value. Defining values to the customer can be as simple as asking what is the need and when is the need (Allen, 2000). The next step is the elimination of waste from the system, where waste is anything that is non-value based on customer definition.

Six Sigma is a mechanism focused on a part of the value stream. In contrast, Lean focuses on improving the entire value stream (Ferguson, 2006). In most cases, the Lean concepts, and Six Sigma concepts work concurrently. In Six Sigma manufacturing, the manufacturer tries to minimize the effects of process variation. High process variation can lead to compensation for the poor quality in terms overproduction leading to waste. In service settings, the excess processing and transfer of information leads to non-value added processes, hence another form of waste. While the concepts and techniques of Lean and Six Sigma may differ in what they accomplish, the overall goal for both concepts is the same, waste reduction. Therefore, from this point, Lean Six Sigma is the focus of this research.

CHAPTER 3: REVIEW OF LEAN SIX SIGMA LITERATURE

3.1. Traditional Lean Six Sigma Definition and Implementation

Lean Six Sigma can be defined as the reduction of waste in a system that is producing three or four errors per million opportunities. The traditional methodology of using Lean Six Sigma has been one of two methods. The DMADV methodology is used for systems that are not capable of delivering the results needed. The DMADV process redesigns the system to a higher quality and efficiency rating. The DMAIC process finds means of improving the existing system through statistical and quality improvement tools.

3.2. Review of Lean Six Sigma in Manufacturing

The concept of Six Sigma benefits the implementer in multiple ways. The benefits vary from profit enhancement, increased customer satisfaction, and cost reduction. There are case studies within multiple manufacturing industries that will serve as a model for the basis of this study. Table 3.1 is a summary of cases in the manufacturing sector, where Lean Six Sigma has been implemented.

Table 3.1. Summary of the Lean Six Sigma results.

Researcher(s)	Case Study Company	Case Study Results
Smith (2003)	Landscape Structures Inc	92% lead time reduction 0.6% scrap rate reduction
Smith (2003)	Heatcraft	75% reduction in defects 40% reduction in total defects
Hill & Kearney (2003)	Honeywell	$1.2 Billion gain in Improvement
Marselli (2004)	Algonquin	50% reduction in setup time (due to new process) 33% reduction in total setup time
Lee-Mortimer (2006)	Dairy Crest	£85,000 in cost savings
Lee-Mortimer (2006)	Kohler	£250,000 in cost savings

Playground manufacturer, Landscape Structures, Inc. is another example of the success of Lean Six Sigma in the manufacturing setting (Smith, 2003). Landscape Structures manufactures playground equipment and components. The product range of the company is from fitness equipments to skate park equipment. The company was founded in 1971 and has expanded to 300 staff members. The company started using the concepts and philosophy of Lean Six Sigma to enhance quality ratings and profits (Smith, 2003).

In the second case study, related to Heatcraft, the refrigerator part manufacturer used Lean engineering to assess the product quality (Smith, 2003). They find that many products were problematic due to quality issues, leading to rework, customer complaints, and warranty claims. In 2002, Honeywell International, Inc. gained $1.2 billion from productivity improvements, from which a significant portion is from waste reduction, through their Six Sigma plus program. The Six Sigma plus program is the combination of the Lean concepts in waste reduction and variation

reduction in Six Sigma. Honeywell saves over $3.5 billion since 1995 using Six Sigma (Hill & Kearney, 2003). Another case company is the Algonquin Industries at which the concept of Six Sigma is responsible for the 33% reduction in setup time in the plant (Marselli, 2004).

The company under study had $17.2 billion in sales, making it one of the frontrunners in the defense, government and commercial electronics, and business and special mission aircrafts. After the merger with another unnamed company in 1997, this company faced the critical task of sharing information across the company structure and cultures. The commitment to Lean Six Sigma allowed the company to accomplish all of its goals and tasks, while saving $50 million in the first year and $2 billion in total. The company has delivered over $2 billion in savings through 14,000 completed Six Sigma projects (Greene, Ellis, Waller, & Osborne, 2008).

Dairy Crest is one of the most important contributors to the frozen dairy products (Lee-Mortimer, 2006). Once the company realized that poor quality were the sole cause of low profits, the company uses the concept of Six Sigma to assess the cause of the quality problems. In another case study, the Kohler Mira Company, known for water management products, realizes a high level of variation in its process. As result of using Lean Six Sigma, Kohler reduces failures by 70%, reducing wait times, and has an estimated impact of £250,000.

A company, who is a leader in research of manufacturing and marketing leader within the automotive and aerospace industries, focuses on achieving its target in two tasks -- one being a Six Sigma project to reduce variation and defects and the other being a Lean project to reduce cost and waste. At the end of both projects, the company realizes the following gains (Thomas, Barton, & Okafor, 2009):

1) Reject rate reduction on the pilot line of 55% indicating a potential saving over the year of £29,000. Cost of rejects before LSS = £69,000, cost of rejects after LSS = £36,000.
2) Cell OEE increased from 34 to 55%.
3) A 31% increase in parts per hour from the production system. Throughput before LSS = 15 pph, throughput after LSS = 22 pph. Equating to 2,800 additional parts per annum.
4) Energy usage reduction of 12% per annum from 23,000 to 21,500 KWh.
5) In conjunction with the OEE performance increase, the TPM program reduced equipment downtime to 2% from 5%. Based upon nominal operating hours of 2,000 per annum. Hours downtime before LSS = 100 hours = 5%. Hours downtime after LSS = 40 hours = 2%.

This next section reviews the application of Lean Six Sigma project implementation within the service settings.

3.3. Review of Lean Six Sigma in Service

The service industry provides the most challenge in the application of Lean Six Sigma concepts. It is the application of manufacturing concepts to a non-manufacturing setting. Service is performing a set of tasks that are requested by a customer. Quality of the service provided is not only hard to assess for the provider of the service, it is difficult for the customer. The most consistent findings suggest three key behaviors are central when assessing quality of a service (Nakhai & Neves, 2009):

1) Service quality is far more difficult for the consumer to evaluate than product quality;
2) It is a comparison of the consumer expectations with the actual performance; and

3) Service quality evaluations are not solely based the outcome of the service, but also from the delivery method.

Services have several characteristics that does not lend well to the traditional view of quality. These characteristics are (Jiang, Shiu, & Cheng, 2004):

1) Intangibility;
2) Variability;
3) Perishable; and
4) Inseparable.

Intangibility relates to the perceived quality and actual quality of a service would match under ideal conditions. However, there is a gap between the actual and perceived quality of a service provided. Variability introduced into the quality of services provided comes from time of delivery, method of delivery, the delivery personnel, and the consumer. Services are perishable. This means that, once the demand is established and satisfied, the demand terminates. The inseparability is what makes services unique and challenging in terms of quality. Service is perishable in the sense that it must be consumed immediately. Most services are provided and consumed instantly, making the quality judgment far more difficult (Jiang, Shiu, & Cheng, 2004).

The notion that quality improvement with Lean Six Sigma is manufacturing-based is a misrepresentation of the facts. The financial, healthcare, public sector, education and construction industries, and many other non-manufacturing settings utilize Lean Six Sigma to reap benefits. However, there are difficulties with applying Six Sigma in a service setting (Hensley & Dobie, 2005):

1) It is difficult to collect data on service processes;
2) It is hard to measure due to interactions between customers and service providers;
3) Sub-processes create difficulty in terms of evaluating and controlling the impact of Six Sigma; and
4) The data may not be as reliable due to the collection nature (face to face).

3.3.1. Review of Lean Six Sigma Project Implementations within the Healthcare Industry

The previous methods of improvement in the healthcare industry centered on the concept of cost saving, (Caldwell, 2005). Cost saving can occur in one three categories:

1) Throughput Improvement with Direct Cost Recovery;
2) Throughput Improvement with Non-Direct Cost Recovery (i.e., time); and
3) Throughput Improvement resulting in optimized capacity.

These cost recovery methods by enhancing throughput also exist within Lean Six Sigma. As Lean Six Sigma, decreases process variation, thereby, increasing time through, saving time, and optimizing capacity. Knowledge management is also a concept that has showed some effect on quality improvement efforts in healthcare (Gowen, Stock, & McFadden, Dec 2008). The case studies that follow will provide a more accurate view of these concepts.

The medical field is one of the fields that Lean Six Sigma has showed steady promise in terms of results. The DMAIC process can reduce medical errors in prescription medications, mistakes in the operating room, and wait times before and after operation(s). The concept of Six Sigma applied to a healthcare setting reduces medication errors (Esimai, 2005). After understanding the process, the team began defining the objective that would be the target of the

project. After the implementation of the solutions, they measured the performance to assess the difference. The medication errors decrease from 213 to 96, a decrease of 55%. The total error rate reduces from 0.33% to 0.14% that summed to $1.32 million when annualized. It also improves patient satisfaction and morale as well as the staff's morale.

In another case in the medical field, a Red Cross Hospital in Netherland with 930 staff members and budget of $7 million. In 2002, the hospital admits over 11,000 patients, performs over 8,000 treatments, and has over 190,000 visits to its outpatient units. The hospital obtained the ISO9002 certification in 2002 after significant work in the quality improvement/management concepts. Through their use of total quality management techniques, the hospital realizes that there are shortcomings in terms of controlling the projects and their outcomes. The shortcomings are the following (Huevel, Does, & Bisgaard, 2005):

1) Projects are often poorly aligned with company vision and goals;
2) No systematic way of assessing the projects' value to the overall company vision;
3) No procedure to assess effectiveness of the projects; and
4) Management had difficulty deciding on project ideas.

After the realization of the shortcomings, the management decides on a group of 16 Green Belts with authority over seven projects. The six projects resulted in shorter length of stay for the COPD patients, reduced errors in invoices from temporary agencies, revision of the terms of payment, reducing the number of mistakes in invoices, and rooming in the children's department. The estimated cost savings from these projects was approximately $210,000 on an annual basis with the use Six Sigma and Lean concepts. A popular understanding of Lean Six Sigma within the healthcare industry is savings in operating costs.

Any service performed in the healthcare setting has to maintain three characteristics, excellence in clinical outcomes, high customer satisfaction, and high efficiency. Thus, improvement in each of these categories translates to six attributes that are examined closely. Any service provided must be safe, effective, patient-oriented, timely, efficient, and equitable. Lean Six Sigma uses the Lean and Statistical Process Control concepts to achieve a high level in each of the categories to ensure the viability of the organization. However, progress has been slow over the years by a number of impeding factors such lack of financial commitment, poor training process, and lack of leadership among others (Taner, Sezen, & Antony, 2007).

Knowledge management is an important concept in the healthcare industry. Any Six Sigma projects to improve operating conditions can be more effective with an efficient knowledge management system. It is worth noting that knowledge management along with Lean Six Sigma will provide a pathway to gaining the competitive advantage desired (Gowen, Stock, & McFadden, Dec 2008).

Continuous Quality Improvement (CQI) and Six Sigma can prove as a powerful tool for process improvement (Revere, Black, & Huq, 2004). The Donabedian model has been a consistent model for CQI (Donabedian, 1980). It has three domains; structure, process, and outcome, which correspond to the main four phases of Lean Six Sigma, identify, characterize, optimize, and institutionalize. Another approach of Six Sigma in healthcare has been three-step approach to improve the operating conditions. The three steps are: (1) identify the improvement areas, (2) generate solutions, and (3) evaluate solutions (Nakajo, McLean, Weinstein, & Sears, 2006). There are similarities between this approach and the traditional DMAIC. In the DMAIC process, the first three phases are synonymous with the first stage of this approach. The Improve

phase is identical with the second phase in which solution generation takes place to solve the defined problem. The Control phase is similar to the last phase in that the solution proposed in this phase is under evaluation through a short implementation of it, which is the evaluation process under this model.

In an application of Six Sigma, the Dutch Red Cross Hospital uses the Lean Six Sigma concepts to introduce improvements in multiple areas of operation (Farrell & Simas, 2005) (Koning, Verver, Heuvel, Bisgaard, & Does, 2006). After a baseline study, they find that only 15% of the generated invoices were correct. The estimated impact through process improvement and setting the target at 100% would be gain of £36,000 annually.. In 2001, Heritage Valley Health System recognize the importance and the need for change in the wake of financial hardship (Beaver, 2004). The staff studies the Toyota Production System and Lean Six Sigma as improvement mechanisms. The organization looked at the admissions process of the facility and the operating room. At the end of the first year, due to surprising results of the process, the facility started expanding its operation with other facilities as industry wide effort to improve quality of care.

The Sutter Health Center is a non-profit organization dedicated to providing the best quality healthcare to its customers (Farrell & Simas, 2005) (Georgia Institute of Technology, 2010). Sutter Health realizes that Lean Six Sigma is a way to sustain the business the way they had been operating. This case study looks at this facility's journey from average quality to outstanding quality. Through the Measure phase of DMAIC, they establish a performance baseline on the proposed medication versus the current. In summary, Lean Six Sigma not only improved the overall quality of care; it also improved the medication that patients used.

Another case of the Lean Six Sigma implementation in healthcare at the Piedmont Newnan Hospital (Georgia Institute of Technology, 2010). One problem area was the case cart requests that on average took 20 minutes. After the transformation, the frequency had increased and the same process now would take five minutes. The overall accuracy of case cart placement increased from 50% to 98%. This process change lead to $118,000 savings annually. In another project, the turnaround time for patient in and patient out reduced from 19 minutes to 14 minutes. Physician turnaround time reduced from 51 minutes to 40 minutes.

Exempla Lutheran Medical Center located in Wheat Ridge, CO is one of the leaders of Six Sigma implementation (Buell, 2010). Hand sanitation issues were at the forefront of the problems in the facility. The sanitation compliance was 80%, needing to be in the 90% range. As result of the Lean Six Sigma project implementation, the rate of acceptance is consistently at 92%, and infections related to such sanitation problem reduced by 50%.

Ashe Memorial Hospital, located in Jefferson, NC, has capacity to treat 25 acute care cases along with 60 other patients (Buell, 2010). With state financial aid and technological aid from a consulting firm, the Lean Six Sigma transformation at Ashe Memorial started in five key areas:

1) Human Development;
2) Delivery of Care;
3) Cost and Productivity;
4) Growth; and
5) Patient Safety and Quality.

Patient handoffs in the Imaging Department were the central focus of the project. After implementation of the improvement for one week, there was 100% improvement in information transfer between departments in terms of accuracy and utility of the information.

3.3.2. Review of Lean Six Sigma Project Implementations within Financial Institutions

The recent surge of Lean Six Sigma has spread to the financial world. The financial institutions with the economic downtime need a mechanism to lower their operating cost in order to ensure available credit. For example, in 2001, Bank of America started a Lean Six Sigma improvement program. Now three years later, it has become an integral part of the organization (Jones.Jr, 2004). Management realizes that Lean Six Sigma offers the best set of performance metrics available to assess the performance of their operation. Customer responses at Bank of America in the area of process quality was low, with 40% recognizing their experience as 9 out of 10, on a 10-point scale. Through 2001-2002, the Lean Six Sigma alleviated traditional problems such as late posting of transactions, encoding errors, and omissions from customer statements. Online customers saw error reductions in online banking by 88%. Today, same day payments improved by 36% and deposit processing improved by 47%.

GE Money in Portugal is another example of how Lean Six Sigma is relevant to the financial applications. GE Money is an organization within the General Electric that operates in the financial realm in the credit services with $163 billion in assets. Application of Six Sigma has helped the organization reduce its lead-time to $1/10^{th}$ of the original, while improving customer satisfaction.

Citibank took the Lean Six Sigma initiative and made it a company-wide standard. Citibank wanted to reduce the cycle time or service time its staff spent on a customer. By definition, they define any process that does not contribute to the goal of meeting the customers' demands. After relocation of staff member, the company started using Lean Six Sigma as a measure to detect defects and eliminate them. The original goal was to reduce the cycle time and defects by 10 times the original amount from the start time to December 2000. A reduction of 1,000% was the goal on a two-year frequency. After initial analysis of the data, the team of operators and bankers found that the main problem was the callback feature that allowed the reaffirming of a ready for process request. The improvements made reduced the number of callbacks from 8,000 to 1,000.

3.3.3. Review of Lean Six Sigma Project Implementation within Educational Settings

Education is an important service sector of the economy. The challenges facing any improvement concept in service organizations such as educational institutions is the lack of an operational definition for customer and process. The end customer is the student and the process is the actual transfer of knowledge. The difficulty arises from the fact that any one of educational settings could have their own definition and goals in terms of the needs of the customers. Any improvement in the educational setting should realize that infrastructure; faculty, learning community, research, data management, project and activities, training and industry interactions, and technology curriculum play important roles in the educational outcomes and their improvement.

An application of the Lean Six Sigma in the education institution is the University of Central Florida and its effort to expedite the admission process of qualified students (Coowar, Furterer, Akinrefon, Battikhi, Ferreras, & Gibson, 2006). The focus is on process improvement in two areas:

1) The distinction between qualified and unqualified student; and
2) Recruiting from selected institutions could be expedited by flagging the student and contacting them in a more timely fashion.

After using the DMAIC method to improve the process, the short-term plan to improve the conditions is set. At the end of the project, the main points of further discussion are the following:

1) Implement the recommended changes to the process;
2) Train staff members and faculty in accordance to the new changes;
3) Continually monitor the process for alarming behavior; and
4) Seek perfection from the process, knowing that it is a continuous process.

With all the successful implementations of Lean Six Sigma in the education setting, there is further possibility of research and development. The definition of a product and customer are variants (Jenicke, Kumar, & Holmes, 2008). For instance, the students are considered as products and customers. Another major shortcoming is that the measurement of quality is difficult. However, within the educational system, it is a difficult task. Students often add to their learning by interacting with the institution and education process to become co-producers of their learning, which adds more uniqueness to what is taught (Chambers & Fernandez, 2004).

Institutions, based on the goals and values have different reward systems, making the task of changing for the better almost impossible. The focus of every institution at the departmental level is to improve teaching, research, and publishing (Jenicke, Kumar, & Holmes, 2008). This type of quota-oriented approach impedes any major process changes for improving the quality of the outcomes. Instead, an institution wide focus should be on improving the overall quality of education.

3.3.4. Review of Lean Six Sigma Project Implementations within Other Service Settings

Call centers have become an integral part of any service organization. The case study here is a call center within an educational environment. The existence of an established process lends to using the DMAIC process to improve the operating conditions in the following areas (Chakrabarty & Tan, 2006):

1) User-Friendliness of the Telephone System;
2) Responsiveness in directing customers to the right directions;
3) Responsiveness of the departments in answering queries; and
4) Customer Service of the Call Center Staff.

After careful consideration of the Critical to Quality characteristics (CTQs), several Key Performance Indicators (KPIs) have been developed and compared as a benchmark to other service. It is important to note that the close relationship of the KPIs to the CTQ's. There are no established results in terms as evidence of the success or failure of Lean Six Sigma, since this was an ongoing transformation.

Xerox is another important case in Lean Six Sigma success. Xerox, today, is $17.6 billion Company that is located in Norwalk,CT ranging in service from document management to solving problems in online document archiving (Godfrey, 2004). Xerox reveals that during the two-day training session, senior managers gain an understanding of Six Sigma through activities. The activities emphasize that success will come to any Six Sigma project if management has a direct involvement in the project itself.

There are over 3,300 housing authorities in the United States providing affordable housing to elderly, people with disabilities, and low-income families (Kumar & Bauer, 2010). The public service sector is a difficult area to implement any improvement ideas due to there being no major financial motivations. While private sector service providers often use improvement concepts to improve the financial well-being of their organizations, the public sectors notes improvement projects only if it improves efficiency of the process. The public sector usually engages in some business type activities such as public utilities for water, sewer, and electric services, which the entity finances either as a whole or through an external payment concept (Gauthier, 2005). Political factors play another important role in the lack of interest of the public sector in improvement projects. The nature of the politics encourages government to focus on short-term rather long-term performance (Deming, 1986).

Resource constraints are also a major issue when implementing Lean Six Sigma projects in the public sector. The funding for any project or task is based on the taxes paid by the citizens of the district. Often public sector interacts with the private sector for funding of such projects. Workplace culture is a factor often impeding the success of any quality improvement projects. Unlike the private sector, the public sector is non-willing to be active in the non-transactional

activities (Kumar & Bauer, 2010). There are a few examples in the public sector of quality improvement initiatives that have been successful. The Scottish public sector, the social housing in the UK, and city of Fort Wayne, IN are examples of success stories. The Scottish public sector case centered on the evaluation lean approaches in public businesses. One pilot project in the case involves the repair of public housing projects that started in 2005, and continued in 2006. At the end of the study, the members realize that Lean concepts are transferrable to public sector projects with the understanding that there had to be different approach to investigate possible improvements. There is also the need for commitment on the part of all stakeholders to ensure the desired results.

In 2005, following a study of the public housing in the UK, it is realized that the quality improvements were not so successful. The officials handling the housing sector had a pilot project for three settings to ensure the proper use of the quality improvement techniques. After completion of the projects, the findings lead to believe that not only the process had streamlined, it also improves customer perception of the organization (Kumar & Bauer, 2010). The findings lead to a broader use of the concepts across the social public housing sector, and that generated a report in 2006 portraying success in the implementations. In the case Fort Wayne's efforts in quality improvement, the city website reports that Lean Six Sigma saved the city $10 million since 2000 (Kumar & Bauer, 2010).

Lean Six Sigma has had an impact on every manufacturing and service organization that has used the concepts. In managing supply chains, lead time is the important factor, when considering the efficiency of such systems. Lean Six Sigma concepts have been implemented in a food distribution company. The food distributor in Northeastern England received numerous

customer complaints from customers, which accounted for £100,000 on an annual basis (Nabhani & Shokri, 2009). The scope of the project reduced to delivery methods, since a majority of the problem occurred in that process. After gaining an understanding of that process with the SIPOC concept and enumeration of the problem areas from the database, they realized that 50 percent of the problems were in late delivery of the goods. After establishing a baseline for the performance, the team analyzed the causes of the problem and started investigating solutions to alleviate it. After implementation of the solutions, the number of defects reduced from 34 to 20 and the sigma of the process increased from 1.44 to 2.09. The L_i index, which indicates the time, spent loading also reduced from 1.97 to 1.13, which is an improvement in the waiting times. The organization implemented the changes and reduced customer complaints by 60% and nearly saving £30,000 annually.

United States Postal Service is a service provider with transportation expense of approximately $6 billion. Approximately 45.8% is dedicated to air transportation. The study done is at the APC in Columbus, OH, which employs 72 staff member for daily operations. The Lean Six Sigma team find that using a baseline of 50 million pieces of mail delivered, the defective rate was 187,000 per million for a sigma level of 2.4 (Franchetti, 2008). They find that the impact of the airline ground handler delays and SAMS data system errors are major contributors to the problem at 26 % and 23%, respectively. The goal of the process is to have the mail delivered 30 minutes prior to the arrival of the plane in the staging area. The airlines that supported the Port Columbus International Airport achieved the 30 minutes mark on a 69% frequency. SAMS errors were created because packages were assigned to flights that were not even viable for the 12-hour window. The majority of the problem according to the analysis is the

delayed flights. On a three-day survey of the process, the team find that 11% of the flights had incorrect information based on capacity, availability, and time of departure. After standardization of the process took place, the team found 1% inaccuracies in the SAMS mechanism. As result of the improvement, the delivery failure rate dropped by 14.3%, which translated into a decrease from 187,000 to 44,000 defects per time million opportunities, and lead to a saving of $15,000 on an annual basis.

3.4. Summary of Existing Research of Lean Six Sigma Project Implementations within Service Settings

The concept of Lean Six Sigma and its wide study has been the focus of service industries recently. While the Lean engineering and statistical process control (i.e. Six Sigma) are manufacturing concepts that used to assess performance of those settings, with some adaptations, they are applicable to service. As it is visible from the survey of Lean Six Sigma success application, the benefits are numerous and impactful enough to justify using the concepts. From healthcare to financial settings, the impact of Lean Six Sigma is visible.

The taxonomy proposed in this document relates the performance of the service organization in each of the categories to its readiness to implement Lean Six Sigma. The research shows that the taxonomy is a unique mechanism to address the preconditions that must exist before a successful Lean Six Sigma implementation. The central gap in the available research is the lack of proven research in finding the causes of failure of Lean Six Sigma projects and their success. It will be shown that there are causes that will directly influence the outcome of any Lean Six Sigma project. This taxonomy provides a macro level visual aid of the categories of pre-conditions for success. It will also provide an accurate visual of the individual success

factors in their respective categories. Furthermore, this taxonomy will guide the user to understand what drives Lean Six Sigma to success, and provide a static mean of assessing the company's readiness in implementing Lean Six Sigma.

CHAPTER 4:A PROPOSED TAXONOMY OF LEAN SIX SIGMA SUCCESS FACTORS FOR SERVICE SETTINGS

4.1. Introduction

Success has many definitions. A general definition of success is the favorable result of any attempt in any endeavor. Failure can be defined as the condition or fact of not realizing the desired end or ends. The concept of Lean Six Sigma maybe a managerial and statistical implementation to assess and improve the process; however, the success or failure of such mechanism depends on the availability and presence of several factors.

This chapter presents a proposed taxonomy of the key factors attributed to the successful implementation of Lean Six Sigma projects and project findings within service organizations. This taxonomy is based upon a critical survey of the open literature with particular focus on Lean Six Sigma implementations in service settings. In addition to presenting the proposed taxonomy, this chapter also presents a summary of what each success factor contributes to the success or failure of quality improvement projects within service settings.

4.2. Similarities Between Manufacturing and Service Environments

Manufacturing and service industries have several points of similarity. In manufacturing, the quantity of demand and he success of meeting that demand are crucial to the overall success

of the organization. Quality of the demand can mean the accuracy of the demand points and meeting that demand, whereas the quantity of demand is the magnitude of the demand point itself. In service industries, the same holds. The following attributes are common across other manufacturing and service industries:

1) Demand Quantity;
2) Quality Supplied;
3) Cycle Time;
4) Perceived Quality; and
5) Functional Quality.

The point of difference is in the quality of products and service provided. Product quality takes into consideration the conformance to a set standard and the consistency of hitting the target values. Service quality takes into consideration the start of the service incident to the end of the delivery of the requested service. Functional quality and perceived quality are a close in meaning in the context of manufacturing, whereas, in service, the gap between functional quality and perceived quality could be large. The functional quality depends on several factors:

1) The Quality of the Delivery of Service;
2) The Quality of the Service itself; and
3) The Interaction of the customer and the personnel of the service provider.

Service providers have a difficult task of quantifying the quality of their business operations. Measuring the performance in terms of quality is equally as difficult for the customer as is for the provider. The next few sections discuss the contribution of the traditional Lean Six Sigma success factors in service industries.

4.3. Cultural Change

Six Sigma sees a defect or error as improvement opportunity (Coronado & Antony, 2002). Radical changes normally conflict with what an organization believes and holds as strategy for viability. Some successful organizations contend the only way to change the perception of change is through increased communication, education, and motivation. The culture of stagnant daily operations must change for a new look at the process to improve the quality. The company must accept that Six Sigma is an agent of change. The company culture and values must adjust accordingly. People facing this cultural change and challenges must understand this requirement (Chakarbarty & Tan, 2007). In service, clear communication plan, channels to motivate individuals to overcome resistance, and educating senior managers, employees, and customers of the benefits of Six Sigma is critical. (Antony & Bhaiji). In service organizations, high-level managers must realize that Lean Six Sigma must be built into the system at the design phase (McClusky, 2000). Without this fundamental understanding, any efforts to alleviate any problem(s) with Lean Six Sigma will undoubtedly result in failure. The successful introduction of Six Sigma requires adjustment of the organization's culture and a change in the mindset of its employees. Employees have to be motivated towards the introduction and development of Six Sigma program through various reward and recognition schemes.

Culture change is a pre-requisite for Lean Six Sigma implementation. The company culture must be receptive to change and accept change as a positive. The key concepts below are

worthy of consideration when assessing the need for a comprehensive cultural change program within service industries.

1) How positive is the attitude towards change?
2) How resistive is the organization to change?
3) How resistive is the organization to Lean Six Sigma?

When considering rating the service organization's willingness to change, several factors become extremely vital. One of the input factors is the level of skepticism. Another factor is the familiarity level with the potential change. If the perception of change is negative, then the members of the organization will reject the notion of change. The management of the establishment is responsible for changing the perception. Through clear and effective communication of aspirations and expectations, the management can reduce the resistance to changing the operating conditions. Once the results of the change are known, the concept will market itself through increased revenue and gain sharing. In summary, the culture of the organization and its attitude towards change and Lean Six Sigma is an important factor when assessing the readiness of any service organization to undertake the task of implementing Lean Six Sigma concepts. Therefore, having the right culture and attitude towards change will expedite the transformation.

4.4. Organizational Infrastructure

The infrastructure needed for a Lean Six Sigma project normally consists of a team, a project champion, and a process owner. The champion of the project initiates the project, supports, and guides the team. The champion also negotiates resources on behalf of the team. The process owner's

focus is on the outcome of the process, and identifying various improvement areas to maximize the efficiency of that process. The Lean Six Sigma project team is a multidiscipline team of a typical size five to eight with the task of identifying the best ways to improve the process and complete the project (Antony & Bhaiji). Organizational infrastructure established depends on well-trained individuals. The Six Sigma organizational structure is generally found to be integrated as a matrix within the overall structure of the organization. With such groundwork, the implementation of any quality improvement mechanism can take place within the normal daily operation of the organization. Resource commitment is an important factor under organizational infrastructure. The company must be able to commit the resource needed to establish the kind of environment where Lean Six Sigma thrives. Any second guessing in the level of commitment to quality improvement will not only have less than desirable effects, but also it may also prove to be a complete failure. Any hasty decisions through the Lean Six Sigma process without the infrastructure and commitment needed will have less than desirable consequences, and may delay the results. The organizational infrastructure provides guidelines in terms of responsibilities and expectations in service organization. Therefore, it is an important contributor to the success of any Lean Six Sigma improvement efforts.

4.5. Financial Benefits

Financial benefits in today's business world is an important factor when considering the true value of a Lean Six Sigma project implementation. The company must be able to show how Lean Six Sigma financially benefits the stakeholders. It may prove difficult to predict the impact of a Lean Six Sigma project; it is a practice to estimate the benefits and costs to ensure that the

net worth of the project is worth the time and effort. There are impeding factors that can influence the outcome of Lean Six Sigma projects. The lack of time and financial resources are more visible within the service industry. Lack of time influences the outcome of Lean Six Sigma projects in high volume services such as healthcare facilities. Since, with many service organizations, there is little to no financial motivation, the only area that these organizations may consider is the improvement in efficiency. Representing the success of Six Sigma projects in terms of financial benefits and measurement performance has made their selection and completion an important aspect for organizations. The representation of Six Sigma projects in terms of their financial benefits and performance measures has a decisive role in the selection of the project (Henderson & Evans, 2000). Financial benefits as a measure of achievement convey the change and benefit clearly and concisely (Goh, 2002).

4.6. Lean Six Sigma Familiarity

The understanding of the Lean Six Sigma tools is an important factor in determining the outcome of any improvement project (Chakarbarty & Tan, 2007). The DMAIC concept is a well-known process with a set of tools designed to understand and improve any process. In addition to the understanding of how the Lean Six Sigma process works, the understanding the metrics designed for assessing performance are important. Common metrics such as defect rate, cost of poor quality, and number of customer complaints are measures to provide a baseline for the performance of any process. In service industry, the number of customer complaints can be a powerful metric. The cycle time or service time is another strong indication of how the service organization is performing. The understanding of Lean Six Sigma from a tool set standing point

is an important factor. Equally important is the effort to understand the customer needs (Coronado & Antony, 2002).

The understanding of the Lean Six Sigma concept divides in three categories (Antony & Bhaiji):

1) Team Tools: Responsibility Grid, Threat vs. Opportunity Matrix;
2) Process Improvement Tools: Process Mapping, Pareto Analysis, FMEA; and
3) Statistical Tools: ANOVA, Scatter plots, Process Capability Analysis

Any successful attempt at the implementation of Lean Six Sigma requires a firm understanding of the concepts. Without the needed understanding, there will skepticism and doubt in the implementation of such concepts. It is important to ensure that all members of the organization understand what Lean Six Sigma attempts to achieve. The importance of Lean Six Sigma understanding is a critical concept to measure simply because if people do not understand these concepts, then how will they ever commit to using these concepts on a daily basis. Once, there is a firm understanding of these concepts, and then the organization can move into the implementation of such concepts. Hence, the familiarity with Lean Six Sigma is essential to service organizations.

4.7. Management Commitment and Communication

Any successful initiative as Six Sigma requires top management commitment and provision of appropriate resources. Management influences and restructures the organization and its attitudes toward change and quality improvement in relatively a short time interval (Henderson & Evans, 2000). Top management must be involved in the process from the start and

must understand that success means an everyday approach. Once, the top management understands the improvement process and commits to it, the next important step is the communication of such notion. It is important to design and implement a communication program that shows to whom to communicate and how often. Normally, when change is to take place, there are multiple error possibilities that management can make (Watson, 2007):

1) No communication about the urgency;
2) The lack of guidance through the change;
3) Lack of vision;
4) Under-communication;
5) No short term gains or aspirations; and
6) Victory declared too soon.

While the selection of the right people and acquiring the correct knowledge base are excellent steps in any change or improvement procedure, the most important factor is the management's belief in the change (Banuelas, Antony, & Brace, 2007). In service, it is crucial that top management is committed to Lean Six Sigma. Active participation of senior management is essential in the success of any improvement methods within any service organization. It is essential that management commit to the change and provides guidelines for the members of the organization throughout the entire process. It is also important that management sets specific, attainable goals for the organization and establish mechanism to ensure their achievement. All members of the service organization must embrace Lean Six Sigma and understand it (Coronado & Antony, 2002). Top management's embrace of the change

culture is highly vital to the sustaining the efforts of quality improvement. The role of management and its communication is critical to success of Lean Six Sigma.

4.8. Human Resources

Human resources-based actions are a necessity to promote desired behavior and results. Some studies show that above 60% of the top performing companies practicing Six Sigma link their rewards to their business strategies (Harry & Schroder, 2000). At GE, for instance, for any manager to be considered for promotion, they have to be Six Sigma trained. Likewise, up to 40% of top management bonuses are tied to their specific Six Sigma success (Henderson & Evans, 2000). Human resource is critical component of the Lean Six Sigma transformation, simply because the workforce at any organization needs to understand the improvement concept (Wyper & Harrison, 2000). It is imperative that the human resource plays an active role in the Lean Six Sigma transformation. According to one of the impeding factors in the application of Lean Six Sigma in the healthcare industry is the lack of human resources necessary for successful completion of quality improvement initiative.

Human resource refers to the concept of individuals who comprise the workforce of an organization. The role of human resources in the Lean Six Sigma is a critical one. Since all members of the service organization have to commit to Lean Six Sigma, the human resource has the unenviable task of managing individuals in that direction.

The human resource is vital to the well being of service organizations' quality efforts. Human resources, responsible for the management of the workforce, should have priority in terms of gaining access to the changes that will occur. The human resources within the company

are the most important to the concept of change, and selling them on the concept helps navigate the change without turbulence.

4.9. Lean Six Sigma as a Business Strategy

The managers recognized that Lean Six Sigma needs a business strategy to identify the direction and focal point. The drivers or CTQs are what forces the improvement in certain direction. (Coronado & Antony, 2002) highlights the importance of this link. However, such approach's long-term efforts are not long term. Senior managers must convey the business case to the members of the organization. If the business case is made for the use of Lean Six Sigma, then the broad base of Lean Six Sigma will compact to a specific set of goals (Coronado & Antony, 2002). The deployment of a business plan in service organizations for Lean Six Sigma efforts is imperative. The deployment plan is the foundation of Lean Six Sigma. It is the anticipated answers to the needs of Lean Six Sigma. For instance, the foundation of a house is the frame that will support the different functions (Sehwall & Deyong, 2003). The foundation needed for Lean Six Sigma is the creation of a detailed plan that includes training, communication, reward system, and the needed resources. Without the consideration for the full scope of Lean Six Sigma, the efforts will be futile. The business case for Lean Six Sigma is critical because the service organization must understand the concept of change in terms of its business implications.

4.10. Performance Metrics

The use of proper of metrics is arguably the most important success factor. Without clear performance metrics, the process performance assessment is improper. This is an important factor from a service point of view. Oftentimes the difficulty is with identifying what to measure (Sehwall & Deyong, 2003). Before starting any Six Sigma initiative, it is best to have a clear idea and agreement on the performance metrics. The use of poorly constructed metrics will leave the team in charge of improving conditions without any answers. Normally, within the DMAIC process, once the problem definitions definition is known, the metrics are established based on the attribute in question. For instance, if the goal or problem statement is to improve customer satisfaction, then the performance metrics related quality such as defect rate, and process capability index are relevant. If the focus is inventory reduction, then the measures with which to assess the current conditions could be the average inventory value in dollars or units. The process performance metrics is critical in terms of establishing a baseline for performance any organization. If the utilization of the performance metrics is low, the current and future states' performance is in doubt. That does pose a serious risk to the overall well-being of the organization. To spend time and resources in a process that is not measurable is less than ideal for any organization regardless of manufacturing or service, non-profit or profit motivated.

Performance metrics are an important contributor to the overall success of Lean Six Sigma. They are developed in the Define/Measure phase of the DMAIC used to assess the performance of the system at the current time. Performance metrics are the framework assessment for the performance of future states of the system, upon completion of the project. Most performance metrics have a financial basis, while others have quality, reliability, and cycle

time as the basis. The key here is to develop the correct metric that will portray a meaningful result. For instance, in inventory management, average inventory may be a performance metric; however, the better metric would total inventory for some situations. In some instances, the defect rate is appropriate, while in others customer complaints may be relevant. The following questions will assist the user in assessing their developed metrics, and the development of any additional ones.

1) How easy is data collection for process monitoring?
2) How effective are performance metrics, if any?

The first question is regarding the relative ease of data collection. The ease of data collection has an impact on the selection of performance metric. The availability of data is another important issue. Performance metric assignment is in such way that the availability of data is a non-issue. Adapting the metrics to the process such that the output of the system is the input of the performance metric is the ideal condition. For instance, the average cycle time is a better indicator of performance than the number of customer complaints. Performance metrics must be clear in what they accomplish. The performance metrics for service organizations must be clear, concise, and meaningful. The correct metrics can influence the direction of the project and its success in service organizations.

4.11. Reward System

Creation of a reward system has a direct impact on the outcome of a Lean Six Sigma project (Goldstein, 2007). A reward, however small, could be what tempts the members of the organization to participating in quality improvement projects. Financial rewards have the greatest

impact on the involvement of organization's members. The creation of individual rewards promotes involvement and competition, which may be less than ideal. To alleviate that need, group rewards can be a valuable tool. There is a notion that notion that Lean Six Sigma is detrimental to careers. Conversely, it is the best career paths. Black Belts working on Lean Six Sigma projects tend to leap into leadership roles that might otherwise be difficult placement. There is one concerning issue with a reward system, the judgment of who is deserving of a reward is far more challenging than previously believed. The excessive use of such mechanism could prove detrimental to group dynamic, which will end in less than desirable results for the improvement project, which could derail the organization's commitment to improving quality.

The following key points are worth considering when establishing a reward system for the purpose of Lean Six Sigma:

1) How often are the members of the organization rewarded?
2) How meaningful are the rewards awarded?

The frequency of recognition is important in terms of promoting certain standards. If an organization consistently rewards efficiency and quality, then quality and efficiency will be at the forefront of the thought process of the members of that organization. The concept of gain sharing is a powerful concept that will help the pursuit of perfection. The effectiveness of the rewards is evaluated in many ways. Rewards could range from recognition to financial rewards such as boost in salary and bonuses. The effectiveness of the reward system can be evaluated from the involvement of the members in the activity recognized as reward worthy. It is worth noting that rewards have to be meaningful and significant to change the culture of the organization from a routine behavior to an ever-improving concept. The size of service

organizations has a large contribution to the reward system. Smaller service organizations tend to be cautious with rewards, however, medium sized organizations tend to encourage the culture of improvement through rewards, and recognition In summary, the effectiveness of a rewards program has a direct impact on the Lean Six Sigma efforts within the organization

4.12. Autonomy

The safety of the work environment has a direct impact on the level of involvement of the members of any organization in quality improvement initiatives. If the members suspect that, the quality improvement will mean lower number of staff or lower number of hours, the level of involvement will be minimal. Members of any organization providing service or product to customers are best familiar with the process they are running. If the process is in need of improving, they will know where and when. However, most of the time, the members keep silent in fear that the improvement will either lead to replacement or permanent job loss. Management's expectation detailing responsibilities should be clear, in a format similar to the format presented as follows (Goldstein, 2007):

1) Clearly communicate the expectations;
2) Providing capable process or equipment;
3) Enabling them by providing the necessary tools and training to make necessary improvements; and
4) Giving the autonomy to stop the process for improvement.

Without the feeling of safety, the level of autonomy desirable is never achievable. Members of the organization need to understand, they can stop the process to make a process improvement

decision. They need to understand, they are the process owners, and they must understand their responsibilities.

Every individual in an organization is an individual with responsibilities and expectations. In the manufacturing setting, the issue of autonomy is complex. For instance, shutting down production to improve on a key opportunity depends on a multitude of factors. However, it is easier in service to take an opportunity to improve. Unlike production, the act of providing the service is a separate entity. The customers are separate entities and their arrivals are discrete based arrival times. Answers to the following questions should help the user determine the autonomy level within his or her organization.

1) How autonomous are the members of the organization in decision making?
2) How often do they improve on their own?

In service organizations, it is part of the communication plan of management to ensure job safety is a company-wide policy. Employees must be able to acknowledge the safety of their position. Without job safety, any member of any organization only performs what is necessary. A clear understanding the responsibilities and expectations helps the staff understand their roles and buy into the system of improvement. If the expectations are clear, then each member knows what to expect and what is required. If the management communicates the culture of change and the concepts of Lean Six Sigma under the right environment, all members of the organization will take part of the improvement efforts. There should be a level of autonomy within the members of the organization, in which the organization trusts its members to achieve what is set out as the goals of the company moving forward.

4.13. Internal Resistance

Internal resistance is the biggest impeding factor when consider why Lean Six Sigma might fail. Internal resistance comes from three causes:

1) Lack of Knowledge about the Improvement;
2) Lack of Job Security; and
3) Lack of Communication.

Lack of knowledge about the improvement can be attributed to the lack of knowledge about what it takes to improve the process and what will be the effects of the improvement. If members of the organization realize that improving conditions does not lead to their employment termination, then the willingness to participate will gradually build. Members of any organization regardless of the type have the skepticism about any new concept, due to lack of job security. .Job security is a fundamental factor when introducing the concept of lean and Six Sigma. Management must communicate that while Lean Six Sigma leads to the most efficient method of operation, the members of the organization have a high job security. If that level of communication has been achieved and the trust factor is already placed, then and only then, can Lean Six Sigma be the most successful improvement tool to date.

4.14. Customer

Lean Six Sigma should begin and end with customer. The customer should be the focus of any process improvement mechanism in any organization. In manufacturing, the customer requirements could be lower defect, cheaper price, and better quality product. In service, it could be lower wait time, knowledgeable staff, and lower cycle time. The focus of any project

improvement mechanism should address what the customer needs from the process. Through the DMAIC process of improving the quality of any service provided, the CTQs developed in the measure phase are critical to understanding what is required (Coronado & Antony, 2002). Some companies and organizations have realized the importance of the relationship, and have begun to seek the input of the customers from consumption standpoint. The Lean Six Sigma initiative must focus on the customer. Customer must be considered when changing the operations. It must be determined how the proposed changes affect the customer's view of the product or service provided. Mark Goldstein argues that the reason any organization is business is to benefit financially by providing what the customer needs. In doing so, the customer must remain the focal point throughout the daily operations. The only means of measuring if the impact is meaningful is to assess the performance after the completion of the changes. The company inadvertently may impress the customer that new sales could occur, or there is an increase in the customer loyalty for the efforts. Customer focus is one of the major requirements in applying Lean Six Sigma. Lean Six-sigma is highly sensitive to requirements for customer satisfaction (Goh, 2002). It is highly effective to seek the active role of customers in any quality improvements. Customer is the initiator of the business and the end of the business. The concept of Voice of Customer (VOC) is beginning to gain some importance (Antony & Bhaiji). The data from the VOC is valuable in terms of finding out what the customer needs. However, any indecisiveness in acting on that information decrements the potential gains. The business should be customer focused. The customer generates and terminates business. Customers are the business.

Customers are the initiators and terminators of any service. Performance of any service organization depends on how the customers view the entire transaction. Quality problems in service arise from several sources, customer complaints, high wait time, high cycle time, and high error rate. Unlike manufacturing where defects and low quality can be inspected before the delivery of the goods, in service the quality rate of the service provided is unknown, if quality is not built into the system. Some service providers are using customer input as an input into their operations and a guideline for their quality rating. The following questions assess the role of the customer within any service organization.

1) How often does the organization get customer complaints?
2) How often is the input of the customer required?
3) How often is the customer involved in quality?

The high frequency of customer complaint can be a cause for concern. If the complaints are often enough to lead to loss of sales, then the management of the establishment has a responsibility to assess the problem and alleviate it. Normally, any customer complaints would be a good input to the define phase of the Lean Six Sigma DMAIC. The complaint is the central problem statement and using the DMAIC methodology, it can be resolved. The second question is the question of the volume of customer input. If customers are not led to providing insights on the quality of their experience with the organization, then the organization will never know what quality problems exist. Therefore, it is essential to the organization to find a method with which to include the customer in the system. The lower the frequency of the customer input request, the higher the likelihood of quality problems. The final question deals with the frequency of the customer involvement in the quality programs of the organization. To maximize the return of any

quality improvement concept, the customer must be a part of the quality program. In manufacturing, the customer is the end user of the product, and therefore, the judge of the final functionality of the product. More emphatically in service, the customer uses the service provided, thereby judging it based on the quality of the actual service requested, and its method of delivery. In summary, in any organization the customer or the end user of product/service should be an important consideration in the Lean Six Sigma efforts. It is the customer generating the need for the daily operations; therefore, it must be involved in the output's quality.

4.15. Supplier

In service and manufacturing alike, the supplier plays an important role in the final quality of the product or service. The alignment of the suppliers within the supply chain of information has a permanent effect on the quality of the outcome (Antony & Bhaiji). Most companies found it imperative to have a representative from their suppliers on their quality improvement efforts (Goldstein, 2007). In manufacturing, the quality of the initial raw material is critical to the quality of the final product. This means that the supplier the organization depends on are required to show proof of quality through various certifications and mechanisms. However, within service industries, a win-win practice should be the norm. In service, information is vital to the quality of the service performed and delivered. From a supplier standpoint, if the supplier of information, whether internal or external, does not supply the correct and accurate information, the service performed is not in a timely and satisfying manner. The approach of including a supplier representative in the Lean Six Sigma transformation has yielded some promising results in order to eliminate quality problems at the supply source. The

interactions with suppliers are important. From a cost perspective, many suppliers will reduce the cost of the procurement of the material or information. However, from a quality standpoint, having too many suppliers introduces variation into the system. In conclusion, any Lean Six Sigma efforts within any organization must be a win-win for the company and its suppliers (Coronado & Antony, 2002).

The role of supplier(s) in any organization is critical within its supply chain. The suppliers in both manufacturing and service play a critical role in the supply of the needs of higher level in the supply chain. For instance, if the supplier to a manufacturer does not provide its demand at the highest quality rate, the likelihood of quality problems increases. Similarly, in service, if the information transferred from one subsystem to another does not have the highest quality, then the service provided based on the faulty information, will be faulty. Some organizations in both service and manufacturing have started actively including members of their supply team in their Lean Six Sigma efforts. However, before that can be done, there should exist a method of assessing the needed for quality assessment. The following questions provide a guideline to that concept.

1) How often is the information supplied inspected?
2) How often is the information supplied previously inspected?

The frequency of inspection upon receipt of information is not ideal within any service organization. However, it is a necessity to ensure the information provided is accurate and clear. This concept is similar to the concept of inspection in manufacturing, where the supply of raw material is inspected for quality problems. Unlike manufacturing, the information has velocity in service organizations, and its inspection at every level may prove to be challenging and wasteful.

The second key point is to ensure that previously provided information is inspected to be accurate and useful. With consideration of quality in information packaging, the need for inspection of the information at every stage becomes obsolete. For instances, where the information may arrive from an external source, the concept of a quality certification can be an efficient mechanism to ensure the properness and usefulness of the information.

4.16. Project Management Skills

There several key components to project management left unnoticed in failed quality initiatives. Time, cost, and quality are contributors to the project management efforts. Defining the contribution from each of these factors will help shape the resources and commitment needed to deliver achievable results. Two key concepts in project management of such quality improvements are project tracking and project reviews. The tracking of project is a methodical tracking of progress of the goals of the project. It serves as a guideline for the on-time completion of the project (Goldstein, 2007). However, the project reviews are seen as "workshops" that promote learning. The purpose of these reviews should be the discussion of what are the impeding factors, hindering progress. Project tracking and reviews are vital to the successful completion of the goals and aspirations set by the project (Coronado & Antony, 2002). It is rational that reviews and tracking server as a motivator for future endeavors in quality improvement.

Project tracking and reviews serve an important role within the Lean Six Sigma projects in any service organization. Project tracking tracks the progress of the Lean Six Sigma projects to ensure meaningful progress towards meaningful results. Project reviews, however, have a

different role in the success of Lean Six Sigma projects. Project reviews serve as sounding boards to discuss the current difficulties of the project both from a technical and timing standpoint. The questions below investigate the use of project tracking and project reviews within the organization under study.

1) How often are projects tracked for success?
2) How often are project reviews performed?

Project tracking serves only as a mean of assessing the progress made on projects. Setting goals and aspiration to achieve is step one of a three step process. The second step of the process is the actual work done towards achieving those goals. The last step in the achievement of goals and aspirations is the tracking of the completion of those goals. Project reviews are vital to the success of any project. They allow the members performing the tasks of the project to open the project for discussion. However, important project reviews are in project completion, they are even more important in Lean Six Sigma projects. It opens the possibility of discussion on key point, such as negatives, positives, and challenges of the project. Project reviews serve as a brainstorming session designed to improve the current standing of the project in concept and timeline. The project management skills are key contributors the success of Lean Six Sigma in service organizations. In service settings, the quality improvement projects must begin and end on time because of strict budget constraints.

4.17. Project Selection and Prioritization

The project selection is an important process. The selection of the wrong project can lead to failure of the project. There are three criteria by which to consider in project selection. These criteria are the following:

1) Business Benefit
2) Feasibility
3) Organizational Impact

Business Benefit is the most important factor when considering the value of a potential project. It can be attributed to urgency of the project, financial impact of the project, impact on the core competencies of the organization, and the ability to meet external customer demands. Feasibility of the project is categorized into different contributing factor, from complexity issues to likelihood of success to resources available, and resources required by the project.

There are three phases within the project selection for any organization gaining significant benefit from the projects (Bertels & Patterson, 2003). These three phases are the following:

1) Opportunistic Project Selection;
2) Linking to Strategic Imperatives; and
3) Using a Process Management System.

Opportunistic project selection defines as the selection of a project that excites people about the possibilities of improvement. The opportunistic projects could be any cost savings, waste reduction, defect/error reduction, reduced inventory, and increasing capacity. The linking of a project to strategies of the organization is imperative. Any organization should begin by redefining the company vision and goals. Management must assess performance in key processes

that have a direct impact on strategic imperatives, which will lead into the project selection. The systems approach allows the identification of key elements for improvement and their support. This approach forces the organization to understand what customers perceive as excellence, what drives the customers' perception of excellence, the performance of the organization, and the performance of the competitors as a benchmarking point (Bertels & Patterson, 2003).

The failure of a project in a service organization depends on various factors. Arguably, the most common factor is the incorrect project selection. A project has to have the right scope. Scope by definition is the boundary or limit. A project with a broad scope is as non-effective as a project with too strict of a scope. Therefore, assessing whether failure was scope oriented is critical. The two questions below investigate the cause of the failure in any project.

1) How often do projects fail?
2) How often is the cause of project failures analyzed?

The frequency of project failure is important. Organizations that have a high failure rate in projects must correct the needed elements. The causes of failure are critical to the success of later project. As stated previously, one of the causes of failure could be incorrect project selection or incorrect scope selection. In Lean Six Sigma, the projects selection takes place in such way that the duration of the project to successful completion is approximately six months. The viability of the project depends on the impact of it on the daily operations. Project scope serves as the limit for the project. In Lean Six Sigma implementation, the scope of the project is critical because it serves as the boundary for the project. It limits what is under investigation, what is studied, and what is improved. Having too large of scope almost guarantees failure because it broadens the responsibilities and tasks to complete the project. Similarly, too strict of

a scope does not do enough to convey the improvement message to the member of the organization. Finding the right balance in project and scope selection is key to the success of any Lean Six Sigma efforts.

4.18. Training

It is vital to increase the comfort level of the organization's members with proper training. There is wide variety of training mechanisms to utilize in order to achieve the needed understanding. The hierarchy of the training mechanism starts with Yellow Belt (YB) with the minimal amount of knowledge of Lean Six Sigma. Gradual increase in knowledge is achieved through Green Belt (GB) and the Black Belt (BB) training. The highest degree of knowledge that is attainable being the Master Black Belt (MBB) is an indication of complete knowledge of the concepts. The Black Belts (BB) are the most popular training level within the belt system and must possess the following (Snee & Hoerl, Six Sigma Beyond Factory Floor, 2005):

1) Self starter who work on their own initiative
2) Able to lead, mentor, and work in a team
3) An effective communicator at all levels
4) Computer literate and competent in elementary statistics
5) Enthusiastic, energetic, and have a passion for excellence

Harry and (Harry & Schroder, Six Sigma: The Break Through Strategy Revolutionizing the World's Top Corporations) (2000) contend that Black Belts must possess the following:

1) Ability to understand the "big picture" of the business
2) Must possess excellent communication skills

3) Inspire to excel

4) Allow failures and mistakes with a recovery plan

5) Focus on results and understand the importance of the bottom line

6) Encourage commitment, dedication, and team work

7) Promote win-win situations

8) More concern about business success than personal gains

9) Recognize results count more than fancy titles

Training is part of the communication process to make sure that manager and employees apply and implement the Six Sigma techniques effectively (Kwak & Anbari, 2006). The key benefits of the belt system in the training of Lean Six Sigma is that everyone in the training programs speaks the same language, which makes the task of understanding and communicating is easier than otherwise. It is imperative that throughout the training the approach taken, to be hands on approach, as it is the best learning method.

Govindarajan (2007) contends that Lean Six Sigma training done properly takes four years. In each year of training, there are gaps in the skill set acquired. For instance, in the first year, the trainee lacks serious management experience, and in Year 3, for instance, the trainee might lack strong change management skills.

A typical curriculum of Lean Six Sigma training is designed in four weeks (Hahn, 1999). In Week 1, the MAIC roadmap, process mapping, FMEA, process capability analysis are the topics of discussion. In Week 2, the topics are statistical thinking, hypothesis testing, correlation, Regression analysis, and team assessment. In Week 3, control plan, mistake proofing, team development, and the final exercise are topics of extensive discussion.

The question(s) in this section are relevant to training as a success factor for Lean Six Sigma implementation. Training is the backbone of Lean Six Sigma. The role of training cannot be understated in such concept. New concepts such as FMEA, DOE, and SWOT analysis need the required training to become second nature to the member of the organization. The lack of proper training both in terms of amount and in terms of direction can have undesired results. The next three questions will assess the effect of any training to ensure that the direction and amount of training are estimated correctly.

1) How frequent is training within the organization?
2) How effective does the staff view the training?
3) How effective has previous training been?

The three questions above summarize the important factors in consideration of training. The frequency of training is an important concept. If the frequency of training for the staff is at the lower end of the spectrum, then the training for Lean Six Sigma would have to be done in the most diligent manner. Every member of the staff at the organization must understand and recognize that Lean Six Sigma is the quality improvement concept that will be beneficial to the organization, and therefore beneficial to its members. The effectiveness of the training is a key contributor to the training efforts. If the message from any training regiment is unclear, then the causes must be investigated and alleviated. The view of the staff about the training program is a key contributor to the success of the training program. If the members of the organization do not have a favorable opinion of the current or previous training for which they partook, then new training will not be effective. If the members of the organization are not motivated about the Lean Six Sigma training, then likelihood of failure increases.

4.19. Proposed Lean Six Sigma Success Factor Hierarchy

This section presents the proposed hierarchy and relationship for the proposed success factors for Lean Six Sigma project implementation within service organizations. This hierarchy is shown in Figure 4.1. Managerial Factors are those factors that management can control and influence. Cultural and Organizational Factors relate to the culture of the company. They range from the acceptance of culture of change to the need for an infrastructure and training methods and rewards system. Business Factors category centers on the business view of the operations and the influence of Lean Six Sigma on daily operations. The Project Control Factors are those factors that influence the outcome of the project during its completion phase. External Factors category are those categories that will influence the outcome of the project from an external source.

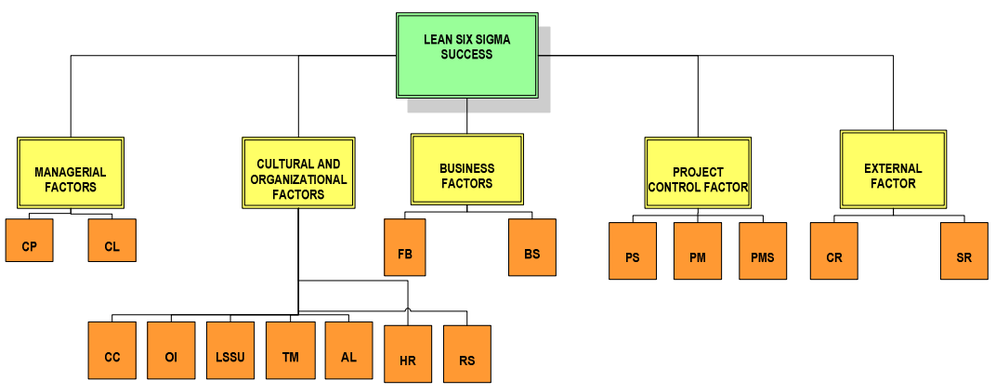

Figure 4.1. Proposed Lean Six Sigma taxonomy of success factors for service organizations.

The first category of success factors is the Managerial Factors. This category includes the Communications plan and the commitment level to Lean Six Sigma. The commitment of a service organization to Lean Six Sigma philosophy is the most important factor in determining the level of success of the efforts. Management must commit to Lean Six Sigma and understand it is a robust improvement mechanism. After management commits to the Lean Six Sigma transformation, the members of the organization must commit. Through an effective and efficient communication plan, all members of any service organization must understand that Lean Six Sigma will increase customer satisfaction and reduce the overall cost. The type of commitments divides into two categories. The first category is the financial commitments, which are those that have an impact on the financial well-being of the company. The initial investment is an important factor in the success or failure of quality improvement (Henderson & Evans, 2000). The size of the investment is subject to further research and discussion; however, the impact of the concept is unequivocal. Any Lean Six Sigma efforts require a non-financial commitment from the top management of the organization (Halliday, 2001). Goldstein (2007) argues that the decision to commit full time resources to Lean Six Sigma versus partial commitment is a case-to-case basis that depends on the following factors:

1) Is major competitive threat looming on the near horizon?
2) Is a major customer close to leaving you because of high degree of dissatisfaction with your performance?
3) Is a new product introduction program on the near horizon?
4) Is a major product or service redesign program planned in the near future?
5) Is the company's stock performing poorly in the marketplace?

6) What are the cost or defect reduction goals and the schedule to achieve them?

In summary, the impact of management commitment and communication is the most important factor in deciding the effects of a Lean Six Sigma project. Table 4.1 summarizes existing research with emphasis on managerial factors.

Table 4.1. Summary of research with emphasis on management factors.

Management Commitment and Communication	
Henderson & Evans (2000)	Importance of Management Commitment
Halliday (2001)	• Importance of Management Commitment
Goldstein (2007)	Importance of Management Commitment

Next category in this hierarchy is the cultural and organizational factors. This category divides into eight traditional success factors. These success factors are cultural change, organizational infrastructure, Lean Six Sigma understanding, training methods, autonomy level, internal resistance, human resources, and reward system. The cultural change factor explains that Lean Six Sigma success hinges on the understanding that Lean Six Sigma needs the proper view from the members of the service organization. The management must install the culture of change in the organization.

The culture change deals with the change in attitude and resistance level to Lean Six Sigma. Many theories developed over the years to classify the categories and explain the reasons. (Crosby, 1979) explains these theories and their solutions. The focal point of cultural change is to sell Lean Six Sigma to every member of the organization. The management must emphasize the contributions of Lean Six Sigma. Management must communicate with managers to address their concerns regarding Lean Six Sigma. Theories and methods have been developed to

accomplish such critical task (Bounds, 1994). The need for the development of the right culture is an important concept. (Coronado & Antony, 2002) highlights the importance of such commitment. (Johnson & Swisher, 2003) Provides a guideline to ensuring the cultural change is effective and thorough.

1) Sustained and visible management commitment

2) Set clear expectations and select project leaders carefully for leadership skills

Lean Six Sigma requires a change in organization's values and culture (Chakarbarty & Tan, 2007). A clear communication plan and appropriate motivational channels will play an important role in installing the right organizational culture needed for Lean Six Sigma success (Kwak & Anbari, 2006).

The next contributing factor is the understanding of Lean Six Sigma. The body of research in Lean Six Sigma hints the direct relationship between the success level and understanding of its fundamentals. While in most successful implementations, the importance of understanding the Lean Six Sigma concept remains silent, the importance is unfelt. Lean Six Sigma divides into two categories the DMAIC applications and the Design for Six Sigma (DFSS). While the DMAIC methodology applies to any problem solving application, the DFSS solves the issues of quality problems prevention, the IDOV, which shortens Identify, Design, Optimize, and Validate (Pande, Neuman, & Cavanagh, 2000). The two Six Sigma methodologies require a fundamental understanding of statistics and quality tools. The tools range from the traditional quality tools to statistical tools such as control charts, ANOVA, regression analysis, and others (Halliday, 2001). The importance of understanding Lean Six Sigma and its tools is the subject of the study of (Coronado & Antony, 2002). They contend that the importance of this

factor remains understated. The understanding Lean Six Sigma and the use of correct metrics is important in consideration of Lean Six Sigma (Antony & Bhaiji).

The next factor of importance in this category is the concept of training. The understanding of Lean Six Sigma and training have a close relationship. The Lean Six Sigma understanding has an initial importance of finding a baseline for the level of understanding of the concepts and a secondary purpose of assessing the effectiveness of the training program. The training program focuses on the fundamental concepts of Lean Six Sigma. The most popular training method is the Belt System, which allows all users of the Lean Six Sigma to communicate in a common language.

The autonomy level is the next important factor. This factor is a direct result of the culture change. If the correct culture is in place in service organizations, the members of the organization understand what is expected and required. Based on this understanding, the members of the organization must have the autonomy to improve the conditions. It is critical that people understand that they must improve the conditions. Internal resistance is closely related to the autonomy of the individuals within a service organization. The internal resistance is directly influenced by the member’s understanding of Lean Six Sigma. The internal resistance stems from the lack of knowledge and skepticism about the organization’s behavior.

The reward system is an important factor influencing the outcome of a Lean Six Sigma project. It is a human psychology concept that people will behave in a certain manner, if enticed. The amount of the reward and its effect may not be the topic of study. However, the impact of such concept is not understated. The magnitude of the reward system depends on the financial well being of the company. Table 4.2 summarizes existing research with emphasis on cultural

and organization factors.

Table 4.2. Summary of research with emphasis on cultural and organizational factors.

Cultural and Organizational Factors			
Crosby (1979)	CC	Govindarajan (2007)	TM
Bounds (1994)	CC	Breyfogle III (2001)	TM
Coronado & Antony (2002)	CC, OI, TM, HR	Goldstein (2007)	TM, AL,RS
Johnson & Swisher (2003)	CC, LSSU, TM	Snee(2004)	TM
Chakarbarty & Tan (2007)	CC	Antony & Douglas (2007)	TM
Kwak & Anbari (2006)	CC, TM	Harry & Schroder (2000)	TM,HR
Dale(2000)	OI	Snee & Hoerl (2005)	TM
Aviation Week (1998)	OI	Wyper & Harrison (2000)	HR
Rucker (2001)	OI		
Antony and Bhaiji	OI, LSSU, TM		
Pande et al	LSSU		
Halliday (2001)	LSSU		
Goh (2002)	TM		
Henderson & Evans (2000)	TM,HR		

The next category is the Business Factors. This category divides into two success factors. The Financial benefits and Business Strategy. The financial benefits success factor refers to the concept of a positive financial impact from the improvement implementation. Similar to other improvement concepts, Lean Six Sigma requires an initial financial investment. The return on the investment must be positive to entice the organization to transform to the new setting. The size of the initial investment and the magnitude of the return could be topics for future research. However, the importance of selling Lean Six Sigma as a concept that will enhance the overall financial well being of the company cannot be understated. Therefore, the representation of Lean Six Sigma projects has a decisive role in the selection of the project (Henderson & Evans, 2000).The measure of benefits will serves an enticement tool to the members of the organization in conveying the message of change (Goh, 2002). The focal point of service organizations in

terms of strategy must be that Lean Six Sigma is the only strategy for success in business. In other words, Lean Six Sigma must be the only business strategy. Table 4.3 summarizes existing research with emphasis on business factors.

Table 4.3. Summary of research with emphasis on business factors.

Business Success Factors	
Goldstein (2007)	Financial Benefits
Goh (2002)	Financial Benefits
Henderson and Evans (2000)	Financial Benefits
Anbari (2002b)	Business Strategy
Antony and Banuelas (2001)	Business Strategy
Eckes (2000)	Business Strategy
Harry and Schroder (2000)	Business Strategy
Dale (2000)	Business Strategy

Project control category of the success factors is those that will influence the project outcome. Project selection, performance metrics, project management skills are the success factors that classify under this category. Project Selection refers to the concept of selecting the right project and right scope for that project. Incorrect projects and scopes will result in failure of the improvement efforts. Project and scope selection must be in accordance with the company vision and values. Choosing the proper scope is important because the incorrect scope will result in either project failure or dissatisfaction with the results. Performance metrics is the second success factor in the project controls category. Performance metrics are means to assess the performance of the system prior and after the implementation of the project. The development of correct metrics is critical in the implementation of Lean Six Sigma concepts. Incorrect metrics will create confusion and difficulties. Project management skills are a set of skills used to assess the progress of the project in terms of both concept and timeline. Project tracking skills allows

the user to track the progress of the project from start to finish. Project reviews serve a mean of communication about the conceptual difficulties of the project. Table 4.4 summarizes existing research with emphasis on management factors.

Table 4.4. Summary of research with emphasis on management factors.

Project Control Success Factors	
Kwak and Anbari(2004)	Project Selection and Selection Criteria
Welsh and Byne(2001)	Project Selection and Selection Criteria
Pande et al	Project Selection
Ingle and Roe(2001)	Project Selection
Berterls and Patterson(2003)	Project Selection
Coronado and Antony(2002)	Project Selection and Prioritization
Harry and Schroder(2000)	Project Selection and Prioritization
Goh(2002)	Performance Metrics Selection
Sehwall and Deyong(2003)	Importance of Correct Performance Metrics
Kwak and Anbari(2004)	Importance of Correct Metrics
Banuelas and Antony(2002)	Project Management Skills
Eckes(2000)	Project Management Skills
Goldstein(2007)	Project Management Skills
Starbird(2000)	Project Management Skills

The final category of success factors is the external category, where by definition the influence on the outcome of a Lean Six Sigma project comes from an external source. There are two sources with influence on the outcome of the project. The suppliers and customers of the final service provided. The suppliers in the chain are those that provide the information needed to service providers. In manufacturing, the suppliers have a larger role in Lean Six Sigma efforts, simply because products are built on initial raw materials. For instance, in a hospital the diagnosis information of a patient is on hand for further point of reference. This is uniqueness of the service settings will allow the user to correct any errors in the process before providing the

service. The suppliers of the information must inspect the information to ensure its integrity and accuracy.

The customer generates the business. The demand of the customer is the business. The customer's input, therefore, is extremely crucial in any improvement mechanism. Customer input is valuable because it allows the organization to pinpoint its weaknesses and assess those in an improvement project. However, the quality of the customer input depends on several factors. The collection method influences the quality of the input taken from the customer. If the method of collection is an easy, straightforward method, the results of the collection will be meaningful. The frequency of collection is also important. A high frequency of collection shows the diligence of the organization in finding its weaknesses. The customers' diligence is also important because without a proper consideration on the part of the customer, an improvement cannot take place. Table 4.5 summarizes existing research with emphasis on external factors.

Table 4.5. Summary of research with emphasis on external factors.

External Success Factors	
Eckes (2000)	Customer Role
Goldstein (2007)	Customer Role, Supplier Role
Coronado & Antony (2002)	Customer Role, Supplier Role
Goh (2002)	Customer Role
Starbird (2000)	Customer Role
Porter (1985)	Customer Role
Antony & Banuelas (2001)	Customer Role and Supplier Role

At the end of this taxonomy, it is important to note that while these categories are different what they assess in terms of success factors for Lean Six Sigma, the mere presence of one or a group of factor does not guarantee success in improvement projects. There is a strong

connection among the categories, and existence of one category is dependent on the others. This relationship is depicted in Figure 4.2.

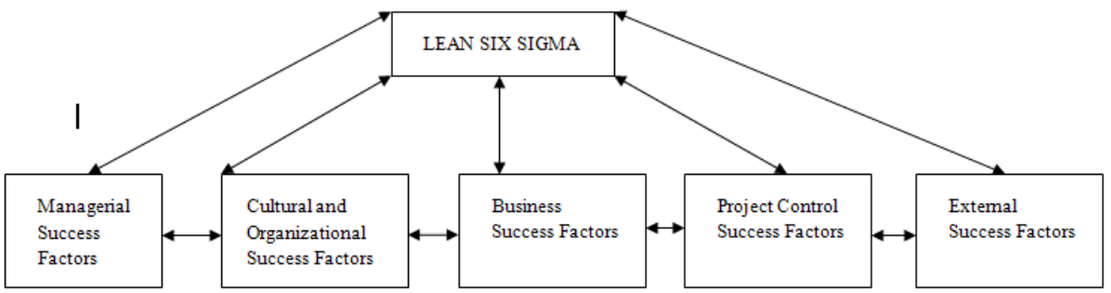

Figure 4.2. Proposed Lean Six Sigma success factor hierarchy.

CHAPTER 5: SUMMARY OF RESEARCH AND DIRECTIONS FOR FUTURE WORK

5.1. Summary of Research

In Chapter 1, the impact of quality on daily operations in both manufacturing and service settings is discussed. In this chapter, the current state of the research in quality and Lean Six Sigma is summarized and the shortcomings in the research available are identified.

Chapter 2 discusses the concepts of Lean and Six Sigma in theory. Chapter 3 discusses existing research in Lean Six Sigma with the intent to show that Lean Six Sigma performs well in service settings, including, for example, the financial industry, healthcare industry, and within governmental entities.

Chapter 4 presents the proposed taxonomy of success factors for Lean Six Sigma implementation. The summary of research allows the reader to understand the impact of each success factor on the overall result obtained from Lean Six Sigma. This chapter also discusses the interrelationships and relative importance of each success factor. The proposed success factors are categorized in two categories: 1) the factors to consider before the start of the Lean Six Sigma Project and 2) the factors to consider after the start of the Lean Six Sigma project. The before-project-initiation success factors are those that influence the outcome prior to the start of a project. The after project-initiation success factors are those success factors that influence the outcome after the project has started.

5.2. Future Research Directions

This research provides a basis for the understanding of Lean Six Sigma and the factors contribute to its success. However, this body of work does not provide any input or assistance in determining and making the case for the Lean Six Sigma implementation. The continuous assessment of Lean Six Sigma conditions can be a point of future research. The continuous assessment of current conditions can occur in service applications based on performance measures. This assessment can be in the form of a user-friendly application. This application could consist of a database of the performance measures, a set of analysis tools, and a decision-making component, visually displaying the results for the user. This decision support system application could have a continuous timeframe that will serve as the data field for its database. The existence of such mechanism would enhance the benefits of Lean Six Sigma. However, this direction of research is only relevant after it has been determined that Lean Six Sigma is needed.

Another direction of research would be in the training methods. Normally, the training method of choice for Lean Six Sigma is classroom training (Harry & Crawford, Six Sigma-The Next Generation, 2005). The newer training versions have allowed the trainees to gain valuable face time with trainers and practitioners. It is an interesting topic of research to assess the efficiency and performance of a new concept (Antony, Douglas, & Antony, 2007). The training method is one of the success factors within the taxonomy proposed in this document. The training method and its effectiveness is important because it will allow service organizations to pinpoint where focus of the training should be placed. Any further research in investigating the effective training methods and development of such mechanism would be valuable in this area.

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