Graduate Research Project

Researching the business management strategies Lean Six Sigma and DMAIC and its application to improve performance in service area at Fleet and Industrial Supply Center San Diego

By

Thiago Lima

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School of Business Management

National University

Dr. Lawrence Arillo

Dr. Richard Weaver

Dr. John Ferguson

Abstract

The purpose of this dissertation is the application of Lean Six Sigma (LSS) business management strategy, based on the utilization of DMAIC methodology, at the Fleet and Industrial Supply Center San Diego (FISCSD), in order to analyze and demonstrate the degree that such theories can be useful to improve performance in service areas.

LSS is a framework officially adopt by the Department of Defense (DoD) under the Program Continuous Process Improvement (CPI), however, since the implementation of LSS within the Department of Navy, such methodology has been mostly used to improve major manufacturing processes

There is a strong impression within the FISCSD, or even within the United States Navy, that LSS is not applicable in services setting, thus, this research is aimed at demonstrating the benefits that can be obtained through a greater utilization of CPI in service. The specific service area studied was the Purchase Division and its main process.

During the project were collected data about key elements of the process. The analysis of aspects like cycle time, value added time, process cycle efficiency, process flow, etc suggested the implementation of the following improvements: creation of visual management environment, establishment of a routine, creation of new processing procedures, execution of trainings and process remodeling, which generated concrete improvements in process cycle time, on the level of standardization of procedures and on the level of process variation.

Keywords: Lean, Six Sigma, DMAIC, Improvement, Purchase Process, United States Navy.

Dedication

I dedicate this project to God above all, for health, strength and motivation given for this assignment.

I dedicate this work and I owe my deepest gratitude to my wife Mariana, who left her family and work in Brazil to come with me to United States of America, companion of all times, always helpful and advisor, who patiently listened to the conversations about this work, without letting me think about quitting during the two years.

I am heartily thankful to my father Ronaldo Lima and my mother Sandra Lima that have always been an example of strength, honesty and courage. I also thank them to all the support provided to me during my whole life, and especially during the years that I moved to the United States of America.

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Researching the business management strategies Lean Six Sigma and DMAIC and its application to improve performance in service area at Fleet and Industrial Supply Center San Diego

Introduction to the Research

For many years, several managers of both government organization and private sector have taken actions to solve problems in service processes without undergoing a detailed analysis of the roots of problem. Usually, such type of decision delivery weak solutions that only tackles the problem superficially and only addresses its symptoms.

When dealing with simple problems, in general, the answers to them can be prefabricated. However in the contemporary world majority of problems faced by organizations are not simple, consequently, the solutions should be based on analysis of the problem, elements, causes and consequences.

Nevertheless, when seeking to improve process and performance those aspects are either neglected or not properly addressed due to the immediacy and urgency to find solutions for improvement. Furthermore, managers and decision makers still insist to act without utilizing an adequate methodology to analyze and improve processes.

In this manner, Lean Six Sigma (LSS) has emerged in last decades as one of the most successful approach to address an issue in a properly and orderly manner . As a result of that, companies all over the world have widely used such methodology to tackle its issues and problems in order to solve problems and continuously improve performance.

Nevertheless, LSS has been implemented in many companies manufacturing successfully whereas its application in the service sector is still limited. This situation derives from the fact that many companies still have the impression that an approach a LSS is only applicable and useful in main production processes of manufacturing industries.

In order to better visualize such problem, Charkrabarty and Chuan (2009) conducted a study specifically on service companies, listed on “1000 best of Singapore companies in terms of financial results”, and among the organizations that had not implemented Six Sigma the main justifications provided were "unknown to us," "not relevant to the business, "" not interested " among others.

Following the trend exposed above, the government sector has also failed to apply such methodology in service areas and, consequently, such situation has a greater impact on its effectiveness and efficiency. Thus, such scenario shows that there is much work to be done by practitioners of LSS and by researchers to provide the necessary visibility about the benefits that LSS can generates in service organizations.

Background of the Problem

The application of LSS concepts and techniques is a framework officially adopt by the Department of Defense (DoD) under the Program Continuous Process Improvement (CPI) to support managers and decision makers to avoid the occurrence of problems and mistakes. However since the implementation of LSS within the Department of Navy, such methodology has been mostly used to improve major manufacturing processes as exemplified below:

1. The Army, through the application of Lean, increased the average time between maintenance periods of the T700 engine UH-60A Black Hawk 300%.
2. The Navy has reduced the "cycle time" for maintenance of the F404 in 78%.

3. The Marine Corps has reduced the time to complete the repair cycle of helicopters CH 46 Sea Knight by 40%.

It is evident that the application of this program still lacks a greater application upon minor process/project as well as upon the services areas. The impression that Six Sigma is only for manufacturing industries is still present within the Department of Defense. At the same time, there are several service areas underperforming within the Department of Navy and no reasonable reasons for such lack of application of LSS concept after more that five year of the CPI Program launch.

Snee & Hoerl (2009) presented compelling principles regarding service's characteristics in order to advocate that development and implementation a LSS program can be fully applied to the service sector as follows: (a) all work takes place in a system of interconnected processes (b) every process is subject to variability, (c) every process creates the data that explain the variability and (d) the only way to develop effective strategies to reduce or eliminate variability is through understanding the origin of such variability.

Therefore, the theme of this dissertation consist of researching, analyzing and investigating the application of LSS business management strategy at the Fleet and Industrial Supply Center- FISCSD (an organization of the US Navy Supply System), in order to contribute and demonstrate the degree that such methodology can be useful to improve performance.

The service area to be analyzed is located at FISCSD Purchase Division, more specifically the Purchase Card Process within the Purchase Card Program due to the fact that such area have dealt with several issues for the last years and currently there is several complaints from customer regarding the level of service provided.

Statement of the Problem

The purpose of this dissertation is the application of Lean Six Sigma (LSS) business management strategy, through the use of DMAIC methodology, at the Fleet and Industrial Supply Center San Diego, in order to analyze and demonstrate the degree that such theories can be useful to improve performance in service areas.

Thus, the problem statement of the present research is as follows: Which benefits can be obtained from the application of LSS methodology in the improvement of service area within the Purchase Process at FISCSD Purchase Division?

Purpose of the Study

Marczyk, David, & David (2005) advocates that the purpose of a research is to answer question and acquire new knowledge. According to Kumar (2008), research is scientific activity undertaken to stablish something, a fact, a theory, a principle or a application.

Thus, this project is aimed at researching the business management strategies Six Sigma, Lean (which combined are called Lean Six Sigma) and the project methodology DMAIC (Define, Measure, Analyze, Improve and Control), as well as applying LSS methodology through the application of a DMAIC project methodology for diagnosing, analyzing, planning and designing a road map for improvement on Purchase Card Process over at FISCSD in order to contribute and demonstrate the degree that such methodology can be useful to improve performance.

The specifics objectives are as follows: i) applying LSS methodology to diagnose and analyze opportunities for improvement at FISCD Purchase Division ii) assessing during the application of the DMAIC method, what are the tools most appropriated to the context iii) plan an improvement project focusing on a single problem or opportunity for improvement iv) execute a pilot project aimed at testing the new process that will be suggested to improve the current process.

The first part of the work covers the initial comments, the problem being studied and the objective of the research. In the second part will be conducted the literature review of the Six Sigma, Lean, DMAIC and Overview about Implementation of Lean Six Sigma in the DoD.

The third part of the work deals with the methodology procedures, within which the methodological basis of the project, the design and development phases of work, and the techniques collection and methods of data analysis are introduced. The fourth part of the work presents the results of the application of LSS theory and DMAIC methodology on the Purchase Card Process, which also includes the

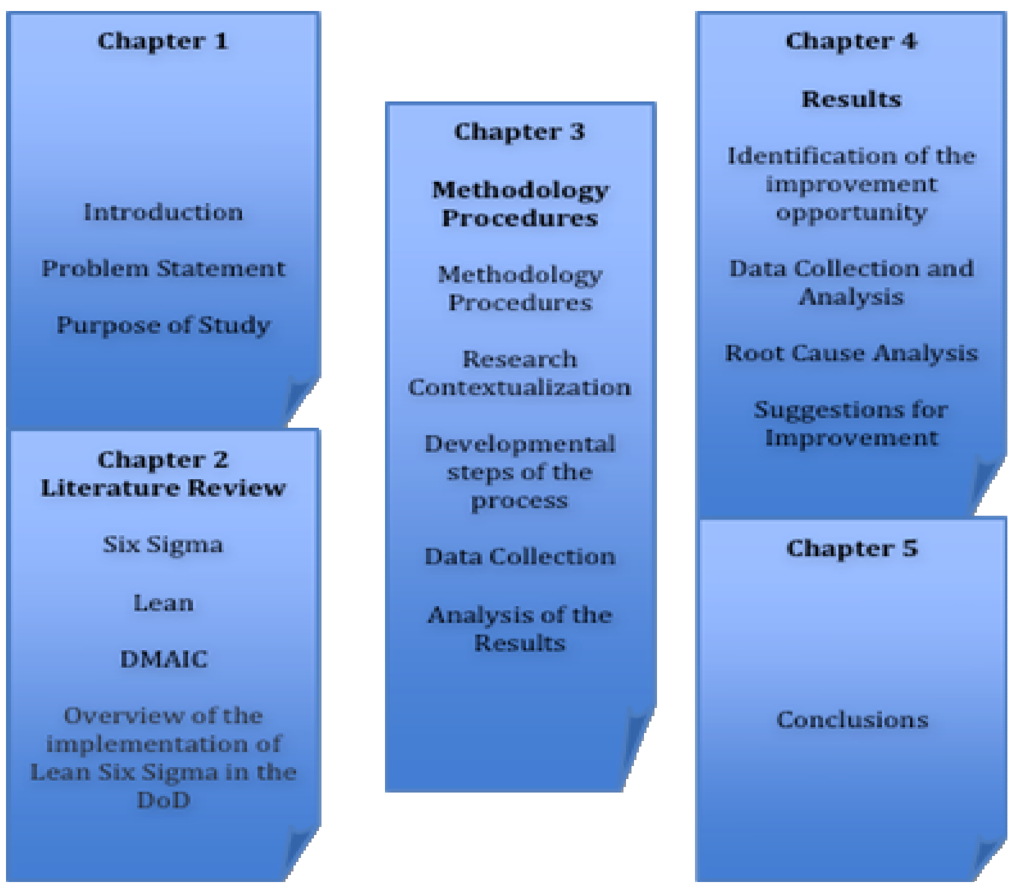


Figure 1. Structure of the research project

identification of the improvement opportunity, data collection analysis, root cause analysis and suggestions for improvement. Finally, in Chapter 5 the conclusions of the research project are presented. The following illustration shows the structure of the research project.

Significance of the Study

The economy of the twenty-first century is firmly rooted in services. Gradually, the primary sectors (agriculture) and secondary (industry) were giving way to the tertiary sector, represented by services. To the extent that this transformation was occurring, levels of competition grew and demand for quality before directed to the manufacturing industry were transferred to the service sector.

Competitiveness is an extremely important factor for the success of organizations, and implementation of quality programs can be a differentiator and a competitive advantage. The organization aims to become more competitive, thus the implementation of programs, methods and tools can leverage its capability to improve the quality of its processes, products and services.

The application of LSS theories as well as DMAIC methodology and its tools have evolved in the context of academic research in recent years, which can be determined by the growth of publications in national and international journals, or even in scientific meetings. However, despite this evolution, it is clear that there is still some lack of more theoretical studies, especially concerning the application of LSS and DMAIC tools in service environments.

Some scholars have confirmed and discussed the situation above as well. For instance, Linderman et al, (2003) stated that currently there are many books and articles on Six Sigma, written by practitioners and consultants, however there are few articles published in academic journals. Antony (2006), also argued that Six Sigma methodology has been implemented in many manufacturing companies successfully; however its application in the service sector is limited. The author attributes this situation to the fact that many companies still have the impression that Six Sigma is only for manufacturing industries in their main processes.

Thus, the evaluation of the application of LSS principles and techniques to improve the Purchase Card process of the Purchase Division, at FISCSD, justified itself because it will bring new knowledge to the process management and continuous improvement approaches. Doubtlessly, those are two areas of crucial importance within the Social Science of Management.

Assumptions

The sample of is representative of the population and the appropriate variables have been selected for examination. The measurement tools utilized are valid and reliable.

Limitations

The application of DMAIC project methodology will tackle the Purchase Card Process from the point that the Card Holder receives the purchase request to the time that the monthly reconciliation is completed.

The present dissertation does not intend to discuss and elaborate on all the statistical tools of Six Sigma and DMAIC approach. The data collection process was made through observation of the process and IT system called Navy Enterprise Planning (Navy ERP) records.

Eighty different purchase processes were observed during the data collection phase, forty for each Credit Card Holder. Forty purchase processes were tested as part of the pilot project (twenty for each Card Holder Agent). Finally, it is important to highlight that none of the improvement suggestion will focus on changing the system settings that currently support the execution of the Purchase Process, due to the fact that there is no authorization and approved budget to execute changes into the System.

Literature Review

In order to provide a basis to analyze the problem at hand and achieve the proposed objectives, the following aspects have been studied based on the literature on the subject: Six Sigma, Lean, DMAIC and Overview about Implementation of Lean Six Sigma in the Department of Defense (DoD).

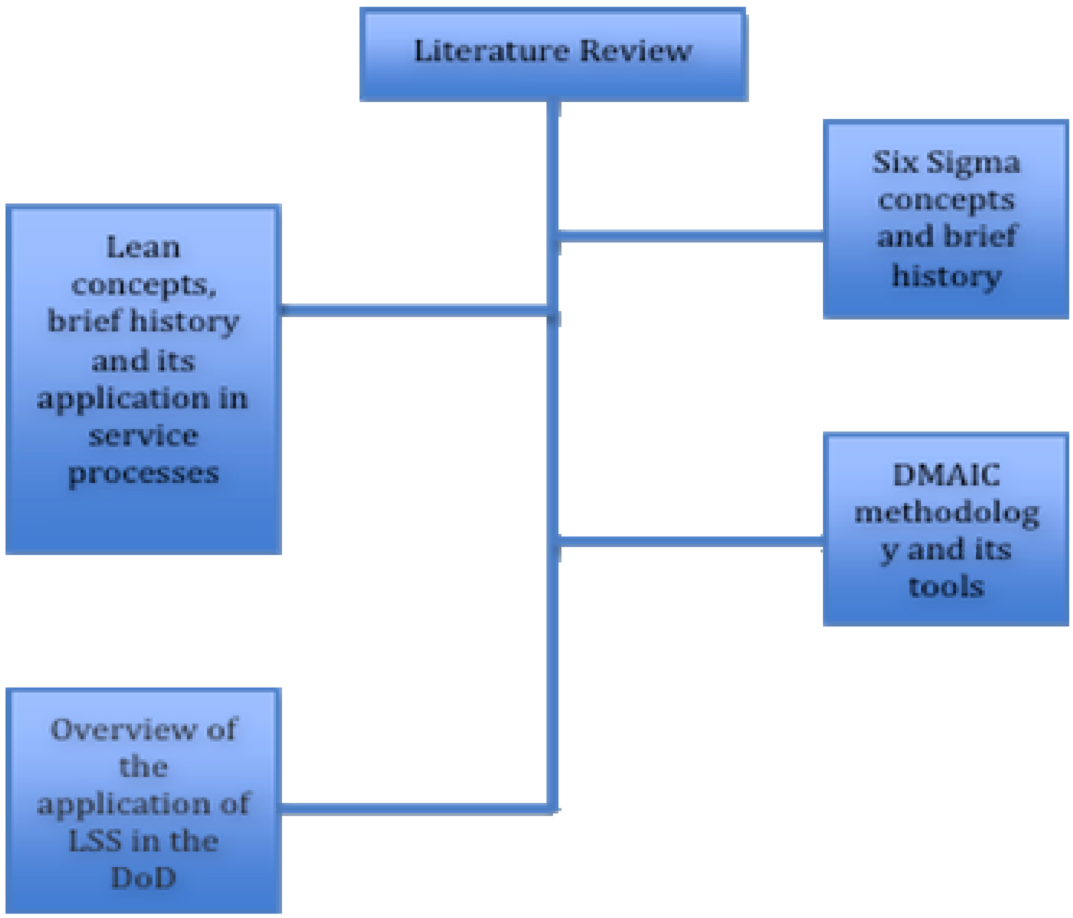


Figure 2. Literature review framework

The quality of a product or service is a critical success factor to maintain competitiveness and prosperity of business. According to the literature, the birth of the concept of quality in the United States happened in early nineties. (Dale, 2003) states that in a linguistic sense, quality is originated from the Latin word “quails” which means “such as the thing really is”.

There is also an international definition of quality “the degree to which a set of inherent characteristics fulfill requirements (Dale, 2003). American Society for Quality (ASQ), considered quality as subjective term for which each person or sector has its own definition. In technical usage, quality can have two meanings: (a) the characteristics of a product or service that bear on its ability to satisfy stated or implied needs and (b) a product or service free of deficiencies.

The importance of quality has been growing. As cited in (Beckford, 2010) during the last years several scholars defined and discussed quality such as Deming, Juran, Shewhart, Shigeo Shing, Genichi Taguchi and others.

One study of Folaron (2003) summarized some agents and events that have contributed to the evolution of quality of for the last almost hundred years as shown on table 1

Table 1

Main Events and Its Contribution to the Evolution of Quality

Year	Agent/Event	Contribution
1924	Walter Shewhart	Process oriented thinking. • Control charts (assignable and common cause)
1945	The Japanese Quality Movement Begins	- Statistical methods and use of statisticians. - Continuous improvement (plan-do-study-act) methodology. - Active engagement of management and involvement of everyone. - Diagnostic and remedial journeys.
1973	The Japanese Make Their	Quick response to changing customer

	Move	needs.
1980	Philip Crosby and Quality Is Free	• Methodology to achieve companywide quality improvement. • Improve product, process and service. Strive for perfection.
1987	International Organization for Standardization	• Widespread sharing of basic elements of sound quality systems. • Organizational rally cry for improvement.
1987	Malcolm Baldrige National Quality Award	Sharing best practices. • Strong focus on customers and results

Note. Adapted from Folaron, J. (2003). Six Sigma Forum Magazine, II (4), 34-39.

(Folaron, 2003) further demonstrated that Total quality management (TQM) approach was also popular for a number of years. It began as total quality control in the mid-1950s, was introduced in the Harvard Business Review, by Armand V. Feigenbaum, and was driven in Japan by Ishakawa.

Even though TQM can be considered the first real attempt to systematically deploy quality, Juran (2005) found that "TQM is still the term the Japanese use to describe their approach to quality"(p.594). In sum, TQM is an approach to improve the competitiveness, effectiveness and efficiency of processes and provide greater flexibility in the organization. It is a way of planning, organizing and understanding each activity, and depends on each individual at each level.

(Folaron, 2003) argued that TQM involved banners and pride in quality, however, such approach fell short two ways: (a) emphasized quality improvement for the sake of quality improvement instead of tying improvements to the bottom line and (b) focused on improvements within departments or business functions, not among them.

Despite these facts, it is important to highlighted that through the efforts towards the implementation of TQM Programs, different organizations were introduced to the use of best quality tools and then started to develop a mindset to strive for continuous quality improvement, but because it didn't have significant dollar benefits, the movement did not endure. Although many of these initiatives have come and gone, several of their elements are apparent in the current LSS methodology.

Six Sigma Methodology

In the 80s, Bill Smith utilized concepts of Deming to develop ways to improve efficiency in order to better compete against companies which, at that time, were delivering better quality and lower prices. According to Larson (2003) Bill Smith was the heart and soul of the Six Sigma algorithms deployment throughout Motorola and was often referred as the father of Six Sigma.

Ravi S. Behara, Gwen F. Fontenot and Alicia Gresham (1995) discussed that before Six Sigma's launching, the overall product error rate was about 4 sigma, which means 6,200 defects per million opportunities (DPMO), whereas some competitors at elite Japanese companies were achieving an error rate of about 6 sigma, which represents only 3.4 DPMO.

During the early years of the implementation of the program, Motorola's corporate leaders toured the world visiting all Motorola sites to explain that this was going to be the operating mantra of Motorola for the future (Larson, 2003). Due to the success of its Quality Program Motorola was awarded with Baldrigde Award of Quality. This event directly contributed to spread around the world the benefits derived from the application of Six Sigma methodology.

The excellent financial results achieved by GE through the application of Six Sigma Program also drove other firms to start to utilized such methodology. The application of such approach born at GE when in September 1995, when Jack Welch invited several employees to come to the auditorium for an important video presentation of a brief statement in which was explained that GE was about to embark on a major new initiative called Six Sigma. According to (Hoerl, 2002), Jack Welch sought with such an initiative to align the efforts aimed at improving quality of business needs.

Larson (2003) argued the use of Six Sigma gradually increased, initially and primarily in manufacturing processes, and thereafter to the service area. According to George (2002), the strategy of the Six Sigma program is based on controlling the process by acting on the causes of variations, keeping the process stable, with the aim of reducing the number of defects in the final products to values close to zero.

Harry (1998) also states that Six Sigma's philosophy recognizes that there is a direct correlation between the number of defects, wasted operating costs, and the level of customer satisfaction. In general, Six Sigma focuses on establishing a world class business performance benchmarks and on providing a organizational structure and a roadmap by which these can be realized (Truscott, 2003)

As discussed so far, Six Sigma has evolved over the last three decades and so has its definition. There are literal, conceptual, and practical definitions. According to Motorola web site, Six Sigma can be seen at three different levels: (a) as a metric, (b) as a methodology and (c) as a management system. In sum, Six Sigma is all three at the same time.

Authors such as Blakeslee (1999), James M. Lucas (2002), Larson (2003) define Six Sigma as a quality strategy that seeks the elimination of root cause and reducing the variability of processes, using quality tools for resolving technical problems such as the cause-effect diagram, Pareto analysis, histogram, sampling, process mapping, control charts and also other more sophisticated techniques as the analysis of failure mode and effect analysis (FMEA), design of experiments and tests hypotheses.

Statistical Definition of Six Sigma. The Sigma symbol (σ) is a letter of the Greek alphabet and is used to indicate the variation about the mean of a process. When Sigma is applied to a process, its value indicates whether the process under control or not. The higher the number of sigma, the best level of quality.

The approach of Six Sigma is basically a Statistical Process Control (SPC) driven by TQM, which seeks to obtain a maximum of 3.4 defects per million processes in manufacturing, service and product performance (Mitchell, 1992). The concept of SPC was introduced by Walter Shewhart, who suggested that given the natural variation of the process, there is a need to intervene in the process when it exceeds the limits of three sigma up and three sigma below the mean.

The concept of three sigma (meant by the distance represented by three standard deviations below and three standard deviations above the mean) is related to a process likely to achieve 99.973% accuracy, which consequently means a defect rate of 0.027%. The number of defects on each level of sigma is highlighted on table 2

Table 2

Number of Defects per Level of Sigma

Sigma	Defects per milion	Cost of poor quality	
6 sigma	3.4 defects per million	<10% of sales	World-class
5 sigma	230 defects per million	10 to 15% of sales	
4 sigma	6,200 defects per million	15 to 20% of sales	Industry Average
3 sigma	67,000 defects per million	20 to 30% of sales	
2 sigma	310,000 defects per million	30 to 40% of sales	Noncompetitive
	700,000 defects per million		

Note. Lucas, M. J. (2002, January). The Essential Six Sigma. Quality Progress , 27-31.

Carl Fredrick Gauss (17777-1855) developed the concept of distribution called normal curve that introduced the use of Six Sigma as a measurement standard. As discussed so far and also argued by Biolos (2002), Six Sigma concept is aimed at measuring the number of sigma from the mean until a defect happened.

In a normal distribution, the area under the curve between the average and one arbitrary point is the number of standard deviations between the average and that point, allowing the calculation of probabilities. If a variable has normal distribution, about 68.26% of their values are within the ± 1 Sigma (counting a standard deviation on either side of average), approximately 95.46% in the second interval, and approximately 99.73% within 3, as follows:

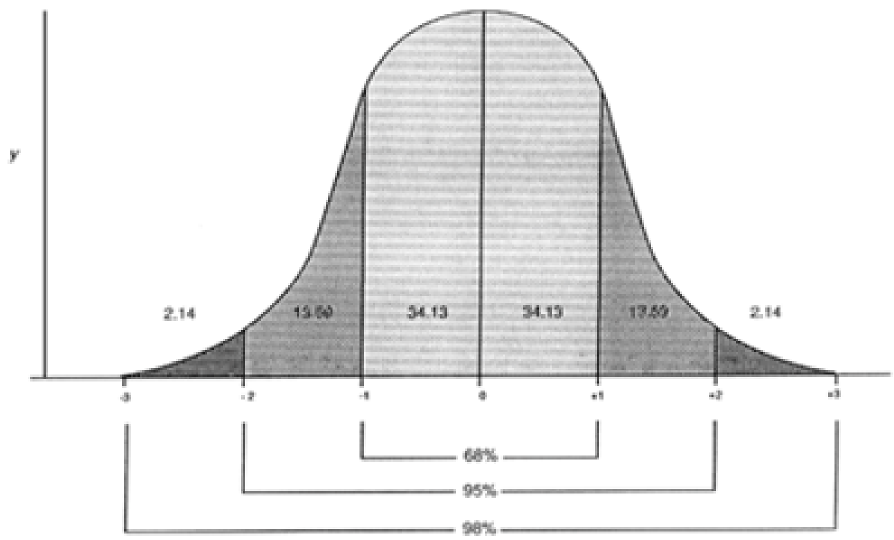


Figure 3. Normal Distribution

An organization can perform an analysis of its performance over the standard six sigma, through the use of measures and coefficients such as DPMO. This coefficient measures the total number of defects in a million units divided by total chance of defects (see ilustration 04).

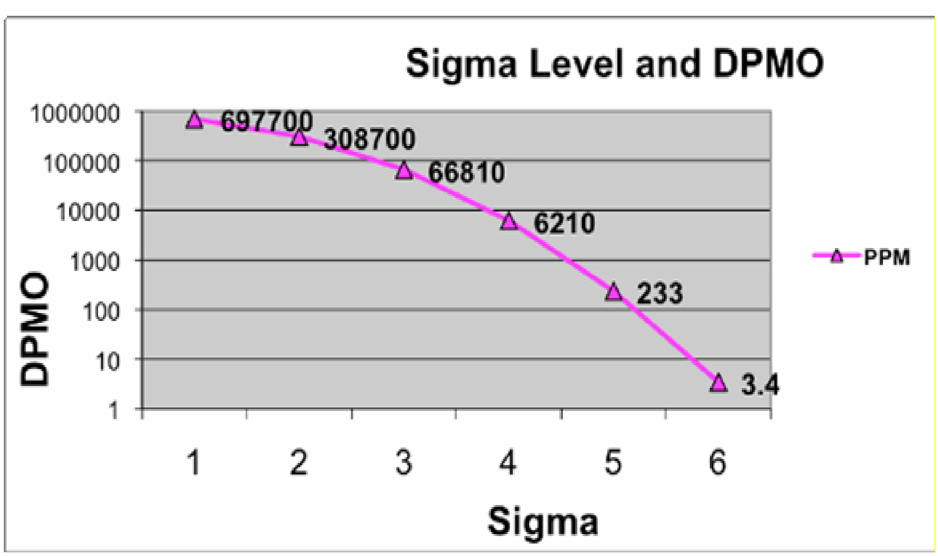


Figure 4. Six sigma level and DPMO

Lean Methodology

Brief History of the Origins of Lean - Toyota production system. Right after the end of World War II, Eiji Toyota and other managers went to United States in order to study and identifying best practices to support Toyota motor to improve its production system in order to overcome a crises. As argued by Liker (2004), instead of being dazzled by Ford's manufacturing process, they were surprised that the development of mass production techniques had not changed since 1930.

Between 1930 and 1945 the car consumers around the world started to desire variety of models as well as shorter model cycles (i.e. Ford Model T lasted 19 years). During that period of time, automakers responded to the need for many models with production systems whose design and fabrication steps regressed toward process areas with much longer throughput times (Lean Enterprise Institute, 2008)

The situation above was also pointed within the study of Womack et al (1990). Such study discussed that over time car manufacturers populated their fabrication shops with larger and larger machines that ran faster and faster, apparently lowering costs per process step, but continually increasing throughput times and inventories.

Eiji Toyoda and other managers also identified such scenario, thus, when they returned to Japan, Mr. Toyoda, the production genius Taiichi Ohno and Kiichiro Toyoda, came out with simply conclusion: the mass production would not work in Japan (Dennis, 2007).

Furthermore, Toyota concluded that by right-sizing machines for the actual volume needed, introducing self-monitoring machines to ensure quality, lining the machines up in process sequence, pioneering quick setups so each machine could make small volumes of many part numbers, and having each process step notify the previous step of its current needs for materials, it would be possible to obtain low cost, high variety, high quality, and very rapid throughput times to respond to changing customer desires (Institute, 2009).

As consequence of this conclusion, Taiichi Ohno developed the Toyota Production System (TPS). TPS is comprised of two pillars: (a) Just in Time (JIT) and (b) Jidoka and often is illustrated with the house shown below. The foundation on which these pillars rest is people and the critical role they play in eliminating waste from manufacturing and business processes.

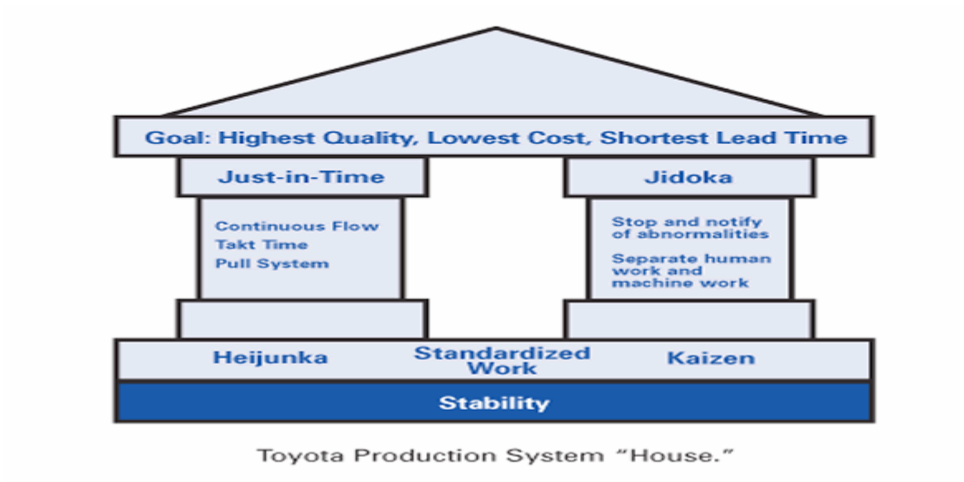


Figure 5. Toyota production system house. Adapted from Lean Enterprise Institute. (2008). Lean Lexicon a graphical glossary for lean thinking. Cambridge, MA, United State of America: Piste Design Inc.

JIT, the first TPS's pillar, is a system in which production and handling of products occur only when necessary. JIT can be defined by the right product at the right time and in the right quantities (Kyokai, 1986)

JIT system encompasses the concept of Pull System within which products are "pulled" downstream and requested only when needed. Such approach aims to avoid the accumulation of large stocks. This system also makes use of visual signals (usually called kanban) to control inventories of activities together with the flow of production. However, it is important to highlight that simply pull the system is not a goal, the motivation relies on synchronizing the supply chain with customer needs (Smalley, 2009).

Continuous flow is another important intrinsic element of the JIT System. The pursuit for achieve it consists of identifying the value chain activities and create steps and procedures, without associated waste.

Jidoka is the second pillar of TPS, which is aimed at producing quality by not allowing the mistakes made in a step to pass to the next step of the process. (Tapping, Luyster, & Shuker (2002) summarized the three main functions of Jidoka: (a) separate human work from machine work; (b) develop defect prevention devices and (c) apply Jidoka to assembly operations.

This system seeks to reduce significantly the production of defective products. In sum, Jidoka means the practical use of automation to mistake-proof the detection of defects and free up workers to perform multiple tasks within the work cell. It is important to highlight that Jidoka uses automation to produce flow.

Another important approach inherent to TPS is Kaizen. Such term derived from Japanese word that stands for continuous improvement. Kaizen improvement means a continual and gradual accumulation of small improvements made by all employees (Nikkan Kogyo Shinbun, Ltd, 1997)

Kaizen's main objectives are the creation of value and the elimination of waste. In the Kaizen approach all employees should constantly seek to find and apply new ways of doing the work and actively and repeatedly make progress in the process.

In short, thus, the main objectives of the methods, techniques and tools of the TPS presented above can be identified as follows: (a) provide customer value (b) implement continuous flow and (c) constantly improve performance (c) eliminate waste and deficiencies of the process.

Liker (2004), further discussed that TPS has 14 main principles as shown on the table 3.

Table 3

Toyota Production Principles

Main Concept	Principle
Long-Term Philosophy	1. Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals
The Right Process Will Produce the Right Results	2. Create a continuous process flow to bring problems to the surface
	3. Use "pull" systems to avoid overproduction
	4. Level out the workload
	5. Build a culture of stopping the production line to fix problems, to get quality right the first time
	6. Standardized tasks and processes are the foundation for continuous improvement and employee empowerment
	7. Use visual control so no problems are hidden.
	8. Use only reliable, thoroughly tested technology that serves your people and processes.
Add Value to the Organization by Developing Your People	9. Grow leaders who thoroughly understand the work, live the philosophy, and teach it to others.
	10. Develop exceptional people and teams who follow your company's philosophy.
	11. Respect your extended network of partners and suppliers by challenging them and helping them improve.
Continuously Solving Root Problems Drives Organizational Learning	12. Go and see for yourself to thoroughly understand the situation
	13. Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly
	14. Become a learning organization

	through relentless reflection and continuous improvement.

Note. From Liker, K. J. (2004). The Toyota Way. New York, NY, United State of America: McGraw-Hill.

Lean and Lean Thinking in a Service Perspective. Lean concept is derived from TPS. The term was defined originally by John Krafcik (cited in Dahlgaard;Dahlgaard, 2006), a researcher at International Motor Vehicle Program , from a five-year study at Massachusetts Institute of Technology on automotive industry world.

James Womack also deeply investigated Lean concept in two books. In the first one, called "The Machine That change the world" in 1990, Womack compares the Japanese production methods with Western methods of mass production using the results of Krafcik's study. The word lean was suggested due to the improved performance of Japanese industry, where resource utilization was much lower than in western industries, characterized by mass production.

In his the second book, published in 1996, Womack defined the term "Lean Thinking as "Banish waste and create wealth in your organization". Womack (1996) further compiles the lean principles as follows: (a) specify the value of the product, (b) identify the value chain of the product, (c) achieve continuous flow without interruptions, (d) allow the customer to "pull" the product, and (d) chasing perfection.

According to Womack & Jones (2003) Lean Thinking can be defined as a set of tools that make the company more competitive by eliminating activities that do not add value to their production processes. Thus, Lean Thinking is a powerfull antidote to muda (waste in english) and provides a way to make work more satisfying by providing immediate feedback on efforts to convert muda into value.

The main goal of lean is the complete elimination of losses to achieve competitive advantage (Womack, Jones, Roos, 1992). Womack and Jones (1994), suggests that even though the focus of the first studies of lean production were based on the auto industry, the same researchers who spread the key concepts of lean production also argued that such concepts can be equally applied to many type of industry as demonstrated on the table 4.

Table 4

Evolution of Lean Concept

Author	Year	Term	Concept
Krafcik , Womack, Jones and Roos	1990	Lean Manufacturing Lean Production	Reduction of waste to achieve competitive advantages (automotive).
Womack e Jones	1994	Lean Enterprise	Chain of activities that create value, generating a value stream.
Bowen e Youngdahl	1998	Lean Service	Lean principles aimed at the service area.
Womack	2005	Lean Consumption	Focus on customer service, without wasting time.
Womack	2008	Lean Management Lean Process	Lean leadership, seeking alignment of purpose, processes and people. Value correctly specified, so that the organization provides what the customer really wants.

Note. Lean Enterprise Institute. (2008). Lean Lexicon a graphical glossary for lean thinking. Cambridge, MA, United State of America: Piste Design Inc.

Value Added and Non-Value Added Concepts. Lean thinking must begin with a conscious attempt to precisely define value in terms of specific products and services. According to Womack and Jones (1998) value should be interpreted as the capacity offered to a customer at the right time, at a suitable price, as defined by the customer

Non-value added activities are those that do not add value to the customer. A study conducted by Lean Enterprise Institute (2008) demonstrated that in most production operations only 5% of activities performed add value, 35% are necessary activities but add no value and 60% of activities performed either add no value to the product or are also not necessary.

In Lean methodology, there are three types of activities that add no value to the process, which are defined by the following Japanese words: Muda (waste), Mura (inequality) and Muri (excess).

Muda is an activity that consumes resources and creates no value for the customer. In general, there are activities considered “Muda” that do not add value to the customer but are necessary for the company, those are also called business rules.

Mura is the waste caused by the variation in quality, cost or transportation process. Mura is the result of non-consistent activities that lead an organization to rework and delays.

Muri is the excess of resources available in conducting a process. Includes excess manpower, equipment and handling. This waste of resources as well as may be necessary to affect the operation of the process.

The seven major types of wastes in a production process are briefly highlighted in the illustration below. A detailed analysis of each cause of waste, its description, main cause and consideration of why it is considered waste can be found at Appendix A .

Figure 6 - Seven types of waste. Extracted from The Seven Wastes Beyond Lean (2006). Retrieved August 05, 2011, from Beyond Lean : ttp://www.beyondlean.com/7-wastes.html

Although it is possible to make a connection between the categories of wastes identified in lean production and those found in services, some type of wastes indicated above are less relevant in services. The terminology used in services can also be inconsistent with the terms of manufacturing sector. As a result of such differences, Maleyeff (2006) suggests seven categories of waste for services as follows: i) delay; ii) review iii) mistake; iv) movement v) duplication; vi) processing inefficiency ; vii) resource inefficiency

Application of Lean Concepts in Services. Bowen &Youngdahl (1998), stated that the service sector gain several benefits from techniques developed in manufacturing world. In fact, the concepts of lean production have expanded to various sectors, including services, considering that these concepts support the company to achieve quality goals, reduce costs and accomplish deadlines (Womack & Jones, 2005; Swank , 2003).

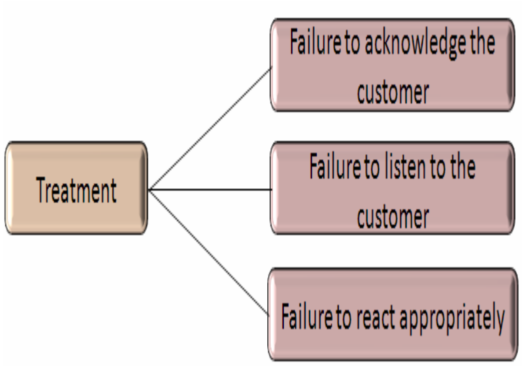
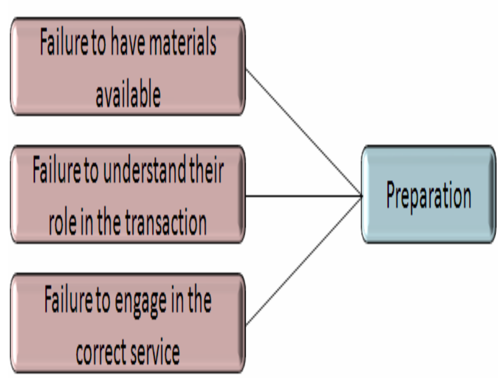
Nevertheless, the process of intervening in services settings in order to impose a system of quality assessment, through the implementation of inspection and testing, is not simple and common as in manufacturing environment.

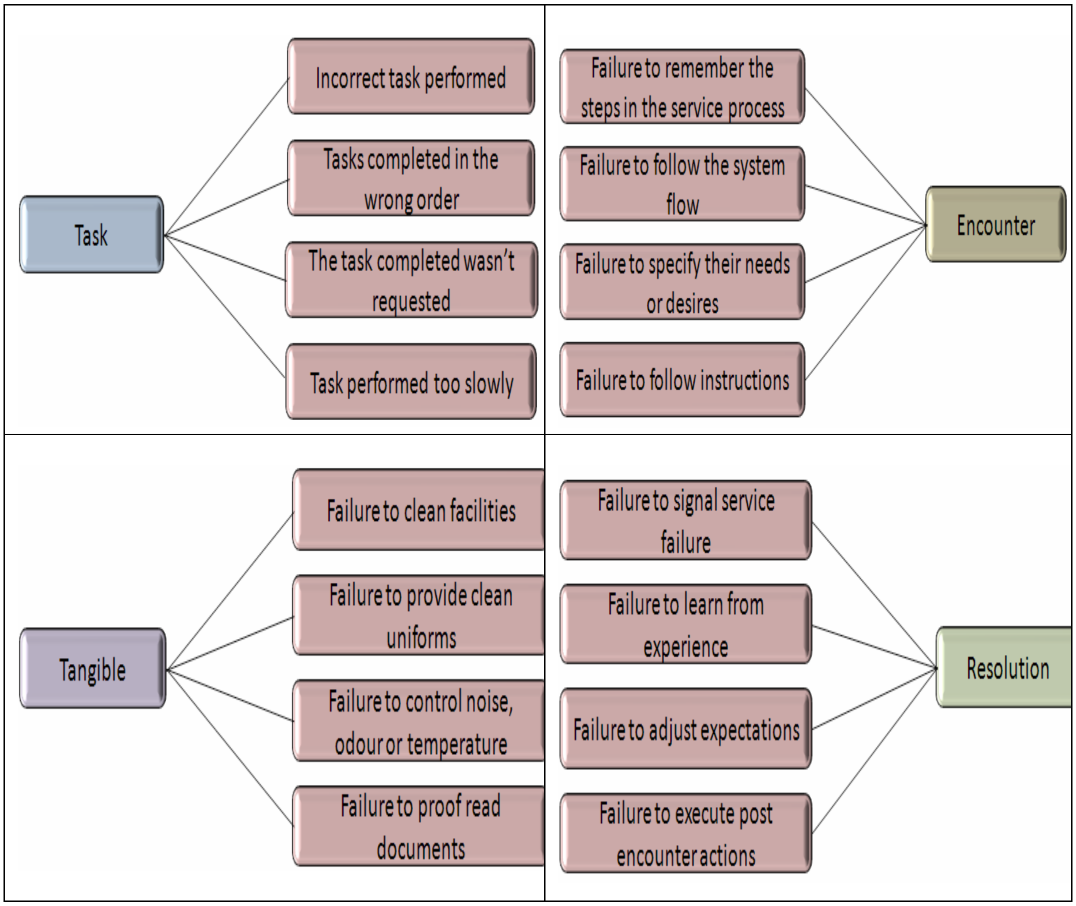
The definition of service quality has been the object of numerous research initiatives. There is agreement, among different scholars (Parasuraman, Zeithaml, and Berry 1985; Triantis and Medina-Borja 1996a; 1996b; Medina-Borja 2002), that service quality is based on customers' perceptions and expectations of both service characteristics and the provider of the service.

The pursuit for operational excellence is a common goal across all types of business. Nevertheless, whereas manufacturers primarily consider errors made by the manufacturing process, service providers need to protect against errors made by themselves and their customers. Service providers also face a different set of potential issues resulting as a result of their direct interfaces with customers as emphasized on table 5. All mistakes represented on the following table are samples of areas where lean concepts can be extremely useful if utilized in an efficient manner.

Table 5

Service Provider and Customer Errors

Service Providers Common Errors and Failures	**Customer Common Errors and Failures**
	



Note. Adapted from Turley, C. (2007). Poka Yoke in the service Sector. Retrieved July 25, 2011, from Lean QCD: http://leanqcd.com/2010/08/poka-yoke-in-the-service-sector/

The conceptual model of Spear and Bowen (1999) discussed four fundamentals principles of lean approach: (a) all work should be highly standardized in terms of content, sequence, timing and outputs; (b) all internal customer-supplier contact must be direct and unambiguous; (c) the flow of all goods and services should be simple and direct; and iv) improvements should be conducted in a structured and scientific manner.

Maleyeff (2006) identified several common structural features on the application of lean principles to services and suggests where improvement efforts should be focused: (a) importance of information, (b) significant variability of tasks

(c) processes flowing between departments or functions, (d) many transfers of information, (e) many technical and management reviews, (f) costs and hidden benefits; (g) no explicit motivation for urgency, (h) there is no single solution

"In a lean system, all activities should be standardized to the extent possible, without sacrificing flexibility, inherent characteristic of human beings" (Maleyeff, 2006).

Reason for Failures When Implementing Lean. It is important to emphasize that the concepts related to the implementation of Lean, whether in manufacturing or services, usually are easily understood. However, the biggest opposition to Lean is the natural resistance to change, because Lean involves a challenge to the status quo. (Alarcón, 2008)

Rubrich (2004) discussed the top ten reasons to failures in implementing lean as follows: (a) lack of top down management support; (b) lack of communication; (c) lack of middle management/ supervisor buy-in; (d) not understanding that it is about people; (e) lack of customer focus; (f) lack of improvement measurements; (g) lack of lean leadership; (h) people measures not aligned with company goals (i) using Kaizen events as the sole improvement mechanism; and (j) bonus pay system where the only measure is the company profitability.

Nevertheless as discussed by Weigan (2006) there are some ingredients that can mitigate the chance of failure when implementing lean philosophy such as: face lean journey as a long-term endeavor, implement a vision of continuous improvement, and make the cultural changes related to empowerment and support lean principles across the value chain.

Lean implementation also requires a cultural change. Kotter (1997) proposes a set of eight steps to be followed to successfully implement a change, which broadly contribute to the implementation of lean thinking: (a) establish a sense of urgency, (b) forming a strong coalition to lead change, (c) create Vision; (d) communicate the vision; (e) distribute power to achieve the Vision (f) generate small gains (g) consolidate improvements and (h) institutionalize the new behavior.

Define, Measure, Analyze, Improve and Control (DMAIC) Methodology

As highlighted by Eckes (2000), DMAIC methodology integration links key statistical tools and then measuring, analyzing, implementing and controlling the sequence of improvement processes. This integration makes Six Sigma an effective improvement methodology. However, to ensure the success of DMAIC integration, top corporate leaders commonly champion support for implementing DMAIC and engage all business process owners in Six Sigma project implementation.

According to (American Society for Quality), improvement teams use the DMAIC methodology to root out and eliminate the causes of defects. Basically, each stage has the following purpose: (a) define a problem or improvement opportunity; (b) measure process performance; (c) analyze the process to determine the root causes of poor performance; determine whether the process can be improved or should be redesigned; (d) improve the process by attacking root causes; and (e) control the improved process to hold the gains.

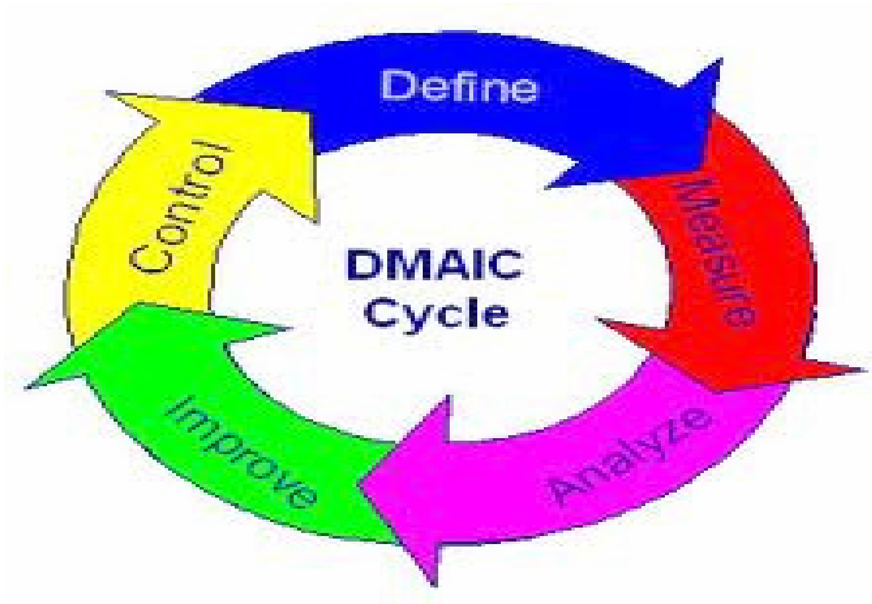


Figure 7. Define, Measure, Analyze, Improve and Control Cycle

DMAIC is aimed at applying different tools where variability is present causing the occurrence of defects in the product or service received by the customer. Table 06 highlights the objectives, activities and tools present within each phase.

Table 6

DMAIC and Its Objectives, Activities and Tools

Steps	Objectives	Activities	Tools
Define	Define the objective of the improvement activity by identifying the problem	i) Identify of the main processes ii) Define the outputs of the process and clients iii) Define customer requirements iv) Define the scope of the project v) mapping the process	i) CTQ ii) SIPOC iii) Voice of the customer
Measure	Collect data about the process	i) plan and execute measurements on the performance in regards to customers'	i) Data Collections Form ii) GEMBA ("walk the process") iii) Pareto Chart

		requirements ii) identify sources of defects and opportunities for improvement	
Analyze	i) Conversion of data into information indicating solutions ii) Identify and prioritize the root causes of the problem	i) Analyze data and process ii) Develop hypothesis about roots of the problem iii) Find solution focused on root causes	i) FMEA iv) Pareto Diagram v) Cause and Effect Diagram vi) Process Map
Improve	Execute actions to improve the process	i) Test and assess solutions ii) implement solutions iii) Standardize iv) Measure results	Brainstroming Pilot Test Plan of Actions
Control	Plan and execute actions to sustain the long term improvement	i) Define responsibilities ii) Implement actions aimed at maintaining the improvements	i) Control Charts ii) Statistical Control of the process

Define phase. As discussed by George et al (2005) the purpose of this phase is to have a team and its sponsor to reach an agreement on the scope, goals and financial and performance targets for the project.

Common tools utilized in this phase.

Critical to quality tree. During this phase, data is gathered, the characteristics critical to the quality (CTQ) and critical to processes (CTP) aspects related to customer, which are generating results below expectations, are identified. As suggested by Basu (2008) CTQ tree is a useful tool during the define stage of an improvement process.

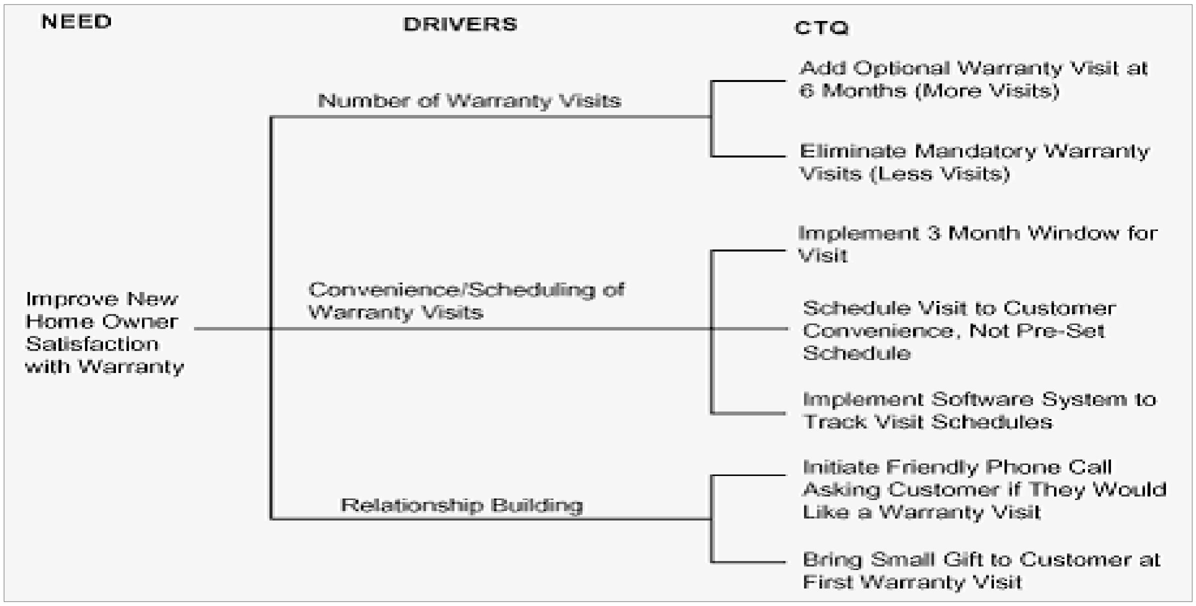


Figure 8. Critical-to Quality Tree. Adapted from US Army Office of Business Transformation. (n.d.). Lean Six Sigma. Retrieved July 07, 2011, from US Army Office of Business Transformation: http://www.armyobt.army.mil/cpi-kc-tools-lss.html

(Melton, Smith, & Yate, 2008) further discussed that such approach is based on Kano analysis, which usually plot critical features required by a customer when receiving a service or a product. It is also important to emphasize that the CTQ tree must also contribute to the visualization of what is critical to the market and what are the critical processes in order to focus and ensure that resources are well allocated.

SIPOC Process Map. Historically quality has been judged based on the output of a process and that quality also has been improved based on the analysis of inputs and process variables. In this sense the utilization of high-level process map, called SIPOC Process Map, which includes Suppliers, Inputs, Process, Output, and Customer, illustrated below, is another fundamental tool of the define phase.

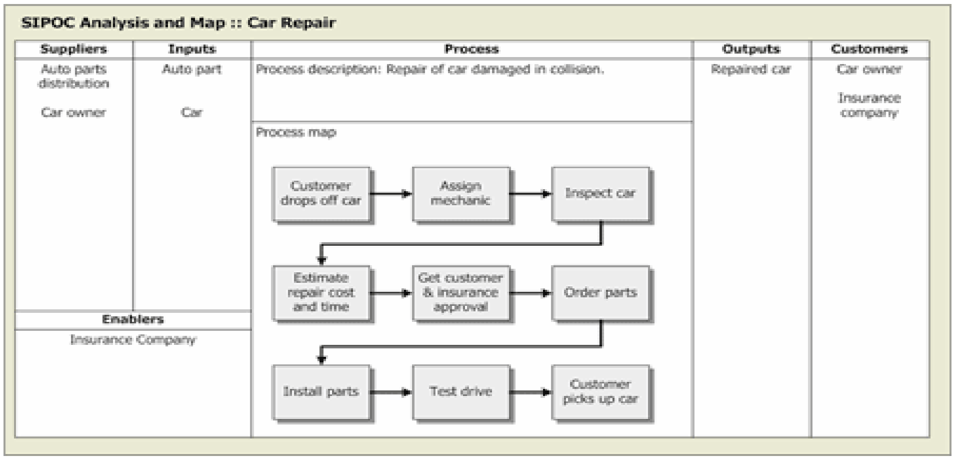


Figure 9. Supplier, Inputs, Process, Outputs and Customer Analysis. Adapted from US Army Office of Business Transformation. (n.d.). Lean Six Sigma. Retrieved July 07, 2011, from US Army Office of Business Transformation: http://www.armyobt.army.mil/cpi-kc-tools-lss.html

Voice of the customer analysis. Another important part of the define phase, as suggested by (Goldsby & Matichenko, 2005) is the clear definition of customer requirements. One tool widely used for this purpose is the Voice of the Customer Analysis , which is aimed at capturing the changing requirements from the customer to provide them with best-in-class service/product quality.

The Voice of the Customer can be captured in a variety of ways: direct discussion or interviews, surveys, focus groups, customer specifications, observation, warranty data, field reports, complaint logs, etc, as suggested by Breyfogle (2003).

The Voice of the Customer is an important to in the process of deciding what products and services to offer, identifying critical features and specifications for those products and services; deciding about where to focus improvement efforts; obtaining a baseline measures of customer satisfaction against which improvement will be measured; and identifying key drivers of customer satisfaction (US Army Office of Business Transformation).

Project charter. Finally, the project charter is also an essential tool commonly used during the define phase. In sum, such tool is a sort of contract between the team responsible for the improvement project and organization. In this document the following aspects are defined as follows: problem being analyzed, goals, team members, project timeline, project scope, and a clear statement of the intended improvement.

Measure phase. The differential of the Six Sigma quality program in relation to other quality programs is related to an emphasis on making decisions based on data. According to Eckes (2000), improve efficiency and effectiveness of the organization is the goal of any quality program. Consequently, this phase is based on measuring the current results and the results after the implementation of the improvements achieved, in terms of enhancements in efficiency and effectiveness of the processes, in order to verify whether the process was improved or not.

In this sense, measures of efficiency and effectiveness are identified during measurement. The efficiency is connected with time, cost or value of the activities that lead to customer satisfaction whereas the effectiveness is related to the capacity to reach or exceed the customer's expectations and needs.

Pande, Neuman, & Cavanagh (2000) analyze these measures by focusing on who gets the benefit of the process: the organization or client. Efficiency measures are related to the organization as it is related to the amount of resources consumed in production of products or provision of services, efficient processes are those that consume fewer resources whereas measures of effectiveness are directly related to the customer, in terms of the fulfillment of their needs and requirements by the organization.

Common tools utilized in this phase.

Data collection plan. The data collection plan is the most important tool for the effectiveness of the measurement phase. This plan defines the following issues: who, what, where, when, and how to measure.

When developing a data collection plan the following elements should be considered: (a) select what to measure, (b) develop operational definitions, (c) identify data source, (d) prepare collection and a sampling plan, (e) implement and refine measurement (Pande, Neuman, & Cavanagh, 2000)

Thus, when selecting what to measure, it is important to have a clear idea about what questions need to be answered and what data should be collected to support these answers. The development of operational definition means describing clearly all factors and things being measured, in way that if different people gather data, the same thing will be interpreted.

The identification of data source concerns the definition of where the data can be found. The preparation of the collection and sampling plan cover the following aspects: (a) who will gather or compile the data, (b) what forms and tools are needed to support them and (c) how many observations or item should be counted to generate an accurate measure.

Finally, in order to execute the measurement phase successfully aspects like: (a) how to train the data collector, (b) what issues can arise during the collection process" and (c) "how to perform test before actually starting to collect data" should be considered as part of the efforts towards implementing and refining the measurements Eckes (2000)..

Gemba walk. Gemba Walk is another important tool of the measurement phase. Gemba is roughly translated from the Japanese as the real place Mann (2005). In this sense, real refers to where the action is happening. In sum, such approach is aimed at assessing the process by actually observing it, in other words, Gemba walk means “go observe the process with your own eyes.”

In summary, when executing Gemba Walk the focus should be on identifying challenges, problems and issues related to that part of the process being observed (Protzman, Mayzell, & Kerpchar, 2011).

Analyze phase. Eckes (2000) argued that among the phases of the DMAIC methodology, the analyze phase is considered the most important considering that, generally, the identification of the root causes of the problem occurs in this phase.

Thus this stage is aimed at determining between different variables of one process, which contribute most to the results. For that, both the data and the process should be analyzed. As discussed previously, data analysis is related to measures of effectiveness, in other words, to customer satisfaction, whereas the review of the process is related to the efficiency measures such as cost and time.

***Common tools utilized in this phase*.**

Pareto chart. By using the data gathered during the measurement phase an analysis is executed to find the root causes of the problems. In this scope, Pareto Chart is a common tool utilized for this purpose. Vilfredo Pareto, a turn-of-the-century Italian economist, studied the distributions of wealth in different countries, concluding that a fairly consistent minority – about 20% – of people controlled the large majority – about 80% – of a society's wealth. (US Army Office of Business Transformation). This same distribution can also be observed in other areas and has been termed the Pareto effect.

As stated by Dow & Taylor (2008), Pareto chart has been used to support Project Managers to focus and resolve project issues in order of priority. Pareto analysis is a process for ranking causes, alternatives, or outcomes to help determine which should be pursued as high priority actions and opportunities for improvements (Florac & Carleton, 1999).

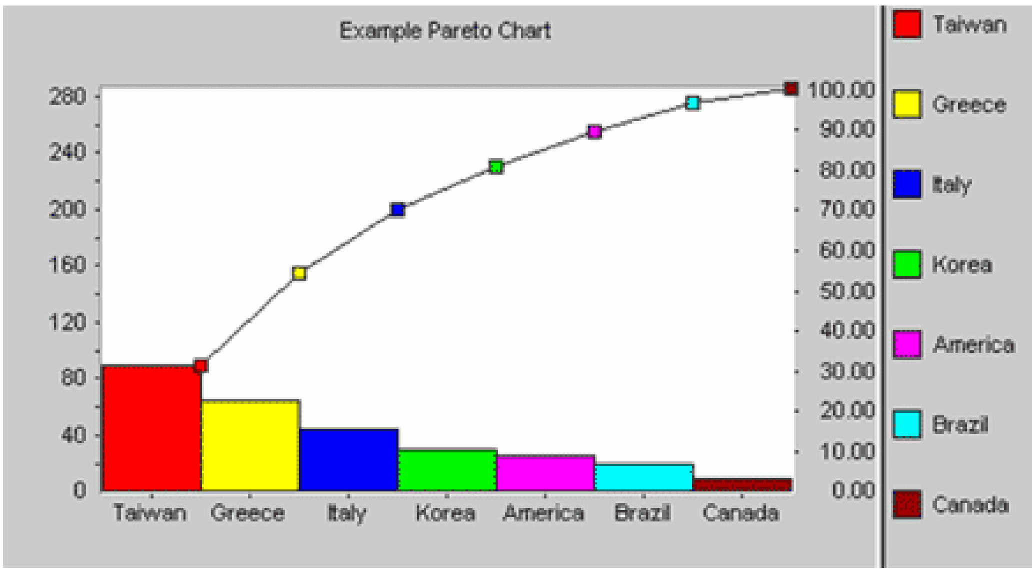


Figure 10. Pareto Chart

Value stream mapping. Another tool of the analyze phase is the Value Stream Mapping. This approach is a technique widely used in the last 20 years, to visualize the production process, correctly describe the operations performed and their associations of resources and time consumed. (Rivera and Chen, 2007).

According Abdulmalek and Jayant (2007), citing Rother and Shook, the main objective of value stream mapping is to identify all types of waste in the value chain and eliminate it. With this tool all actions that add and do not add value to the process or product can be identified by mapping each stage of the process. In sum, process mapping helps make work visible.

The diagrams that model the flow of the process need to be clear and precise, using for this purpose standardized icons and text boxes as follows:

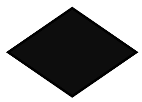
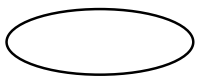
	**A box or rectangle to show the tasks or activities of the process.**
	**A diamond represents the stage in the process where a questions is asked or a decision is required.**
	**An oval shows the start of the process and the inputs requires and also show marks the end of the process with the results or outputs. The symbol is the same for the start and end of a process to emphasis interdependency.**
	**Arrows show the direction or flow of the process**

Figure 11. Process map icons. Adapted from Institute for Innovation and Improvement. (n.d.). Fundamentals for Quality Improvement.

According Abdulmalek and Jayant (2007), the first step in building a value stream mapping is to choose a product or product family that will be targeted for improvement. Then elaborate the value stream mapping by focusing on how the process is being run, analyzing the system and identifies its weaknesses.

The last step is to create value stream mapping of the future state, which should describe the system optimized the process and answer the problems related to efficiency.

During the execution of value stream mapping the SIPOC (high-level process map that includes Suppliers, Inputs, Process, Output, and Customers) is reviewed in details. The process maps in following illustrations are two of the most used framework to mapping a process (Damelio, 1996).

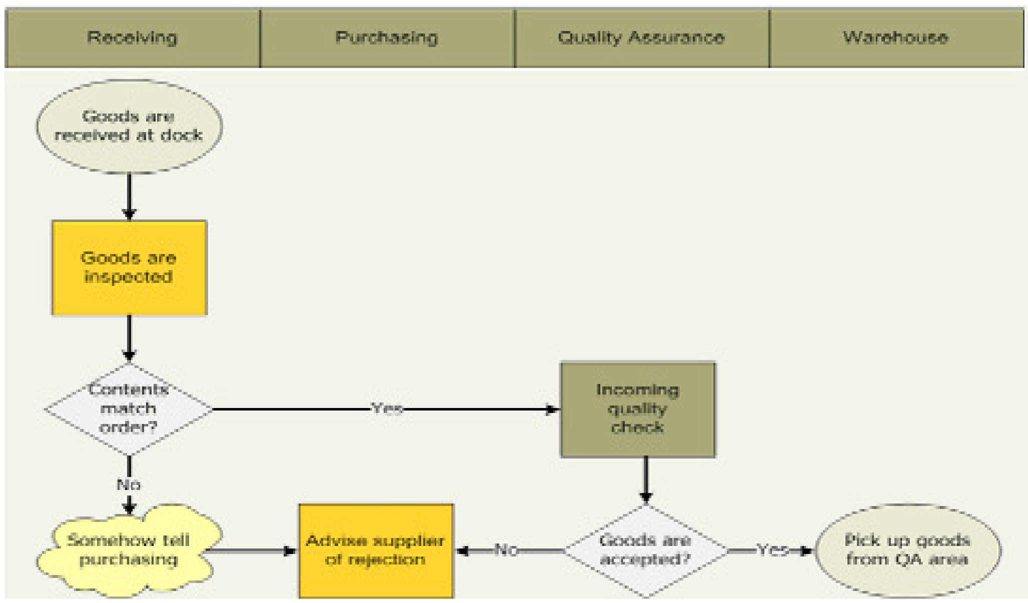


Figure 12. Swimlane or cross functional map. Adapted from US Army Office of Business Transformation. (n.d.). Lean Six Sigma. Retrieved July 07, 2011, from US Army Office of Business Transformation: http://www.armyobt.army.mil/cpi-kc-tools-lss.html

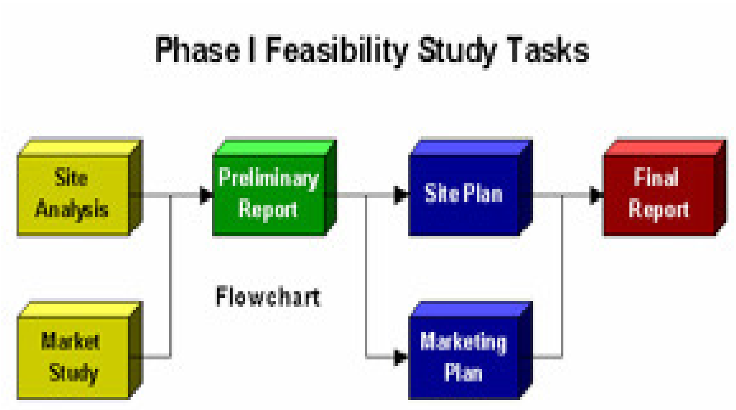


Figure 13. Flow chart map. Adapted from Quality Management & Training Limited . (n.d.). Process mapping introduction. Retrieved July 1, 2011, from Process mapping: http://www.process-mapping.co.uk/

Pande, Neuman, & Cavanagh (2000), discussed that through the use of process map tool the following issues can be analyzed: (a) bottlenecks (points of the process where the volume is greater than the capacity, which reduces the flow of work), (b) discontinuities; (c) points where parts and service are being returned in order to be repaired or corrected (loops), (d) redundancy (e) decisions and inspections that are creating potential delays.

Specifically within the service environment, according to Eckes (2000), there are three crucial aspects that must be taken into consideration when mapping and analyzing a service-type process: (a) moments of truth, (b) the nature of work and (c) the cycle time.

A moment of truth in the service process, for example, occurs when there is interaction between the client and service provider, because this point can be made a positive or negative image. Thus, positive moments of truth contribute to increased customer loyalty.

The identification of the nature of work is used to determine what steps of the process that add or not add value to the process. According to George et al (2005), to be considered a value-added an activity should meets three criteria: (a) the customer is willing to pay for that step of the process, (b) step transforms the product or service; and (c) the activity is performed correctly the first time. Besides the value and non-values added activities there are also some stages of process called business rules which are not targets for improvement.

Cycle time analysis. Another common tool of the analysis phase is the cycle time analysis. Cycle time represents the amount of time spent in each stage of the process until the final product or service is delivered. By calculating of the total amount of time spent to perform the process it is possible to analyze the workflow.

From the combined analysis of workflow and time spent in each stage, the most time consuming steps in the process can be identified, which enables the possibility to identify bottlenecks and constrains in order to eliminate it. Two types of indicators usually associated with cycle time analysis are as follows: (a) Process Cycle efficiency and (b) First Pass Yield.

George (2002) advocates the utilization of Process Cycle Efficiency indicator in order to analyze the proportion of value added activity in regards to the total lead time of the process, as exposed in the following formula: Process Cycle Efficiency (PCE) = Time spent performing Value-added activities / Total Lead Time. A PCE lower than 10% indicates that the process has several improvement opportunities.

According to George (2002), First Pass Yield means the percentage of “things-in-process” that make it all the way through the process first time without needing to be fixed or handled again in some way. Thus, the first pass yield is a excellent indicator of how well the process is functioning

Five whys. Five Whys analysis is a problem solving technique that seeks to identify the root cause of a problem fairly quickly (US Army Office of Business Transformation). Such approach became popular due to its broad application within the Toyota Production System (1970's). The utilization of this tool involves taking any problem and ask "Why - what caused this problem?"

According to Eckes (2000), the benefits originated from the application of the Five Whys are as follows**:** (a) it helps to quickly identify the root cause of a problem, (b) it helps determine the relationship between different root causes of a problem and (c) It can be learned quickly and does not require statistical analysis to be used.

Cause and effect (C&E) diagram. As discussed so far, the collection of ideas is a effective mean to explain the root causes of the problem. In this context, the Cause and Effect Diagram (also called Ishikawa or fishbone chart graph) is extremely useful tool to identify the many possible causes for an effect or problem.

In general, the ideas are sorted into useful four categories: (a) Manpower, (b) methods, (c) materials, and (d) machinery recommended for manufacturing environment. When applying the Cause and Effect Diagram to analyze a problem originated in a service process the following categories are recommended: (a) Equipment, (b) policies, (c) procedures, and (d) people, as illustrated below:

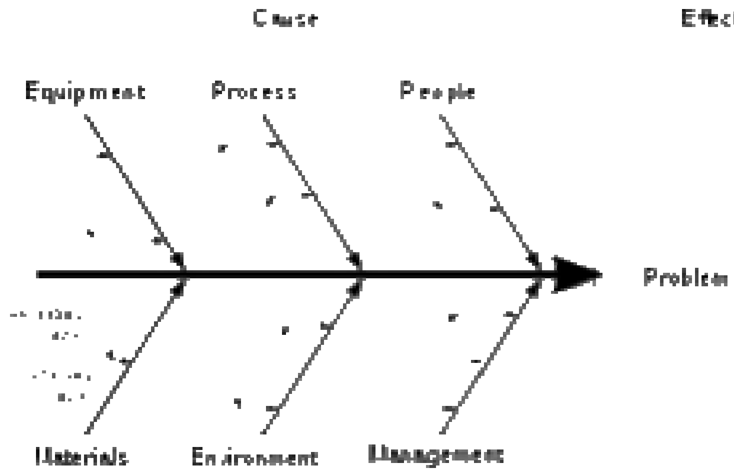


Figure 14. Cause and effect diagram

Failure mode and effect analysis (FMEA). The utilization of FMEA involves the application of procedures and tools that help to identify every possible failure mode of a process or product and determine its effect on other sub-items and on the required function of the product or process. The FMEA is also used to rank and prioritize the possible causes of failure as well as develop and implement preventive actions, with responsible persons assigned to carry out these actions (Eckes, 2000).

According to Tague (2004), FMEA should be applied in the following circumstances: i) when a process, product or service is being designed or redesigned, after quality function deployment ii) when an existing process, product or service is being applied in a new way, iii) before developing control plans for a new or modified process, iv) when improvement goals are planned for an existing process, product or service v) when analyzing failures of an existing process, product or service, vi) Periodically throughout the life of the process, product or service. In following the illustration a sample of FMEA form is presented:

Function	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential Cause(s) of Failure	O	Current Process Controls	D	RPN	CRIT	Recommended Action(s)	Responsibility and Target Completion Date	Action Results					
												Action Taken	S	O	D	RPN	CRIT
Dispense amount of cash requested by customer	Does not dispense cash	Customer very dissatisfied Incorrect entry to demand deposit system Discrepancy in cash balancing	8	Out of cash	5	Internal low-cash alert	5	200	40								
				Machine jams	3	Internal jam alert	10	240	24								
				Power failure during transaction	2	None	10	160	16								
	Dispenses too much cash	Bank loses money Discrepancy in cash balancing	6	Bills stuck together	2	Loading procedure (riffle ends of stack)	7	84	12								
				Denominations in wrong trays	3	Two-person visual verification	4	72	18								
	Takes too long to dispense cash	Customer somewhat annoyed	3	Heavy computer network traffic	7	None	10	210	21								
				Power interruption during transaction	2	None	10	60	6								

Figure 15. Part of it—the function “dispense cash” and a few of the failure modes for that function (A bank performed a process FMEA on their ATM system.)

Improve phase. The purpose of the improvement phase is to select and implement solutions focused on root causes validated in the previous phase (Eckes, 2000). These solutions must be able to impact the cause of the problem by eliminating or minimizing its effects. Thus, in sum, at this stage the team should generate many ideas on how to address the root cause of the problem.

Pande, Neuman, & Cavanagh (2000), discussed that during this phase ideas must be refined in order to become feasible approaches that can be implemented in the process as a way of solving the problems being faced.

The proposed solutions should lead to good control of the process, which entails take into account the reduction in variation of results and the centralization of the average of the results between the specification limits, as illustrated below.

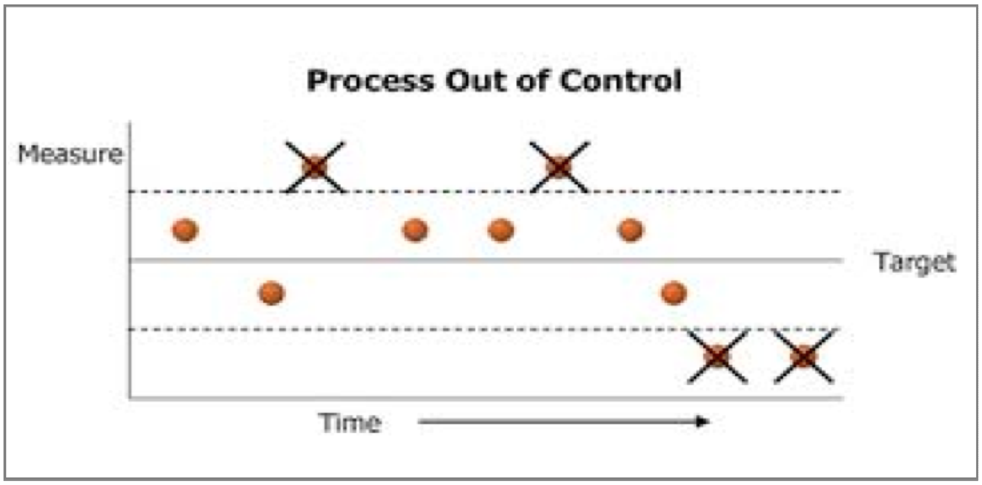


Figure 16. Process control limits

The points located out of the specification limits above are considered out of control results. Thus, the improvement should be based on eliminating the causes that are leading the process to these circumstances. Nevertheless, before implementing any improvements, as suggested by Pande, Neuman, & Cavanagh (2000), the following criteria should be considered for choosing the most appropriate solution: probability of achieving the goal of the process, benefits for the organization, costs of implementing, operating cost and ease of implementation.

Besides taking into consideration the criteria above, before implementing the possible solutions a pilot test should be undertaken in view of the high likelihood of unforeseen problems occur. In this sense, the pilot test aims to try the solution on a small scale to determine whether these will lead to expected improvement, allowing correct or modify the proposed project.

Common tools utilized in this phase. 5S method and Setup Reduction are two of the several tools that have been used to implement solution with success by different organizations.

5S method. The 5S is a technique defined by five Japanese words that describe the activities necessary to create a more efficient workspace as follows: Seiri, Seiton, Seiso, Seiketsu, Shitsuke. Sowards (2003) presented the intent of such words in a manufacturing field:

1. Seiri - The tools not needed must be segregated (sorting)
2. Seiton - The tools must be available at a fixed location (setting in order).
3. Seiso - The space should be clean and tidy. The tools after use should be placed at the place of storage (shining).
4. Seiketsu - The production system must be planned and standardized, regularly repeating the above in order to improve continuously (standardizing work tasks).
5. Shitsuke - The habit of following the first four must be created (sustaining the improvements).

Martin (2009) studied how the 5S methodology can be applied in services and the main finding are exposed on table 7.

Table 7.

The Application of 5S in Services

5S Category	Service Application
Sorting	Maintain clear work areas and eliminate materials or information that is not needed to do the work. Example: dump old files.
Set in order	Place all tools, equipment, and information within easy access of the worker.
Shine	Maintain work areas clean in way that any abnormal condition can be easily seen.
Standardize	Ensure work tasks are performed in a standardized manner using checklists, procedures, and instructions. If the work is complicated, then separate operations that can be standardized (back office) and ensure the customized operations are tightly controlled.
Sustain	Use control plans and deploy continuous improvement teams.

Note. Adapted from Martin, J. W. (2009). Lean Six Sigma for the Office. Boca Raton , Florida, United Stated of America: CRC Press.

In summary, according to Sowards (2003), the 5S's technique leads to reduction of waste (time and materials) present in all operations, increase productivity of operations and committed workers in continuous improvement.

Setup reduction. Setup reduction is the process of reducing changeover time (i.e., from the last good piece of the previous run to the first good piece of the next run). Since setup activities add no marketable form, fit, or function to the product, they are by definition non-value added activities (US Army Office of Business Transformation)

(Martin, 2009) suggested several tasks aimed at minimizing the Setup time, this approach is called reduced setup time (SMED) and is listed in Appendix B. In sum, the goal of the tasks suggested consist of eliminating anything that interrupts or hinders productivity.

Control phase. The last phase of the DMAIC methodology is called control. At this stage of application of the methodology activities are implemented aimed at ensuring the maintenance of improvements achieved in the process. As argued by Breyfogle (2003), the project success at one point does not necessarily means that the changes will stick after the project leader moves on to another project.

In other words the Control phase is designed to ensure that the problem does not reoccur and that the new processes can be further improved over time" (US Army Office of Business Transformation).

(Brue & Howes, 2006) suggested that the objective of the control phase is establish the required action plan that reflects the findings from the improve phase and to drive control to sustain the improved performance overtime though the application of the following tools.

Common Tools utilized in this phase.

Control plan. One of the most important tools in this phase is the Control Plan. The use of such tool is one of the important aspects that differentiate Six Sigma from other quality tools. According to (Brue & Howes, 2006) this plan should include: (a) training plan; (b) documentation plan; (c) monitoring plan; (d) Response plan; (e) institutionalization plan, to align system and structure.

(Martin, 2009), illustrated the the control plan should entails the following aspects: (a) system characteristics of key process input variables (KPIVs) and key process output variables (KPOVs) including its definitions, target, performance level, and measurement systems, (b) specification of tolarances on KPIV's and KPOV's, (c) specification of measurement of KIPVs and KPOVs, (d) specification of controls on KPIVs and KPOVs, (e) specification of reactions plans to out-of-control conditions, and (f) description of who is responsible for each corrective action.

Martin (2009) presented important control tools that can be used in combination to ensure process performance is sustained over time such as: training, updating procedures, audits, statistical process control, measurement system improvements, failure mode and effects analysis (FMEA), 5S (simplification and standardization), mistake proofing, and Process modification and redesign

Statistical process control (SPC). Doty (2006) highlighted that even though the SPC has its first application as a mean of controlling production in a manufacturing plant, its principle has been widely extended into all areas of service-type industry. The SPC is used to monitor the process and keep it with an adequate and predictable performance, avoiding the chances of losing the improvements obtained in the previous phase.

Control charts have a centerline, an upper control limit (UCL) and a lower control limit (LCL). The middle line represents the average value of the process under statistical control. The control limits are usually set at three standard deviations from the mean value.

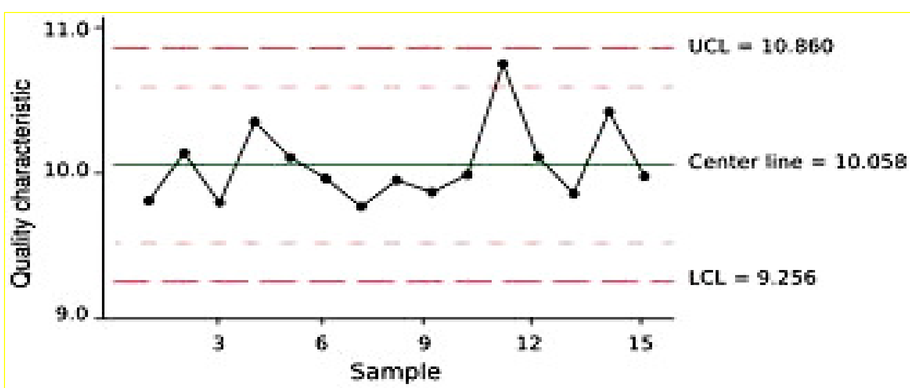


Figure 17. Statistical process control

Martin (2009) argued that control charts are used to monitor the performance of key process variable to identify nonrandom patterns that may indicate loss of process control. The main control chart concepts are summarized within table 8.

Table 8

Ten Control Chart Concepts

1. The variation of the stable process contains random or common cause variation
2. Common cause variation is due to many sources, it is stable, sampling can be applied to a process having common cause variation, and it is difficult to eliminate from a process.
3. Special or assignable cause variation is due to one of few sources, it is not stable, sampling cannot be used to monitor process performance, and it may be easy to eliminate it from a process.
4. Control charts differentiate special from common cause variation.
5. Statistical evaluations of process performance can be made for a stable process
6. It enables the identification and elimination of special cause variation
7. A process will operate with less variability if it is in a state of statistical control
8. Control Charts promote less frequent process adjustments
9. A process variable must exhibit both statistical control and meet customer requirements
10. Specialized control charts are used to monitor specifics conditions such as metric performance over short periods of time, when small samples are used to collect process data, and when small changes must be detected within a process.

Note. Adapted from Martin, J. W. (2009). Lean Six Sigma for the Office. Boca Raton , Florida, UnitedStated of America: CRC Press.

DMAIC failures mode and countermeasures. Even though DMAIC is a powerful framework for process improvement, there are several case of failures in carrying out such methodology. The illustration below summarize some of the reasons that have led companies to such situation presented in study of Nilakantasrinivasan (2005):

Table 9

DMAIC Failure Mode and Countermeasures

Failure Mode	**Countermeasure**
Pseudo problems spotted in process with high detectability.	Use quality control story approach of total quality management for small problems.
	Trim off analyze in DMAIC and use DMIC to solve pseudo problems.
	Strategically focus on lean techniques before starting a serious Six Sigma program.
Pseudo problems due to absence of business process management system (BPMS).	Champions and Master Black Belts (MBBs) focus on creating BPMS as a first step in Six Sigma deployment.
Lack of control in completed DMAIC projects.	MBBs conduct audits on completed projects.
Acute focus on cost reduction.	Champions and MBBs include the suggested three questions in the project selection approach.
Inappropriate use of DMAIC.	MBBs check for inappropriate usage of DMAIC in project selection and other tollgates
	Globally standardized Six Sigma program.

Note. Adapted from Nilakantasrinivasan, N. (2005, May). DMAIC Failure Modes. Six Sigma Forum Magazine, pp. 30-34.

Overview of the application of LSS in the DoD

The DoD has a very complex structure that moves an average of $ 500 billion and employs approximately 5 million people in different geographic regions of the globe. If it were a country, the DoD would be the sixteenth Gross Domestic Product and its population would be greater than 43% of countries around the globe.

Thus, due to the challenges posed by its magnitude, and the constant pressure imposed by budget cuts, the DoD is seeking constantly to increase efficiency and effectiveness of its activities. Nowadays, the Program Continuous Improvement

Process (Continuous Process Improvement - CPI) is configured as the foundation of all activities aimed at improving the management culture, processes and performance.

This initiative was started in the Navy and the Marines Corps when the then Secretary of the Navy, Mr. Donald C. Winter, published a memorandum entitled "Transformation Through Six Sigma" on May 3, 2006, as contained in Appendix C.

The above memo emphasizes that Lean Six Sigma is a method of improving management that combines the proven success Lean methodologies (eliminating activities that do not produce value and optimization of the "cycle time") and Six Sigma (reducing variation of results and creation of efficient and effective process).

On April 30, 2007, the then Deputy Secretary of Defense Gordon England issued a new memo, contained in Appendix D, in which were established the following policies for all U.S. Armed Forces:

1. Creation of a Central Department in each of the Armed Forces, in order to conduct the program "Continuous Process Improvement (CPI)", in conjunction with the "Department of Defense Lean Six Sigma Program Office." These departments must report every 30 (thirty) days the progress and results achieved within the Forces;
2. It is noteworthy that the mission of "Department of Defense Lean Six Sigma Program Office" is to accelerate the process of change and increase the performance of the U.S. military. This unit is characterized as the main agent responsible for monitoring and controlling of the disciplined application of LSS methodology among the various organizations of the Navy, Air Force, Army, Marines and Coast Guard.
3. Briefly, this Department seeks to foster the creation of an organizational culture focused on process improvement at all levels, the elimination of waste

in the administration of public resources and, finally, continuous improvement in all activities that affect the warfighters

4. Create a training schedule of 12-18 months duration in order to train Black Belts and Green Belts. Currently, 1% of the workforce of each force should have the Six Sigma Black Belt qualification and 5% Six Sigma Green Belt.
5. Inclusion of the CPI Program as part of the performance objectives of the work force.

On May 15, 2008, approximately one year after the release of normative discussed above, the Memorandum 5010.42 was published, as constant in Appendix E. Such document contains the major policies of the CPI program. Among other things, this document discusses general guidelines for the Program, and the main actions to be taken aimed at institutionalizing the CPI Program as the main initiative for assessing and improving the efficiency and effectiveness of the processes within the DoD.

The memorandum above also emphasizes that the overall goal of the program is based on strengthening the operational power and combat capability of the Joint Forces Command and the Military, by promoting improvement in the following aspects: (a) productivity, (b) performance vs. Mission (availability, reliability, processing time, investment and operational costs), (c) security, (d) flexibility to meet the needs related to the mission of the Department of Defense, and (e) energy efficiency.

It is important to note that on July 17, 2009, the DoD released the Instruction Number 5010.43, the main aspects of such instruction is listed in Appendix F. In sum, this Instruction establishes policy, assigns responsibilities, and provides guidance for the DoD-wide implementation of the CPI/LSS program.

Methodology

Methodology Procedures

Etymologically, methodology can be defined as the study of methods or the study of paths used to carry out a scientific research. In turn, the method represents a rational and orderly procedure consisting of basic elements, which implies the use of reflection and experimentation to achieve the goals established during the research planning (Kumar, 2008)

According to Wilson (1990), the scientific method is a planned path to be followed in scientific research, that is, a set of systematic and rational procedures that enable the researcher to achieve a particular goal.

The purpose of research is to find answers to some questions by applying scientific methods that are developed for intensifying the likelihood of the information obtained be useful and reliable to answer the questions under analysis. Although research does not always result in unbiased information, scientific methods are more likely to succeed than any other known system (Sekaran & Bougie, 2010)

The methodology procedures of this study can be divided into two different parts. The first one called research contextualization is focused on defining the type of research suited to the situation under study, whereas, the second part presents the steps of the process.

Research contextualization. The research design communicates the intention of the researcher. In a study by Thomos Kinner (cited in Kumar, 2008) research design is defined as the basic plan which guides the data collection and analyse the phase of the project. It is required when you do not have enough information to answer the problem, or when the information is in such disarray that it can not be adequately related to the problem.

The type of research conducted in this dissertation was, in its essence, exploratory and descriptive considering that the present project is, respectively, aimed at researching and analyzing the improvement opportunity through application of LSS methodology based on DMAIC project methodology at Purchase Card Process over at FISCSD.

As suggested by Stebbins (2001), an exploratory research aims to provide greater familiarity with the situation being studied in order to make it more clear and evident. Its main objective is to provide understanding of the problem being faced.

As discussed by Kothari (2006), when analyzing a problem the following aspects must be considered: (a) whether the analyzes of the problem will bring new knowledge, (b) feasibility of addressing the problem through a research and (c) the adequacy of problem with the current stage of the development of the scientific field being analyzed (in other words its relevance).

Furthermore, an exploratory study is used in cases where it is necessary to define the problem under study more accurately, identify relevant courses of action or additional data before applying an approach to address the problem (Stebbins, 2001)

Thus, this type of research is used in areas where the knowledge is not completely accumulated and systematized. Due to its exploratory nature such approach does not support hypotheses or propositions, however, it may arise during or at the end of the study.

Kumar (2008), further demonstrate that the application of exploratory research is recommended in cases where the knowledge of the subject is reduced, as is the case of this research project in regards to the application of LSS theory, through the application of DMAIC methodology, upon service processes or specifically upon the FISCSD Purchase Card Program**.**

The second type of research used was descriptive. As presented by Canzer (2006), such type of research focuses on helping to shed the descriptive light on some are of interest. The primary objective of descriptive research is a description of the characteristics of a given population or phenomenon and then establishment of the relationship between variables.

In the descriptive research the researcher has to work with specific research problem, proposition or hypothesis (Piekkari & Welch, 2004). The descriptive study seeks to discover the caracteríticas of a phenomenon. In this sense, can be considered as an object of study an individual, group, or a specific situation.

(Thomas, Nelson, & Silverman, 2011) discussed that several techniques can be applied in descriptive research as follows: surveys, case study, job analysis and observational research. In sum, the descriptive research, observe, analyzes and correlates events and variables, without manipulating them, seeking to discover the nature and characteristics of the situation being researched.

Due to the objectives of diagnosing and evaluating opportunities for improvement in the Purchase Card Program at FISCSD as well as identifying the potential benefits that can obtained through the application of LSS concepts and DMAIC methodology, the execution of descriptive research is essential to accomplish the objectives of this dissertation.

Steps of the process. The design of the present research will be developed as a field research, in a two-step approach, due to the characteristics of the technical procedures to be applied. As advocated by Babbie (2010), field research is one type of observational method that can be used to collect both qualitative and quantitative data.

According to Burgess (1996), when executing a field research the facts are observed where they spontaneously occur, which allows the visualization of details and the identification of variables (dependent and independent) of a process, phenomenon, behavior, etc

The first step performed in all field researches, is the literature review about the subject under study. The literature review presented previously in this project was aimed at studying LSS concepts as well as the DMAIC methodology in order to identify the most appropriated tools, procedures and techniques to be applied within the service environment.

Eckes (2000) emphasizes that there are a variety of tools that can be useful, but the excessive use of tools with the same characteristic and similar results in order to avoid duplication of efforts. In sum, the application of DMAIC methodology should be adjusted to the circumstances in way that its utilization remain comprehensible and lead to useful conclusions. Thus, the choice among the various tools of DMAIC methodology applied upon the Purchase Card Program was based on objectives to be achieved.

The second step of the work concerns the development of an improvement project at the Purchase Card Program and the presentation of the results obtained from the application of LSS theories and DMAIC methodology.

Table 10

Steps of the Process

Steps of the Process	Components	Results
Step 1	i) Literature Review ii) Application of LSS Theory and DMAIC Methodology	Analysis of Lean Six Sigma Concepts and DMAIC methodology and its tools within the service context
Step 2 -	Development of an improvement project	Assessment of the results of the application of DMAIC methodology in the Purchase Card Program

The two steps outlined above are detailed below:

Step 1 – exploratory research. This step of the study has the characteristics of a descriptive research, because it aimed at acquiring a better comprehension of Lean Six Sigma Concepts and the DMAIC methodology as well as its application on the Purchase Card Program.

In order to achieve the first specific goal, which is to study and apply theories and Lean Six Sigma DMAIC methodology, a literature review of books, articles, dissertations and other scientific publications were performed.

The literature review seeks to know and analyze the cultural and scientific contributions of the past works on a particular problem, issue or theme. In sum, the literature review provides an analytical tool for any other type of research and can be performed based on the consultation of material published in books, journals, articles, magazines, Internet, etc.

The second specific objective of the research was achieved based on the observation of processes of the Purchase Card Program and the review of the literature on theories and Lean Six Sigma, and the consequent verification of tools that could be used in the context of a Purchase Card Process. As suggested by Eckes (2000), the use of the LSS methodology approaches and DMAIC tools should be appropriate to the context of the application.

Step 2: descriptive research. This step of the research has a descriptive element, because it should describe the characteristics of the application of LSS the theories and DMAIC methodology on FISCSD Purchase Card Process.

To achieve the third specific goal of the research, a study was conducted to develop an improvement project in the Purchase Card Program, using the procedures and tools of DMAIC as well as LSS concepts, that resulted in proposals for actions to solve problems and improve performance (which was the last specific objective of this project).

The results of applying the theoretical model in the Purchase Card Program FISCSD resulted in the improvement process. Therefore, improvement project planning was conducted together with the application of the theoretical model.

The application of LSS Concepts and DMAIC methodology in and its tools in Purchase Process and the development of an improvement plan occurred simultaneously, considering that the results of the application led to the improvement actions. In sum, the combined application mentioned above was undertaken through the execution of the following steps:

1. Literature review on LSS, including its application within the Department of Defense and the literature review of the DMAIC methodology and its main tools applicable in this project.

2. Creation of a team formed by employees of the Purchase Card Program Division and some stakeholders who assisted in the identification of opportunities for improvement.

3. Definition of the data collection plan.

4. Execution of the process analysis and data analysis using the data collect during the field research.

5. Definition of the improvement opportunities.

6. Formulation of improvement Plan.

7. Execution of a Pilot Test

In order to contribute to a better understanding of the methodology, the structure of the process is illustrated as follows:

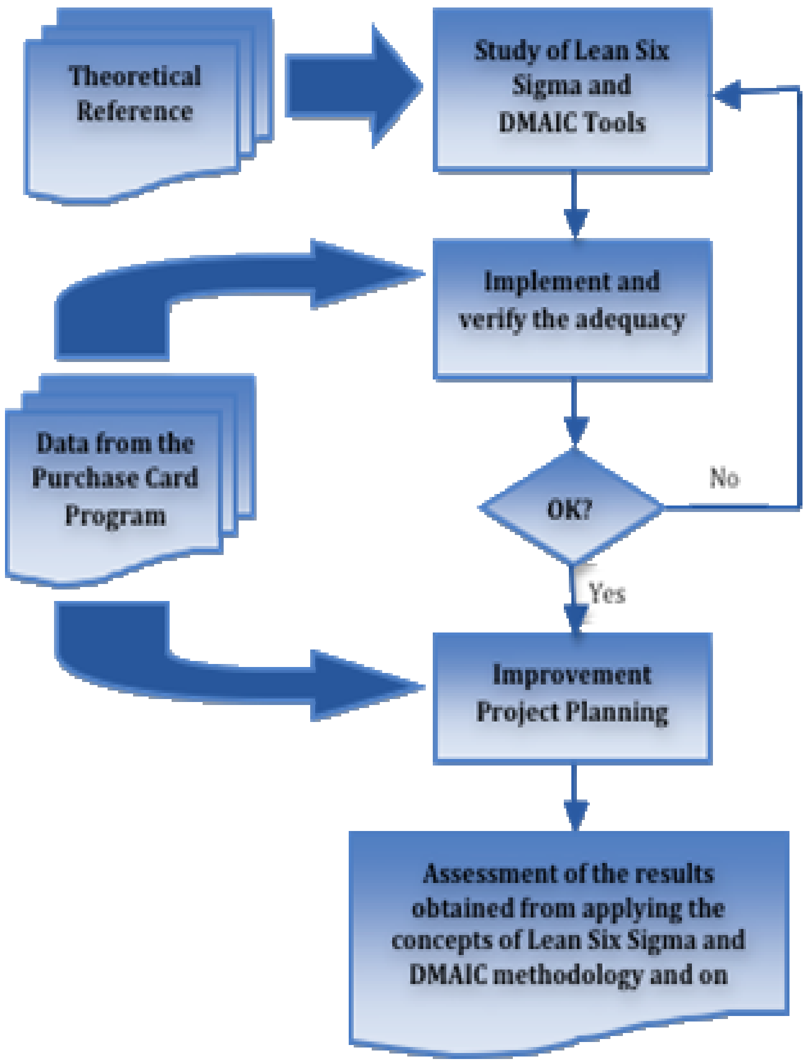


Figure 18. Flow chart of the development o the process

Considering that all LSS projects should be executed in teams of people working together Brusse (2006). Such team should be composed of people from all areas impacted by the project. In this sense, all activities aimed at collecting, analyzing, diagnosing and improving the Purchase Process were performed by the following key players stated in the Table 11.

Table 11

Improvement Team Composition

Function	Name
FISCSD CPI Deployment Champion	Colleen Curtiss
Green Belt (facilitator)	Thiago Lima
Project Sponsor	Ann Braeutigan
Team Leader	Paula Hoff (Purchase Division Supervisor)
Team Member	Rich Harvey (Approving Official)
Team Member	Carlo Aban (Card Holder)
Team Member	Debra Sutherland (Card Holder)

Data collection procedures

The scope of the present research project entails the Purchase Card Process from the point that the Card Holder receives the purchase request to the time that the Approving Official completes the monthly reconciliation. All transaction necessary to execute the purchase are supposed to be processed through the System called Navy ERP, which started to be used on the beginning of 2009.

The data collection was conducted between 07/01/2011 and 08/05/2011, considering that the scope of the process was intended to analyze the purchase process including the monthly reconciliation, within which all documentation and transaction are revised by the approving Official in order approve and validate the transactions prior to submit it for payment by the Comptroller.

The following data collection techniques were used: Gemba Walk, Data Collection Form, meetings and brainstorming.

Data analysis procedures

As further detailed in Table 12, in order to analyze the data collected and the process were used: (a) Pareto Diagram; (b) Cause and Effect Diagram, (c) Value Stream Analysis; (d) SIPOC, (e) CTQ Tree; (f) Process Cycle Efficiency and (g) First Pass Yield.

Table 12

Tools Applied to Analyze Data and the Purchase Process

Tool	Objective	Methods of Data Collection
Pareto Diagram	Identify the main reasons of poor performance	Gemba Walk associated with Data Collection Form
Cause and Effect Diagram	Identify the reasons related to the problems	Gemba Walk associated with Data Collection Form
Value Stream Analysis	Identify the non-value added activity and build an optimized value added map	Meeting Gemba Walk
SIPOC	Visualize the high-level process map	Brainstorming Meeting Gemba Walk
CTQ Tree	Plot critical features required by a customer when receiving a service or a product	Brainstorming Meeting Gemba Walk
Process Cycle Efficiency	Analyze the proportion of value added activity in regards to the total lead time of the process	Data Collection Form Observation of the Process
First Pass Yield	Visualize how well the process is functioning in terms of continuous flow	Data Collection Form Observation of the Process
Control Chart	Monitor the process	Data Collection Form Observation of the Process

Results

In this part of the project, the results of the application of LSS business management approach and DMAIC Process methodology in the Purchase Process at FISCSD will be presented. Thus, this part of the research begins with a discussion of the criteria used in identifying opportunities for improvement, followed by the description of data analysis and process. Finally, the proposals for improvement are presented.

The activities to define the opportunity for improvement were focused in the central process of the Purchase Division. This process concerns the activities related to processing of purchase orders. The customers of this process are all the other divisions of FISCSD, which routinely submit its requests to be purchased by the Purchase Division.

After identifying the customers. During a brainstorming session with different customers, employees and stakeholders, the customer's needs were checked in order to delineate critical to quality aspects of the process from customer's perspective.

The application of CTQ tree supported such analysis. As a result of that, the three main requirements that mainly influence customer satisfaction are the following: (a) products and services delivered within the suggest date, (b) ease of submitting a request and (c) ease of submitting the documentation after the order fulfillment (required to prove that the material was received or the service requested was executed in order to support the payment by the comptroller), as exposed in the Illustration 19.

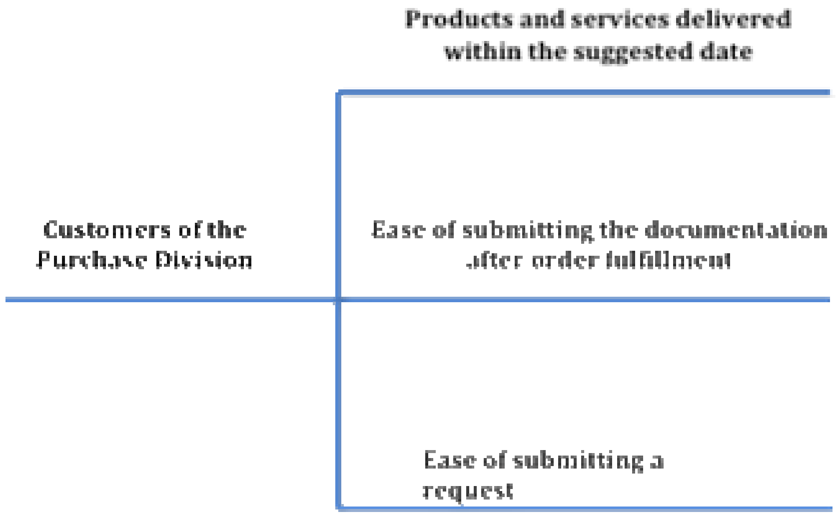


Figure 19. Critical to quality tree (customer perspective)

A similar analysis was performed from the perspective of Card Holders and Approving Official. Thus, employees from the Purchase Division presented as the main requirements for quality the following main requirements: requests correctly submitted and documents necessary for the reconciliation process submitted within the deadline as illustrated below:

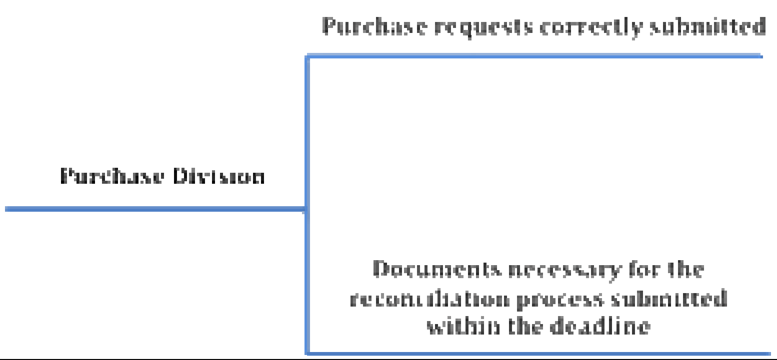


Figure 20. Critical to Quality (Purchase Division perspective)

The next step was the creation of SIPOC map, which identified the main activities of the Purchase Card Division, as well as Suppliers, Input, Output and Customer. All elements can be found within the Table 13.

Table 13

Supplier, Inputs, Processes, Outputs and Clients Analysis

Suppliers	Inputs	Processes	Outputs	Clients	Requirements
Customers from all other FISCSD Division	Purchase Request	i) Purchase Order processing	Purchase Orders	Users	i) products and services delivered within the suggest date ii) ease of submitting a request iii) ease of submitting the documentation after the order fulfillment
	Documents (Invoices and Receipts)	ii) Daily Reconciliation	Documentation Packages	Purchase Division Employees	i) Purchase requests correctly submitted ii) Documents necessary for the reconciliation process submitted within the deadline
		iii) Monthly Reconciliation			

One important aspect of the project concerns the need to align the improvement project not only to the clients' objectives, but to the objectives of the Purchase Card Division as well. In this manner, it is important to emphasize that since the transition to Navy ERP the pace of the purchase process was considered slow and there are still no standardized operating procedures to Card Holders (CH) and Approving Official.

The issues highlighted above were impacting the ability of the purchase division to process the purchase request within the necessary period of time to fulfill the deadline indicated by the customer. As a result of that goods and services were being delivered/executed by vendors/service providers after the requested date indicated on the purchase order.

Furthermore, the purchase division was considering the volume of work extremely excessive to its capacity and had place a request in order to hire a new Purchase Card Holder (the employee responsible to process the purchase request in order to turn it to a purchase order to vendor and suppliers)

Thus, the improvement process focused on the following objectives: Reduce cycle time of the purchase process by at least 50 % and Standardizing operating procedures related to CH activities.

According to (Maleyeff, 2007), the service processes within government sector usually have the following structural characteristics: many handoffs of information, numerous management or technical reviews and no explicit motivation for urgency. These aspects can easily impact the efficiency of the process and then contribute the current issues being faced.

Seeking to analyze the aspect highlighted above and other aspects that could be affecting the efficiency of the purchase card process, which was totally mapped, as illustrated on the Appendix G

On the illustration below the value stream map is exhibited. This figure summarizes the detailed process map.

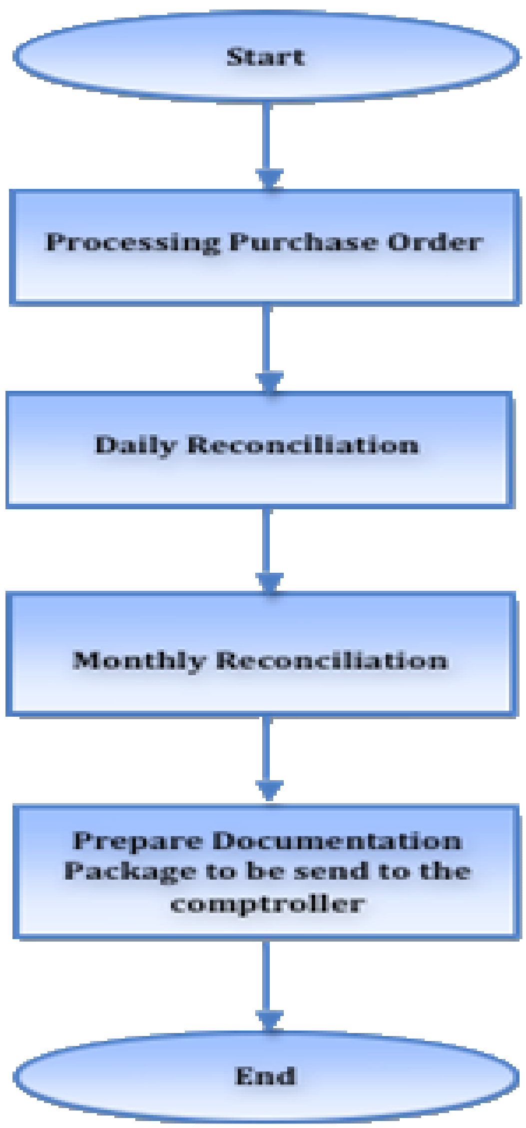


Figure 21. Main activities of the purchase process.

Data Collection and Analysis

The data collection variables were defined based on the critical factors of quality from the perspective of customer as from the perspective of employees of the division's purchasing FISCSD as well as based on the improvement objectives aimed at reducing the time and touch development of standard procedures that seek to standardize the procedures currently performed by the two buyers (credit card holder) and the Approving Official.

The first variable checked was the “touch time”, in other words, the time that each card holder spent performing the main activities required to processing the purchase order, as well the daily and monthly reconciliation.

In parallel, another variable observed was the “value added time”. In this sense, analysis of value was performed to visualize out of the total touch time how much time was actually being spent to execute value added activities, non-values added and mandatory activities (business rules)

The third observed variable was “first pass yield. According to George (2002), such concept means the percentage of “things-in-process” that make it all the way through the process first time without needing to be fixed or handled again in some way.

In order to support the analyze of the variables above, the a data collection form, listed in the Appendix H, details the main processes executed by the Card Holder (purchase request processing, daily reconciliation, monthly reconciliation and documentation package preparation) and the time spent performing each of those processes was collected in a quantitative and qualitative manner in order to differentiate the time spent with Value-Added, Non Value Added and Mandatory Activities (also called Business Rules).

The data about the three variables above was collected between 31/01/2011 and 28/02/2011. In order to ensure the accuracy of the data being collected a maximum of two or three purchase orders processes were observed per time. The following results were observed as exposed in the table 14

Table 14

Data Collection Results

Card Holder	Number of Purchase observed	Average Total Touch Time	First pass yield
Card holder "A"	**40**	32 minutes	12.5%
Card Holder "B	**40**	67 minutes	17,5 %

Variable one – touch time. Considering that the scope of the process was intended to analyze the purchase process including the daily and monthly reconciliation, the observation was executed from the point that the Card Holder receives the request to the time that the monthly reconciliation is completed. The monthly reconciliation is considered completed after the documentation package is sent to the comptroller Division, which reviews the documents and executes the payment of the credit card monthly bill.

As previously discussed, touch time is the time that the material or service is actually being processed. According to (Kubiak & Benbow, 2009) it is useful to segment the touch time by step so that processes with large touch time may be readily identified for improvement purposes. The percentage of the touch time, spent by each card holder, to perform each main step of the process is exposed in Table 15.

Table 15

Card Holders - Touch Time Analysis

Card Holder "A"	
Process	**Percentage of the touch time**
Purchase Order Processing	60%
Daily Reconciliation	3%
Monthly Reconciliation	7%
Preparation of Documentation Package to be send to the comptroller	30%
Card Holder "B"	
Process	**Percentage of the touch time**
Purchase Order Processing	65%
Daily Reconciliation	4%
Monthly Reconciliation	6%
Preparation of Documentation Package to be send to the comptroller	25%

By interpreting the results stated above the following processes can be considered as main sources of improvement opportunities: Purchase Order Processing and Preparation of Documentation Package to be send to the comptroller.

Variable two-value added time. As discussed previously in this dissertation, in order to be considered a value-added an activity should meets, simultaneously, three criteria: the customer is willing to pay for that step of the process, the step transforms the product or service, and the activity is performed correctly the first time. Besides the value and non-values added activities, there are also some stages of process called business rules (mandatory steps of the project, which are not subject to change).

The Purchase Order Processing, which is the main time-consuming process, the amount of time spent executing value added and non-value added activities is listed in the table 16, as follows:

Table 16

Value-Added Analysis

Purchase Order Processing	**Value Added (Touch Time)**	**Non-Value Added (Touch Time)**	**Total Cycle Time of the Purchase Process**	**Average Lead Time of the Execution of the Purchase Order process**
Card Holder “A”	14 min	18 min	1 day	1 day
Card Holder “B”	16 min	51 min	2 day	2 days

The results of value added analysis indicates that the average of the cycle time to execute a purchase order, in other words, to turn a purchase request into a purchase order was 1,5 day, considering that the average of the employee “A” is 1 day, whereas the average of the employee “B” is 2 days.

This situation derives from the fact that almost none of the purchase request was totally process at from the beginning to end at the first time that the Card Holder started to process it. In almost all processes the Card Holder had to send the Purchase

Request back to the Purchase Request creator in order to be fixed or included missing documents.

George (2002) suggests the utilization of Process Cycle Efficiency (PCE) indicator in order to analyze the proportion of value added activity in regards to the total lead time of the process, as exposed in the following formula: PCE = Time spent performing Value-added activities / Total Lead Time.

A PCE lower than 10% indicates that the process has several improvement opportunities. Thus, after calculating the Purchase Process PCE it is possible to identify that there are plenty of room for improvement as exposed in table 17. The following results were obtained:

Table 17

Process Cycle Efficiency Results per Card Holder

Employee	**PCE**
Card Holder "A"	0,009 %
Card Holder "B"	1,1%

Variable Three - First Pass Yield. George (2002) suggests that the first pass yield is a excellent indicator of how well the process is functioning As exposed at Table 18, the first pass yield for purchase processes executed by Card Holder "A" and Card Holder "B" were respectively 12,5% and 17,5 %.

Table 18

First Pass Yield Results per Card Holder

Card Holder	**Number of Processes Executed Correctly at the first time**	**First Pass Yield**
"A"	5 out of 40	12,5 %
"B"	7 out of 40	17,5 %

Root causes of the Problem

In order to analyze the causes of the problem, some tools such as Cause and Effect Diagram and a Pareto Chart were applied in a combined approach by the improvement team and other stakeholders of the process.

During the development of the Cause and Effect Diagram several ideas about the cause that may explain the bad results of PCE and First Pass Yield indicators were raised and analyzed.

As discussed previously, the Cause and Effect Diagram is an extremely useful tool in identifying the many possible causes for an effect or problem. The ideas were sorted into six categories (recommended for administration and service environments) such as: Equipment, Material, Process, Environment, People and Management. The application of such tool will be discussed below and the results of its application are listed on the Appendix I.

In "Equipment Category" (in this case Navy ERP system) the following causes were highlighted: Non-Customer friendly IT System and Lack of use of available IT capability. Currently Navy ERP demands, for instance, entry of data in duplication and the interface are not easy. However, considering that one limitation of this project concerns no changes in the system no further analysis were processed upon this subject.

The second cause in this category concerns the lack of use of available of IT capability. All documents that supports the purchase order process such as quotes, invoices, and receipts are supposed to be transmitted through the System, however, currently this communication is made either by e-mail and/or fax, which causes delays in the processing of orders as well as creates unnecessary paperwork. Furthermore, as result of this situation current there is excessive setup time due to fact that Card holder current have to sorted an organize all document received from the different channels of communication exposed above.

Regarding the “Material Category” the following factors were identified as possible causes of the bad Process Efficiency Cycle and Low First Pass Yield indicator: Excessive flow of documents outside ERP System and Purchase Request Form submitted with errors. It is important to emphasize that documents and the Purchase Request form are considered materials into the scope of the Purchase Card Process.

Every time when a document is transmitted by a mean other than through System (i.e. email and fax), the Card Holder has to stop the process to upload the mandatory documents into the System. The occurrence of purchase request being submitted with fields filled out incorrectly or missing information is another cause for delays in the process.

The following aspects were included into the Process category as possible causes: Lack of standard procedures and Lack of routine to execute the purchase requests. For instance, as observed during the execution of GEMBA Walk, each Card Holder had developed its own way to process the purchase request as well as the daily and monthly reconciliation into Navy ERP in terms of periodicity and type of data record into the System.

There was also a clear lack of routine in carrying out activities, specially regarding the flow of documents between the Card Holders and the Approving Official. The Approving Official has the responsibility to certify the reconciliation process executed by the Card Holder.

In sum, Card Holders were only submitting the daily reconciliation processes, to be approved by the Approving Official, in the end of the month, such practice was resulting in a huge workload to be analyzed at the end of the month, which led both Card Holders and Approving Official to not perform any purchase in the last 4 days of the month to devote themselves exclusively to execute this task.

The lack of visual management tools and lack of a standard work environment were pointed as two causes in the Environment category. During the field research was possible to observe that both Card Holders and Approving Official had difficulties to find a process or a specific document. Furthermore, there is a clear discrepancy on the organization of the workspace between both Card Holders . Whereas, within workspace of the Card Holder “A”, all files are organized according to the step of the process, the Card Holder “B” had all files or either not organized or in shelves tagged by Customer’s name.

A possible cause of the problems under study listed the People Category concerns the lack of training and Purchase Creators’ lack of awareness about the roles and required actions within the buying process. Since the launching of Navy ERP back in 2008, Purchase Request Creators (those responsible for placing the request into system) have only received few trainings on how to fill out the document required by the system, however, such practice is not executed frequently. Purchase

Creators also do not have a clear idea about the deadlines that must be followed regarding the submission of documents (invoices and receipts).

As a result of that currently Card Holders have spent a large amount of time fixing mistakes, explaining procedures individually and contacting Purchase Request Creator in order to ask them to submit required documents.

Finally, within the management category, the lack of proactive management actions from both the Division Supervisor and the Approving Official was pointed out during the session. The Approving Official has not filtered the Purchase Request upfront and rejecting it, in case the Purchase Request does not have all elements that it is supposed to have when it reaches Card Holder work flow inbox.

Improving the process

After identifying the main causes of problems through the application of DMAIC tools, the improvement team gathered to develop an action plan in order to tackle these issues. Such plan is listed at Appendix J, where all steps that need to be taken towards improving are detailed.

The actions suggested by the team are briefly detailed in the table 19 below:

Table 19

Main Problems and Actions to be taken

Problem	Action to be taken
Lack of routine	1) Development of Desk Guide 2) Execution of the reconciliation process during the afternoons and purchases during the morning time
Delay in receiving the receipts/invoices	Approving Official will develop a standard notification that the card holders will send to Purchase Request creator immediately after they place the order.

Lack of mandatory Documents	Approving Official will reject the request if the mandatory documents are not attached to the Purchase Request.
Flow of documents outside ERP System.	Purchase Request Creators will start to scan and upload all quotes and receipts into Navy ERP,
PR creators' lack of awareness about the roles/ Purchase Request submitted with errors.	Development of Desk Guide and training for PR creators
Excessive Setup Time	Eliminate the current task of organizing the paperwork received through e-mail and fax prior to initiate to process the requests by leveraging the use of Navy ERP IT Capability.

The number of occurrence of the problems identified, which are currently hindering the continuous flow of the purchase process, is emphasized within the Table 20 and the subsequent Pareto Analysis, as follows:

Table 20

Number of Occurrence Analysis

Factor	Number of Occurrences
Lack of Mandatory Documents. Card Holder (CH) had to stop to work in order to chase quotes, invoice and receipts with Purchase Request (PR) Creators	60
Flow of documents outside ERP System. Card Holder had to stop the process to upload mandatory documents into the System and/or receive it through the fax machine	65
Purchase Request submitted with errors. Purchase Request with fields filled out incorrectly or missing information	25
Excessive Setup Time	20
Delay in receiving the receipts/invoices	35

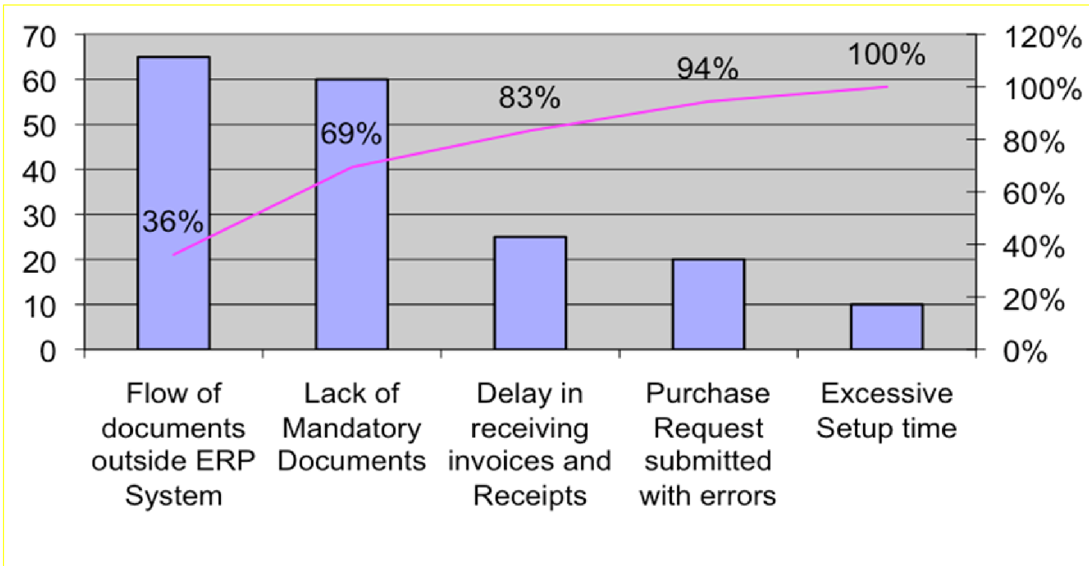


Figure 22. Pareto analysis

Pilot Test. Before the thoroughly implementation of the new guidance in all departments FISCSD, a pilot test was conducted to verify whether the suggested actions would generate the desired effects of decreasing 50% of the cycle time of the purchase process and standardize the procedures between the Card Holder, Approving Official, and Purchase Request Creators.

Meeting. The first action of the pilot test was the execution of meeting, held on 03/03/2011. The purpose of the meeting was to inform Purchase Request Creators of changes taking effect to the Purchase Requisition process as a result of the Lean Six Sigma project focused on process improvements. The new process is effective as of 9/1/11.

Figure 23. Approving Official disseminating the new business rules

5S Event. The second step was the execution of an 5S event within the purchase division workspace. To achieve the goal of the 5S, all work was done in conjunction with the Card Holder. Briefly, the following activities were undertaken:

1. Each employee examined your workspace and put a label on what would not need immediately;
2. The tagged items were examined as follows: publications and outdated file boxes were removed, active items, but unnecessary at the time were moved to a central file area
3. All items considered necessary were organized in the workspace according to its purpose

One of the main improvements made through the application of 5S event was the creation of visual management environment through the utilization of shelves for each stage of the process. The implementation of such action also created a continuous flow to the purchase process. Before such event all orders were processed/managed by customer and there was not a continuous process flow mentality in place

Figure 24. Before 5S event control made by customer, making it difficult to manage the flow of the process

Figure 25. After 5S event (each set of shelve represents one stage of the process)

Figure 26. After 5S (Supervisor can easily manage the volume of work on each stage of the process)

Figure 27. After 5S Event (all old files and not necessary paper work were removed from the work area)

Assessment of the improvements on the goals of the project. After informing all PR creators of changes taking effect to the Purchase Requisition process as a result of the Lean Six Sigma project focused on process improvements and executing the 5S Event, the new process was tested. The test involved the following personnel: five Purchase Request Creators, two Card Holders, Approving Official and Purchase Division Supervisor.

Goal 1- decreases cycle time by at least 50%. Between 8/03/11 and 8/04/11, 40 purchases orders processing were observed. All activities were performed under the new policies and procedures. The results were outstanding, the total cycle time of the purchase was reduced from average of 1.5 days to a average of 19 min, which is far beyond the goal of decreasing it in 50%.

The main reasons of such change derives from the elimination of duplicity and flow interruptions. In the old process, almost none of the purchase request are processed from the beginning to end at the first time that the Card Holder started to process it. In almost all processes, the Card Holder has to send the Purchase Request back to the Purchase Request creator in order to be fixed. There are also a lot of occurrence of lack of mandatory documentation, which also forces the Card Holder to reject it and ask for the inclusion of missing documents.

It is important to emphasize that in the new process, the Approving Official has the responsibility to reject all Purchase Requests missing required documents, filled out with wrong information, and missing information. Such approach reduces the volume of work to the Card Holder and avoid interruption in their work. Previously, the Approving Official was only forwarding the Purchase Request without analyzing it.

Another key improvement of the new process concern the utilization of Navy ERP IT capabilities. By leveraging the utilization of the systems by all users, the physical movements of documents such as quotes, receipts and invoices outside the system was reduced.

Doubtlessly, without such change the cycle time of the results obtained would not be same. The main results achieved are highlighted within the Table 21.

Table 21

Value-Added Analysis after improvements

Purchase Order Processing	Value Added (Touch Time)	Non-Value Added (Touch Time)	Total Cycle Time of the Purchase Process	Average Lead Time of the Execution of the Purchase Order process
Card Holder "A"	15 min	3 min	18 min	18 min
Card Holder "B"	15 min	5 min	20 min	20 min

Goal 2 - standardize operating procedures. In addition to the execution of the 5S event within the Card Holders work space, which brought standard operating procedures on how to execute the purchase order among both Card Holder and Approving Official

The following actions were performed aimed at standardizing operating procedures among all individual involved with the process:

1. The P-Card Program desk guide covering required steps from the creation of Purchase order to reconciliation.

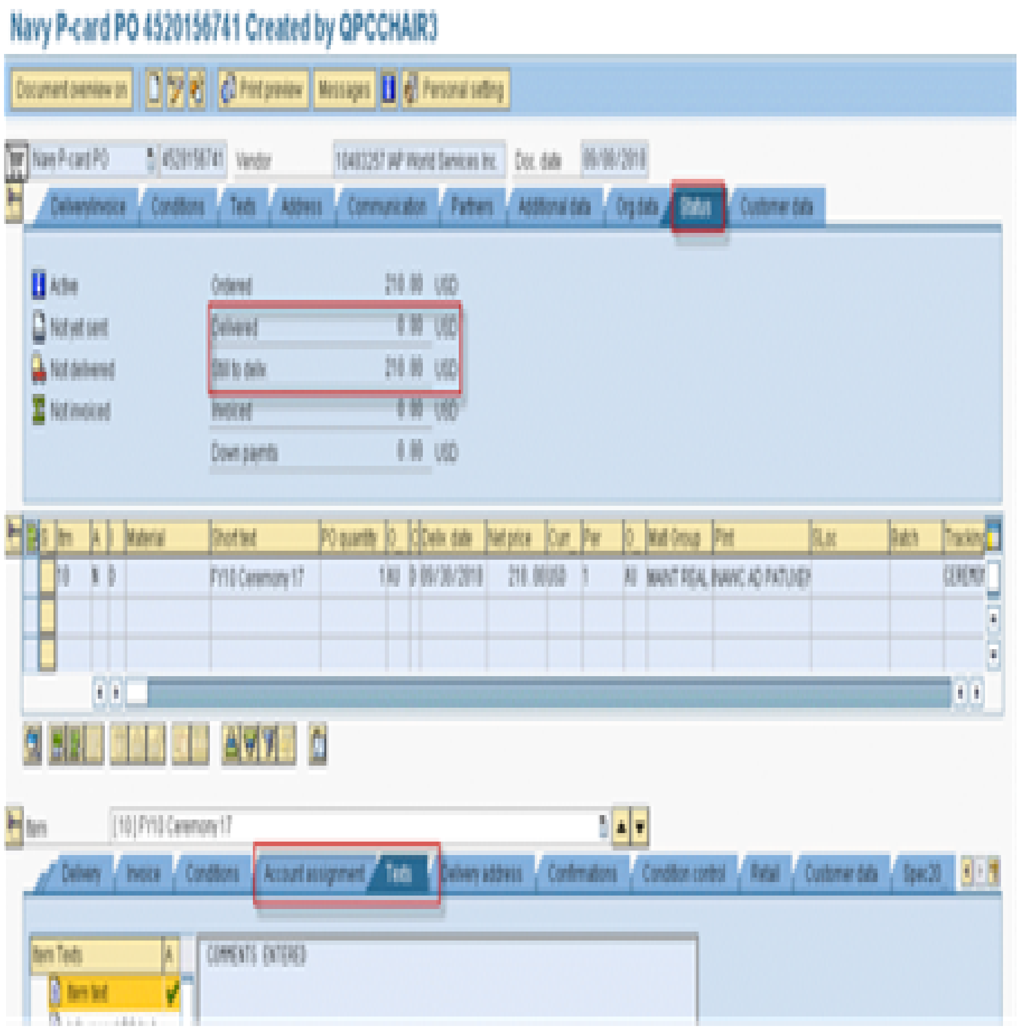
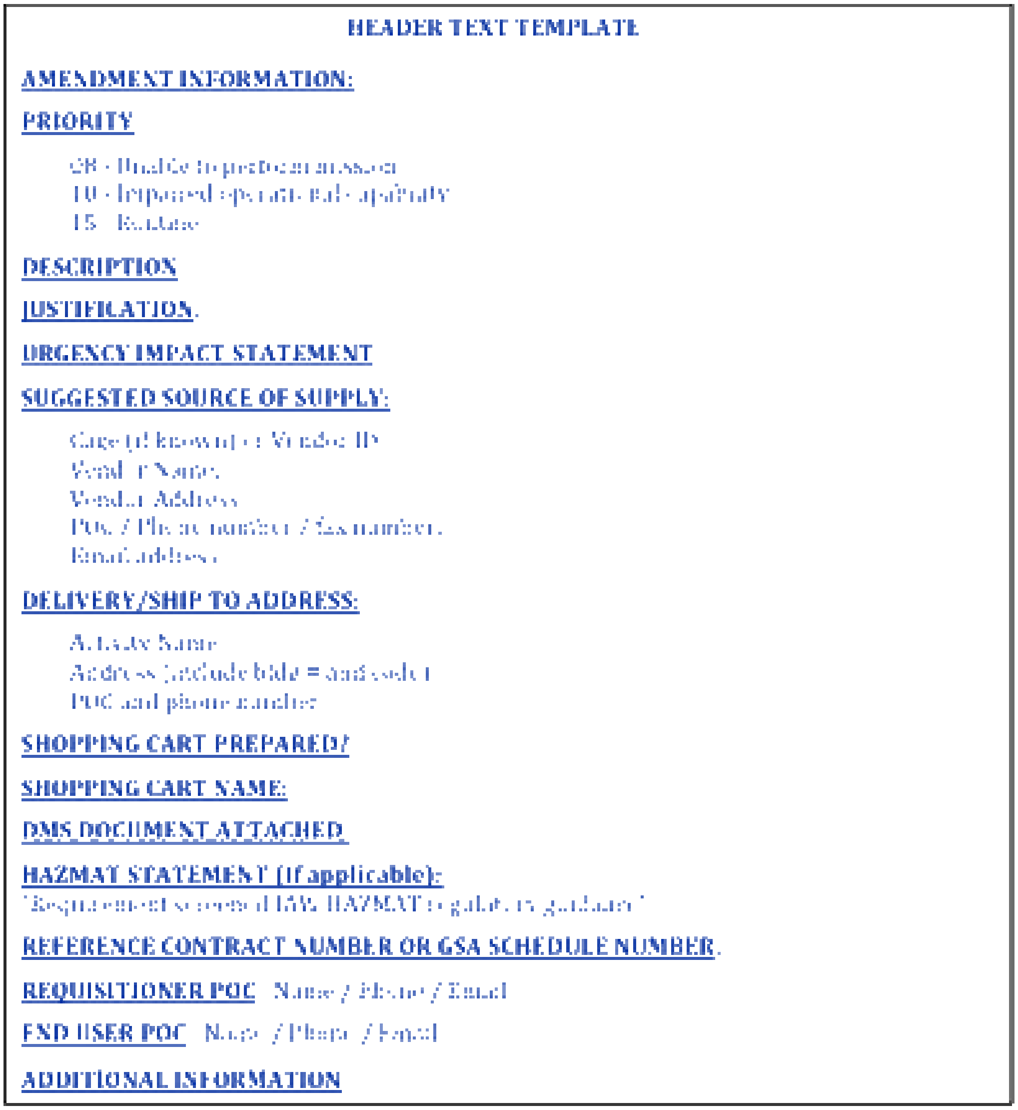


Figure 28. Instructions about how to fill out a purchase order. Extracted from Request Extracted from P-Card Program Desk Guide (Page 90)

2. New header templates/instructions to the Purchase Requisitions were developed.



HEADER TEXT TEMPLATE

AMENDMENT INFORMATION:

PRIORITY

[illegible]

DESCRIPTION

JUSTIFICATION.

URGENCY IMPACT STATEMENT

SUGGESTED SOURCE OF SUPPLY:

[illegible]

DELIVERY/SHIP TO ADDRESS:

[illegible]

SHOPPING CART PREPARED?

SHOPPING CART NAME:

DMS DOCUMENT ATTACHED

HAZMAT STATEMENT (If applicable):
[illegible]

REFERENCE CONTRACT NUMBER OR GSA SCHEDULE NUMBER.

REQUISITIONER POC [illegible]

END USER POC [illegible]

ADDITIONAL INFORMATION

Figure 29. Desk header templates/instructions aimed at standardizing procedures among all users.

3. New instructions to standardize the required steps to purchase Hazmat material were created.

HAZMAT ITEMS

Clarification explaining what does and does not go through Hazmin center for purchase. Only two things can bypass HMC:

1. *Common Use items* (i.e. batteries, toner cartridges, desktop cleaning fluid, etc).
Another phrase for Common Use would be Household products. If you can purchase an item at your local supermarket or office supply store then it's considered common use.

2. *Stoody Aragon gas cylinders*.
Stoody doesn't consider SERCO HMC as Government entity so Stoody charges 25% more for the gases purchased through HMC. I spoke with FISC Hazmat COR office and apparently there is an agreement with Stoody where the customer can order directly and save the extra charges.
All Hazmat items, other than these two exceptions, are required to be purchased through your local base hazmin center.
Creators be aware not to use a material number, such as P-card Miscellaneous, when purchasing Hazmat items.

Figure 30. Standard Procedures of Operation for purchase of hazmat materials.

Process Controls. The following process control were also tested as part of the pilot test to put in place mechanisms focused on support the improvement implemented as well as proactively act in order to avoid the occurrence of mistakes:

- Approving Official is now responsible for filtering the PR upfront and rejecting it in case the PR does not have all elements that it is supposed to have when it reaches CH work flow inbox
- Cardholder's notification to PR creators of buy. Such action is aimed at avoiding delays in flow back of invoices/receipts
- Utilization of automatic ERP report as a substitute to the manual data entry in a daily log as a managerial tool. Such report is also a reliable

source of Metrics in regards to number of transactions and financial amount involved.

- Visual management environment - the utilization of shelves for each stage of the process allows the supervisor to control the flow of the process

Process Control Chart Comparison. The Statistical Process Control Chart is used to monitor the process and keep it with an adequate and predictable performance, avoiding the chances of losing the improvements obtained in the previous phase.

In the new process, both Card Holders achieved similar processing times. Thus, now only one Control Chart represents the process performance as a result of the standardization of procedures. Additionally due to the less amount of time spent to perform a purchase, all three lines parameters: centerline, an upper control limit (UCL) and a lower control limit (LCL) shifted down, as exposed within the Table 22 below and the respective Control Charts.

Table 22

Control Limit Analysis

New Process	*Old Process Card Holder "A"*	*Old Process Card Holder "B*
UCL = 26 minutes	*UCL= 44 minutes*	*UCL = 82 minutes*
LCL = 12 minutes	*LCL = 21 minutes*	*LCL = 52 minutes*
Center Line = 19 minutes	*Center Line = 32 minutes*	*Center Line = 67 minutes*

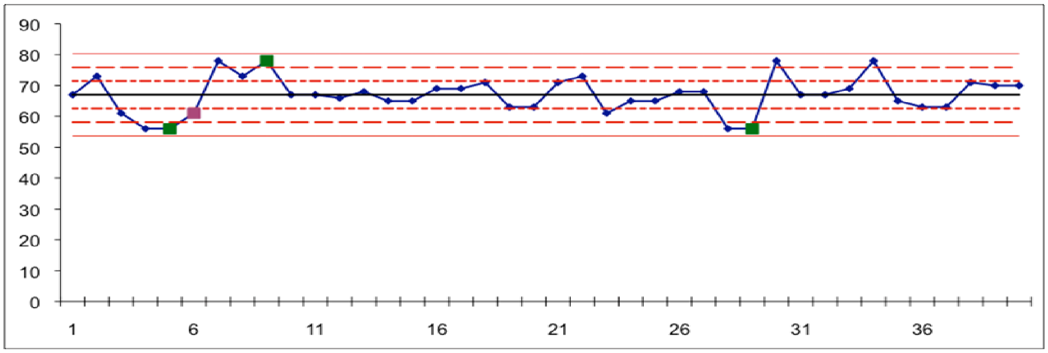


Figure 31. Card Holder B control chart based on the performance prior to the execution of the improvement of the improvement project

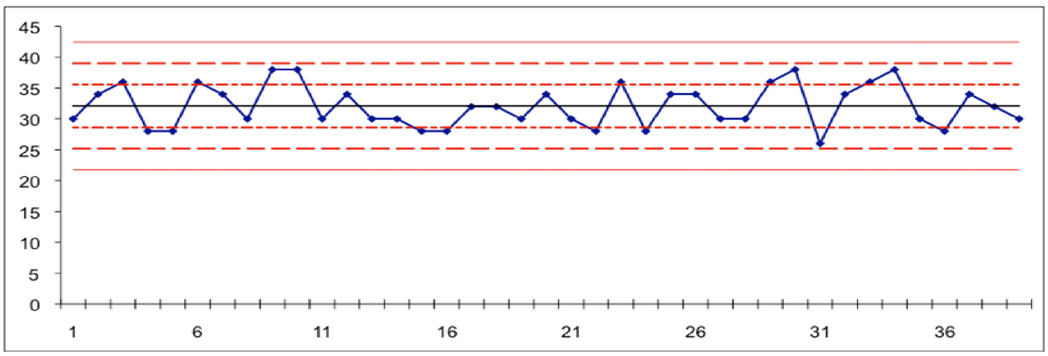


Figure 32 - Card Holder A control chart based on the performance prior to the execution of the improvement project.

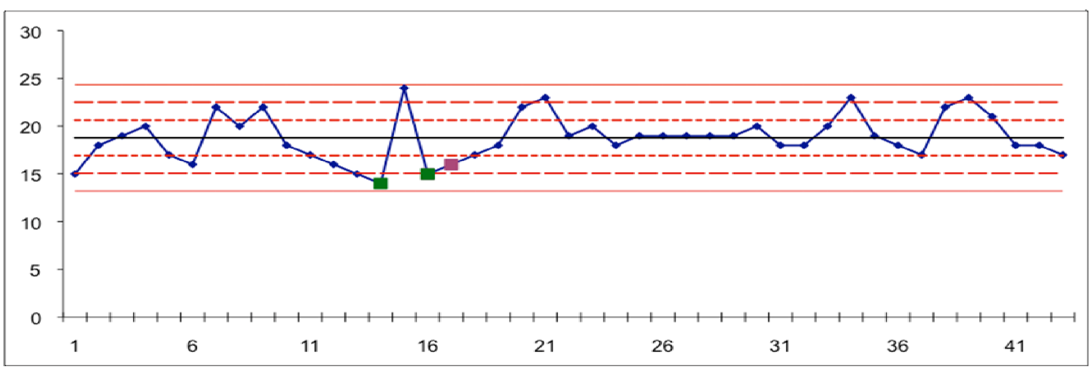


Figure 33 Control Chart of both Card Holders demonstrate an reduction in performance variation

Conclusion

The objective of this research was achieved considering that various improvement opportunities were identified in the Purchase Card Division FISCSD through the application of LSS theory and DMAIC methodology and its tools.

It was observed that a number of factors, such as lack of use of the Navy ERP capabilities, lack of standardization of procedures, lack of clear business rules, etc were heavily impacting the ability of buyers to perform their service. Another important aspect noted concerns the lack of a proactive participation of other entities and stakeholders of the process, which was hindering the process efficiency and effectiveness.

After the implementation of some actions aimed at improving the process, during the execution of the pilot test, the cycle time required for execution of a purchase order was reduced by more than 50%. Furthermore, the level of standardization of procedures was raised through the development of operating standards, restructuring of work areas and establishment of routines for performing the process.

The conduction of the improvement project enabled the Purchase Division staff to learn about their processes. Together the team collected data, analyzed them and developed initiatives to increase performance. Thus, the conduction of the project left a legacy of improvement regarding the importance of completing the work as a team, in a coordinated manner, with clear objectives

In summary, this work contributed to the development of a management mentality that focuses on efficiency and effectiveness of the processes of Purchase

Division, contributing not only to increase customer satisfaction as well as to optimize the human and financial resources being used to execute the purchase at Fleet and Industrial Supply Center San Diego, opening the opportunity for employees to perform new tasks which were being neglected.

Moreover, the project contributed to avoid unnecessary extra financial expenses due to fact that process to hiring a new employee had been placed prior to the execution of the improvement project.

In a broader context within FISCSD as organization, the present research project helped to break the paradigm that the CPI program actions should be focused only macro process or manufacturing areas. The results clearly reflect the benefits that can be obtained through the application of LSS theory and DMAIC tools in smaller scale processes of the services segment.

This research also contributes to the scientific development of this theme, based on literature review through which different approaches of LSS applications were research and presented. The peculiarities of these theories in a service segment were discussed and the differences from the manufacturing setting were highlighted.

Nevertheless, considering that topic being studied is relatively recent, especially regarding its implementation by companies of other countries in the world, as well as regarding the realization of scientific research by scholars from the academic world, it is understood that there is still a gap to be filled on this subject, which opens the possibility of carrying out further research in other service environments.

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Appendix A

Types of Waste Analysis

Type of Waste	**Description**	**Main Causes**	**Why it is considered waste**
Over production	To produce sooner, faster or in greater quantities than the absolute customer demand	To produce sooner, faster or in greater quantities than the absolute customer demand	i) Costs money ii) Consumes resource ahead of plan iii) Creates inventory Hides iv) inventory/defect problems v) Space utilization
Inventory	Any raw material, work in progress (WIP) or finished goods which are not having value added to them	i) Production schedule not level ii) Inaccurate forecasting iii) Excessive downtime/set up iv) Push instead of pull v) Large batching vi) Unreliable suppliers	i) Adds cost ii) Extra storage space required iii) Extra resource to manage iv) Hides shortages and defects v) Can become damaged vi) Shelf life expires
Motion	Adds cost Motion is the movement of "man" Waste motion occurs when individuals move more than is necessary for the process to be completed	i) No standard operating procedure ii) Poor housekeeping iii) Badly designed cell iv) Inadequate training	i) It interrupts production flow ii) Increases production time iii) Can cause injury

Waiting	People or parts that wait for a work cycle to be completed	i) Shortages & unreliable supply chain ii) Lack of multi skilling/flexibility iii) Downtime/Breakdown Ineffective production planning iv)Quality,design,engineering Issues	i) Stop/start production ii) Poor workflow continuity iii) Causes bottlenecks iv) Long lead times v) Failed delivery dates
Transportation	Unnecessary movement of parts between processes	i) Badly designed process/cell ii) Poor value stream flow iii) Complex material flows iv) Sharing of equipment	i) Increases production time ii) It consumes resource & floor space iii) Poor communication iv) Increases work in progress v) Potential damage to products
Over Processing	Processing beyond the standard required by the customer	i) Out of date standards ii) Attitude - 'Always done it like this' iii) Not understanding the process iv) Lack of innovation & improvement • Lack of standard operation procedures	i) It consumes resource ii) It increases production time iii) It's work above and beyond specification iv) Can reduce life of component
Non-Right First Time (Scrap, Rework and Defects)	A defect is a component which the customer would deem unacceptable to pass the quality standard	i) Out of control/Incapable processes ii) Lack of skill and training on the job support iii) Inaccurate design & engineering iv) Machine inaccuracy	Adds costs • It interrupts the scheduled • It consumes resources • It creates paper work • Reduces customer confidence

Appendix B

Reduced Setup Time

Improvement Opportunity	**Key improvement tasks**	**Service Operation Application**
Identify setup elements	Map out in sequence all the elements and characterize them as value-added, non value and business requirements. Eliminate non-value added work tasks from the setup process	Break the setup of a job into down its smallest work tasks.
Separate internal from external setup	Identify those work tasks that can be done offline and do not directly impact production	Identify work tasks that can be completed prior to the job setup
Move elements to external setup	Offline work tasks can be scheduled independent of the job setup. But these tasks should also be studied using SMED methods and simplified offline, but with lower priority than online tasks	Study internal setup work tasks and make design modifications to the process to convert them to external work tasks
Simply, standardized, and mistake proof remaining elements	Study internal or inline setup work tasks and eliminate and standardize them	Study those work tasks that remain part of the internal or online setup of a job. Simplify and standardize these work task using lean and information technology methods

Appendix C

Transformation through Lean Six Sigma Memorandum

THE SECRETARY OF THE NAVY
WASHINGTON, D.C. 20350-1000

May 3, 2006

MEMORANDUM FOR DISTRIBUTION

SUBJECT: Transformation Through Lean Six Sigma

As the Secretary of the Navy, I am challenged to lead the Department in executing two great tasks simultaneously: fighting today's war and positioning our Force for an uncertain future. We face additional fiscal pressures that lead us to better stewardship of taxpayer dollars where greater efficiency leads to improved effectiveness. While in industry, I found that both buyers and suppliers who employed Lean Six Sigma (LSS) experienced better efficiencies, increased morale and higher levels of performance.

LSS is a proven business process that combines the strategies of Lean (eliminate non-value added activities and improve cycle time) and Six Sigma (reduce variation and produce highly repeatable processes). Several elements of the Navy and Marine Corps have engaged in LSS activities to include the training of over 500 Black Belts and 1,500 Green Belts that have facilitated 2,800 events and projects. These activities averaged a 4:1 return on investment. This initiative applies to entities engaged in transactional, service and support missions.

The mission is clear: creation of more readiness and assets within our budget through LSS. I expect that you, my Leadership Team, will personally support this initiative by injecting it into our performance objectives. To accomplish our goal of LSS integration, we will be educated on a broad spectrum of LSS to include framework, efficiency methodologies and tools, and accelerated change management approaches.

LSS will be deployed using a top-down approach. My leadership deployment session will be held on 15 June from 1300-1700. I ask that each of you participate in the deployment session. The objective for this meeting is to: establish a common knowledge baseline among participants; review examples of successful commercial implementations; assess current LSS implementation in the Department; and establish the next steps toward more fully employing LSS in our organization.

Donald C. Winter

Appendix D

CPI General Policies

DEPUTY SECRETARY OF DEFENSE
1010 DEFENSE PENTAGON
WASHINGTON, DC 20301-1010

April 30, 2007

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
UNDER SECRETARIES OF DEFENSE
ASSISTANT SECRETARIES OF DEFENSE
GENERAL COUNSEL OF THE DEPARTMENT OF DEFENSE
DIRECTOR, OPERATIONAL, TEST AND EVALUATION
INSPECTOR GENERAL OF THE DEPARTMENT OF DEFENSE
ASSISTANTS TO THE SECRETARY OF DEFENSE
DIRECTOR, ADMINISTRATION AND MANAGEMENT
DIRECTOR, PROGRAM ANALYSIS AND EVALUATION
DIRECTOR, NET ASSESSMENT
DIRECTORS OF THE DEFENSE AGENCIES
DIRECTORS OF THE DOD FIELD ACTIVITIES

SUBJECT: DoD-Wide Continuous Process Improvement (CPI) / Lean Six Sigma (LSS)

Since our 31 March CPI/LSS off-site, valuable comments on our current baseline of CPI/LSS activities and efforts in DoD have been reported. While I am encouraged by our collective efforts to date, it is important to accelerate adoption of these best practices, and to leverage feedback from the recent CPI/LSS seminar as we define the Department's next steps.

To respond to your near-unanimous feedback from the seminar, I am directing the establishment of a DoD CPI/LSS Program Office within the Office of the Deputy Under Secretary of Business Transformation within AT&L. This office will leverage the existing CPI/LSS Senior Steering Committee (SSC) to drive DoD-wide CPI/LSS activities, rigorously track results and formulate a multi-level "rewards" program. Other forums and/or management structures to accelerate our efforts may be established, if required. The Office of Business Transformation will oversee the activities of this Program Office with strong support and active participation from all OSD offices.

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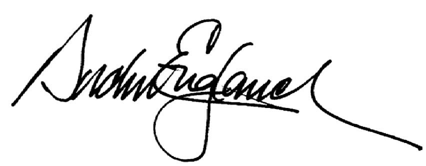
Aggressive implementation of CPI/LSS within all levels of DoD will go a long way to support our overall business transformation efforts. Accordingly, each organization is asked to accomplish the following:

- Assign a CPI/LSS focal point to coordinate with the DoD CPI/LSS Program Office.
- Establish a 12- to18-month workforce training objective of 1% LSS black belt trained and 5% green belt trained personnel. Personnel selected should include top-rated staff members (e.g., at minimum from the top half).
- Include CPI/LSS in individual employee performance objectives.
- Provide support to the DoD CPI/LSS Program Office in DoD-wide process improvement initiatives.
- Report progress and outcomes of ongoing and completed CPI/LSS projects and activities to the DoD CPI/LSS Program Office every 30 days initially.

As with other parts of DoD's ongoing culture change, all levels of our organization need to be directly involved with CPI/LSS. Kindly ensure your organization's maximum attention to forthcoming CPI/LSS Program Office communications, which will provide detailed guidance to help implement this memo. Immediate questions should be directed to Beth McGrath at 703.695.9715 or elizabeth.mcgrath@osd.mil.

Thanks for your leadership and personal involvement in the incorporation of CPI/LSS into your organization, and I look forward to personally hearing from you and your change agents on your CPI/LSS successes.



Appendix E

Directive Number 5010.42

Department of Defense

DIRECTIVE

NUMBER 5010.42
May 15, 2008

DCMO

SUBJECT: DoD-Wide Continuous Process Improvement (CPI)/Lean Six Sigma (LSS) Program

References: (a) Section 113 of title 10, United States Code
(b) Deputy Secretary of Defense Memorandum, "DoD-Wide Continuous Process Improvement (CPI)/Lean Six Sigma (LSS)," April 30, 2007 (hereby canceled)
(c) Deputy Secretary of Defense Memorandum, "Establishment of DoD-wide Continuous Process Improvement (CPI) Programs," May 11, 2006

1. <u>PURPOSE</u>. In accordance with the authority in Reference (a), this Directive:

a. Incorporates and cancels Reference (b).

b. Establishes policy and assigns responsibilities to institutionalize CPI/LSS as one of the primary approaches to assessing and improving the efficiency and effectiveness of DoD processes in support of the Department's national defense mission.

2. <u>APPLICABILITY</u>. This Directive applies to OSD, the Military Departments, the Office of the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities in the Department of Defense (hereafter referred to collectively as the "DoD Components").

3. <u>POLICY</u>. It is DoD policy that:

a. The objective of the DoD CPI/LSS program is to strengthen joint operational Combatant Command and Military Department capabilities including making improvements in:

(1) Productivity.

(2) Performance against mission (availability, reliability, cycle time, investment, and operating costs).

(3) Safety.

(4) Flexibility to meet DoD mission needs.

(5) Energy efficiency.

b. CPI/LSS concepts and tools should be applied to benefit the full range of DoD organizations. These include combat, industrial, service, and office environments of headquarters, field, and operational organizations. The DoD Components should participate in defining, implementing, and sustaining CPI/LSS efforts. Each DoD Component should use CPI/LSS concepts and tools to improve the full range of processes and activities that comprise their operations, including decision-making processes and appropriate engagement with industrial base suppliers.

c. CPI/LSS programs shall be used to help meet organizational objectives. CPI/LSS methods, terminology, training plans, and other program elements may be adapted as required. Given diverse operational requirements, the DoD Components shall have full flexibility to identify CPI/LSS focus areas and training plans and may adapt other CPI/LSS program elements for their use.

d. Resource benefits resulting from CPI/LSS improvements in overall operating effectiveness may be retained by the DoD Components that generate them (Deputy Secretary of Defense Memorandum (Reference (c))). Effective management oversight should lead to reinvestment in additional CPI/LSS efforts, recapitalization, and further strengthening of operational capability.

4. <u>RESPONSIBILITIES</u>

a. The <u>Deputy Chief Management Officer</u> shall:

(1) Establish the DoD CPI/LSS Program Office to serve as the DoD proponent for CPI/LSS.

(2) Develop and maintain applicable CPI/LSS guidance, standards, and best practice information for the DoD Components, to include a DoD-wide CPI awards program and CPI/LSS performance objectives initiatives consistent with Reference (c).

b. The <u>Heads of DoD Components</u> shall:

(1) Ensure implementation of CPI/LSS policies consistent with this Directive and the guidance in Reference (c).

(2) Implement CPI/LSS programs to improve overall effectiveness and efficiency across missions and functions to gain the broadest possible range of organizational improvements.

(3) Develop and implement appropriate education and training procedures and promote CPI/LSS career development opportunities, to include a CPI/LSS award and performance objective initiative as appropriate.

(4) Establish CPI/LSS education, training, and certification procedures consistent with DoD-wide guidelines and standards and include CPI/LSS in individual employee performance objectives as appropriate.

5. RELEASABILITY. UNLIMITED. This Directive is approved for public release. Copies may be obtained through the Internet from the DoD Issuances Web Site at http://www.dtic.mil/whs/directives.

6. EFFECTIVE DATE. This Directive is effective immediately.

Gordon England
Deputy Secretary of Defense

Appendix F

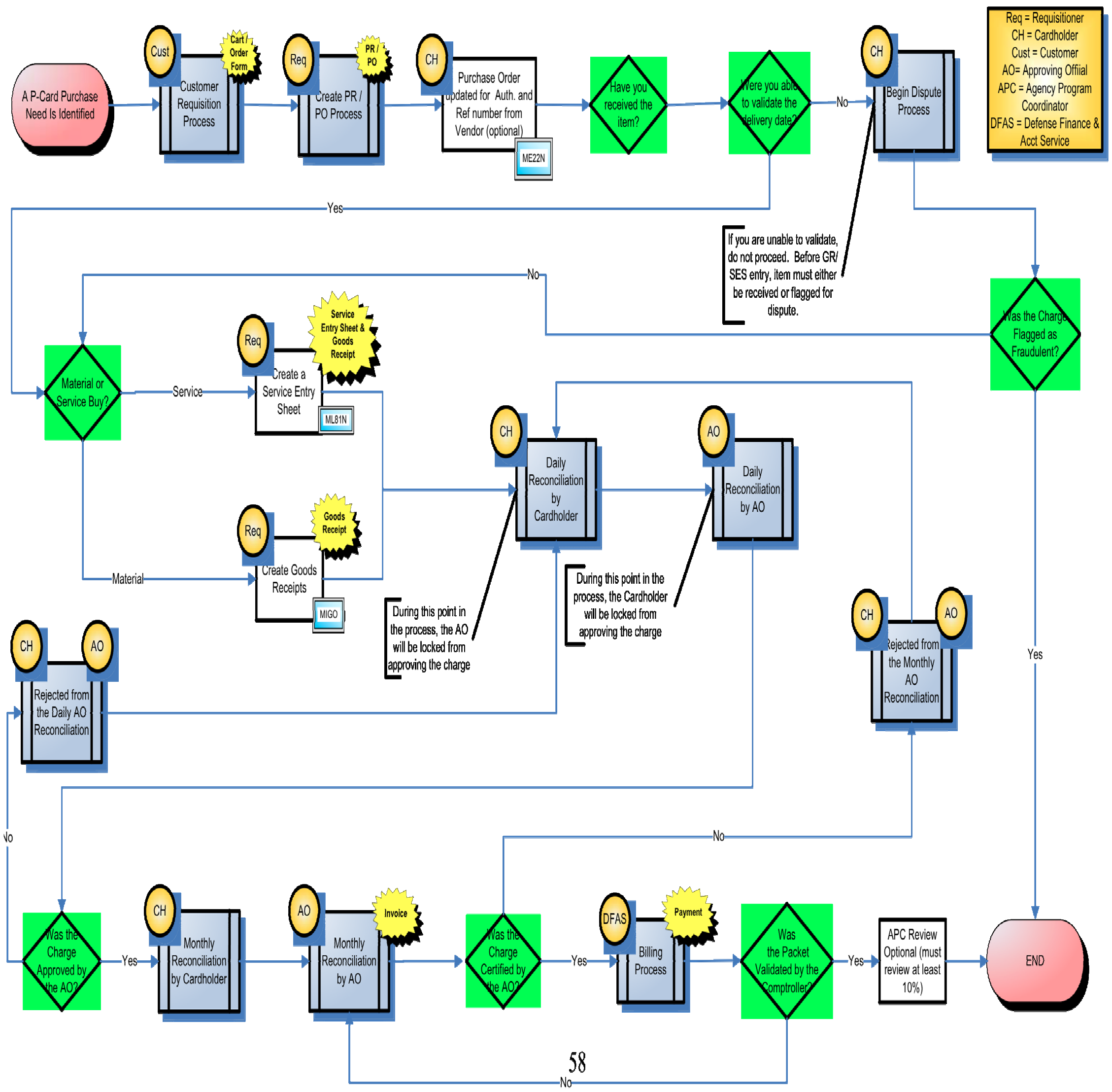
Main aspects of the Directive number 5010.43

Focus Area	Direction
Institutionalization of the CPI/LSS Program	DoD Components shall implement the necessary capabilities to fully institutionalize continuous process improvement within their organizations, to include the use of LSS concepts and tools in their organizational culture and to promote transparency of successful CPI projects throughout the Department of Defense.
Strategic Alignment.	Strategy alignment ensures DoD strategic project selection goals and priorities cascade across the Department with supporting implementation and initiative priorities. OSD and DoD Components shall adopt processes and means to support selection of high priority CPI/LSS projects to improve effective and efficient operations across the Department. An important aspect of strategy alignment and project selection includes performance management methods that make visible performance gaps and problems for resolution using CPI/LSS methods where most appropriate. A key component is accountability and the associated performance dialogue to review progress toward delivering results.
Consistency of Approach	DoD Components shall collaboratively determine a common set of standards for training, certification, deployment, and operational approaches that apply a common body of knowledge for implementation and execution of CPI/LSS across DoD organizations.
CPI/ LSS Integration	DoD Components shall collaboratively determine a structured knowledge management and information sharing capability to foster the CPI/LSS program. This focus on program integration is to increase cross-fertilization of CPI/LSS ideas and adopted DoD-wide business practices.

Focus Area	**Direction**
Human Capital.	In order to attain this fundamental pillar of the program, DoD Components shall take all appropriate actions to educate civilian and military personnel on their role to take full ownership of the continuing DoD emphasis on process improvement and training opportunities.

Appendix G

Overall Purchase Card Process Flow



Appendix H

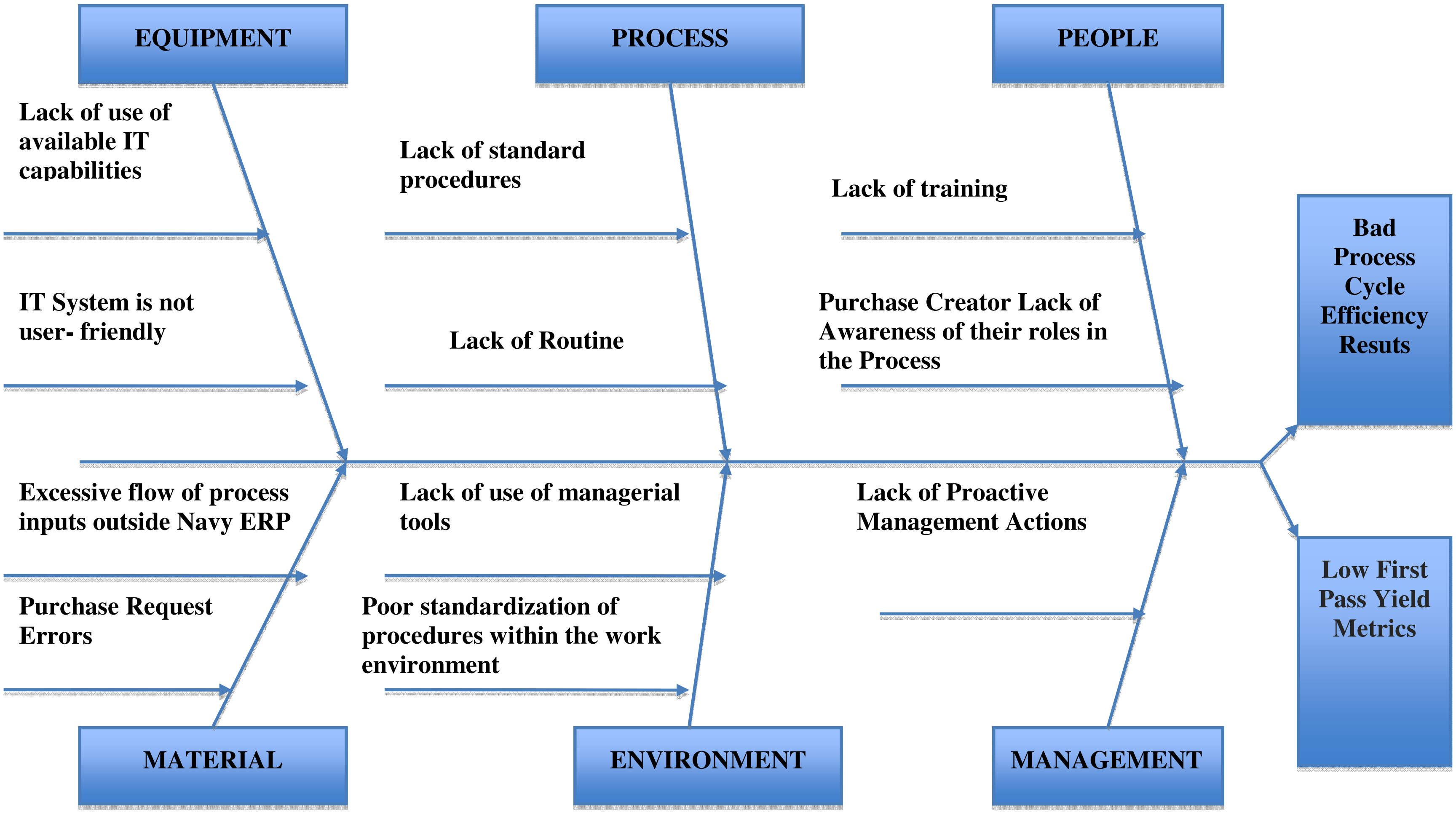
Data Collection Form

Purchase Order Number				
Name of Card Holder				
Event	**Date**	**Touch Time**		
Purchase Request (PR) was submitted		Not Applicable		
Purchase Request Processing		VA	NVA	BR
Date Purchase was made				
Daily Reconciliation Process		VA	NVA	BR
First hand-off to Approving Official		Not Applicable		
Monthly Reconciliation		VA	NVA	BR
Second hand-off to Approving Official		Not Applicable		
Preparation of Documentation Package to send to Comptroller		VA	NVA	BR
File Original PO Package		xxxxxxxx		

Description of the flow stoppers ➔
Legend:
Value Added - VA
Non Value Added - NVA
Business Rules - BR

Appendix I

Cause and Effect Diagram



Appendix J

Plan of Action

Problem being tackled	Improvement needed	Action to be taken	Responsible Person	Start date	Complete Date
Lack of Routine	Establishment of a routine to CH defining time to process orders x time to process other stages of the process as well as days of the month that yearly SES will be processed	1) Development of Desk Guide/Standard Operating Procedures general guidelines 2) Execution of the reconciliation process during the afternoons and execution of the purchase during the morning time	Approving Official/Card Holders	3/8/11	N/A
Delay in receiving the receipts/invoices	1) Development of a standard e-mail that will be sent to PR creator as soon as the transactions hit the Citibank statement 2) Launch the utilizations of scanners among PR creators	Approving Official developed a standard notifiation the card holders will send to creator immediately after they place the order.	Approving Official/Card Holders	3/8/11	N/A

Problem being tackled	Action needed	Action to be taken	Responsible Person	Start date	Complete Date
CH chasing quotes and receipts	1) AO start to reject orders with no quotes attached 2) PR creator proactively upload into ERP receipts without waiting to CH input	Purchase Request Creators will scan and upload all quotes into Navy ERP, AO will reject the request if quote is not attached. 2. Creator will also scan and upload the signed receipt. Instructions will be provided to all creators that have scan capability.	Supervisor/Approving Official	3/8/11	N/A
PR creators' lack of awareness about the roles and required actions within the buying process	Training and development of general guidelines	Development of Desk Guide/ SOP and training for PR creators	Paula/ Rich	3/3/11	3/31/11