A Framework Roadmap For Implementing Lean Six Sigma In Local Governmental Entities

2004

Sandra L. Furterer
University of Central Florida

A FRAMEWORK ROADMAP FOR IMPLEMENTING LEAN SIX SIGMA IN LOCAL GOVERNMENTAL ENTITIES

by

SANDRA L. FURTERER
B.S. The Ohio State University, 1983
M.S. The Ohio State University, 1985
M.B.A. Xavier University, 1990

A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the Department of Industrial Engineering and Management Systems
in the College of Engineering and Computer Science
at the University of Central Florida
Orlando, Florida

Spring Term
2004

Committee Chair: Ahmad K. Elshennawy

ABSTRACT

Lean Six Sigma is an approach focused on improving quality, reducing variation and eliminating waste in an organization. The concept of combining the principles and tools of Lean Enterprise and Six Sigma has occurred in the literature over the last several years. The majority of Lean Six Sigma applications have been in private industry, focusing mostly on manufacturing applications. The literature has not provided a framework for implementing Lean Six Sigma programs applied to local government. This research provides a framework roadmap for implementing Lean Six Sigma in local government. The Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap (SITE MAP) identifies the activities, principles, tools, and important component factors to implement Lean Six Sigma. The framework provides a synergistic approach to integrating the concepts and tools of Lean Enterprise and Six Sigma using the DMAIC (Define-Measure-Analyze-Improve-Control) problem solving approach. A case study was used to validate the framework. Lean Six Sigma was successfully applied in a 7,000-citizen municipality to reduce the cycle time of the financial administrative processes in the Finance Department of the city government.

This research is dedicated to my husband Dan, and my children Kelly, Erik, and Zachary, who have provided continual support and encouragement throughout my Ph.D. program and my everyday life. I also dedicate this research to my parents, Joan and Mel Brumback, who instilled in me the value of education and a lifelong love of learning.

ACKNOWLEDGMENTS

I would like to thank the faculty and staff of the Department of Industrial Engineering and Management Systems at the University of Central Florida for making my doctoral study a memorable and valuable experience. I am grateful to Drs. Ahmad Elshennawy, my advisor and committee chair, Luis Rabelo, William Thompson, Lucy Morse, and Nizam Uddin, who served on my dissertation committee and provided their knowledge and support to this effort.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

5S	5 components: seiri (sort), seiton (set in order), seiso (shine), sieketsu (standardize), shitsuke (sustain)
ACSI	American Customer Satisfaction Index
ANOVA	Analysis of Variance
ASQ	American Society for Quality
BPR	Business Process Reengineering
CEO	Chief Executive Officer
Cp	Process capability index
Cpk	Minimum capability index
CPL	Lower one-sided index
CPU	Upper one-sided index
CTR	Cycle Time Reduction
DMAIC	Design, Measure, Analyze, Improve, Control
DPMO	Defects per million opportunities
DPU	Defects Per Unit
EVOP	Evolutionary Operation
FMEA	Failure Mode and Effect Analysis
Ft. Wayne	Fort Wayne
GASB	Governmental Accounting Standards Board
GE	General Electric
IAFF	International Association of Fire Fighters
ICMA	International City/County Management Association (ICMA)
IFR	Items For Resolution
JIT	Just-in-Time
LSL	Lower Specification Limit
QFD	Quality Function Deployment
R&R	Repeatability and Reproducibility
RSM	Response Surface Methodology
SITE MAP	Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap
SIPOC	Supplier-Input-Process-Output-Customer
SMED	Single Minute Exchange of Dies
SPC	Statistical Process Control
TPM	Total Productive Maintenance
TQM	Total Quality Management
USL	Upper Specification Limit
VOC	Voice of the Customer

CHAPTER 1
INTRODUCTION

1.1 Lean Six Sigma Overview

Lean Six Sigma is an approach focused on improving quality, reducing variation and eliminating waste in an organization. It is based on the concepts of combining two improvement programs, Six Sigma and Lean manufacturing, also known as Lean Enterprise. Six Sigma is both a quality management philosophy and a methodology that focuses on reducing variation, measuring defects and improving the quality of products, processes, and services. The concept of Six Sigma was developed in the early 1980's at Motorola Corporation. Six Sigma became popularized in the late 1990's by General Electric Corporation and their former CEO Jack Welch. Lean Enterprise is a methodology that focuses on reducing cycle time and waste in processes. Lean Enterprise originated from the Toyota Motor Corporation as the Toyota Production System, and increased in popularity after the 1973 energy crisis. The term "Lean Thinking" was coined by James P. Womack and Daniel T. Jones in their book, Lean Thinking (Womack and Jones, 1996). The term "Lean Enterprise" is used to broaden the scope of a Lean program from manufacturing to embrace the enterprise or entire organization (Alukal, 2003). Six Sigma uses the DMAIC problem solving approach, and a wide array of quality problem solving tools. Use of the tools varies based on the type of process studied and the problems that are encountered. There are many tools in the Lean tool set that help to eliminate waste, organize and simplify the work processes.

1.2 Lean Six Sigma Application in Private Industry

The concept of combining Lean manufacturing and Six Sigma principles began in the middle to late 1990's, and has quickly taken hold. There are many examples of manufacturing companies implementing a combined effort of Lean and Six Sigma presented in Chapter 2, the literature review.

1.3 Lean Six Sigma Application in the Public Sector

The majority of the applications of Lean Six Sigma in the literature have been in the private sector, mostly in the manufacturing industry and typically in larger companies. Many experts in Lean and Six Sigma suggest that the tools can be used in non-manufacturing settings including: software development, service industries such as customer service call centers, education, in administrative functions such as accounting and order processing, material procurement, and new product development. (Bossert, and Grayson, 2002)

From a review of the literature, there was no literature found of local governmental entities using a combined approach of Lean Enterprise and Six Sigma. There are some examples of local governmental entities applying Six Sigma principles and tools, and winning the Florida Governor's Sterling Award, which is modeled after the Malcolm Baldrige National Quality Award.

Although the literature does not provide cases of Lean Six Sigma programs in local governments, there is evidence in the literature of applications of quality principles and tools in

the public sector. A study by Hellein and Bowman investigated the impact of implementation of quality management in four Florida state government agencies. (Hellein, and Bowman, 2002)

A study in the UK investigated the use of quality management in the public sector and in the private service sector. (Redman, Mathews, Wilkinson & Snape, 1995)

There are few long-term examples in the literature of mature quality programs and the application of quality principles and tools in the governmental sector. Surveys indicate that large numbers of agencies at all levels of government have adopted quality programs, but it is not clear whether many of them have moved beyond the initial stages with a strong commitment to making quality a way of life on an on-going basis (Poister and Harris, Jr., 2000; Hyde, 1997). The implementation of quality principles and tools began in 1982 at PennDOT allowing a view of a more mature quality program in a public agency (Poister and Harris, 2000).

A critical initial element of any Quality program and also of Lean Six Sigma is the identification and implementation of performance measures. The Government Performance and Results Act of 1993 required government agencies to submit strategic plans and performance measures to justify their budgets (Chmielewski and Phillips, 2002). Subsequently, there has been a major effort in the last five years to implement performance measures in local governmental entities in the United States. (Government Accounting Standard Board (GASB), 2002).

1.4 Research Objective

The combination of Lean Enterprise and Six Sigma principles has been applied in private industry, mainly in manufacturing companies. The research literature does not provide a framework for implementing Lean and Six Sigma in local government.

The objective of this research is to develop an implementation framework roadmap for implementing Lean Six Sigma principles and tools in local governmental entities. The research will provide a framework roadmap so that local governmental entities can implement Lean Six Sigma to improve quality, reduce variation, and eliminate waste using the author's framework roadmap.

1.5 Overview of Research Methodology

Upon review of the existing literature, none has been dealing with the implementation of a Lean Six Sigma methodology in local governmental entities. A framework for implementing Lean Six Sigma in local government is developed that includes the activities, principles, tools, and important component factors that can be used to implement Lean Six Sigma in local government. A case study is developed to validate the framework roadmap in a financial department in a local government. Financial process measures will be developed from the case study that can be used to improve the financial processes. Results and conclusions from the case study are presented, and limitations and ideas for future research in the area of Lean and Six Sigma are also highlighted.

CHAPTER 2
LITERATURE REVIEW

2.1 Lean and Six Sigma Defined

Lean Six Sigma is an approach focused on improving quality, reducing variation and eliminating waste in an organization. It is based on the concept of combining two improvement programs, Six Sigma and Lean Enterprise. Six Sigma is a both a quality management philosophy and a methodology that focuses on reducing variation, measuring defects and improving the quality of products, processes and services. The concept of Six Sigma was developed in the early 1980's at Motorola Corporation. Six Sigma became popularized in the late 1990's by General Electric Corporation and their former CEO Jack Welch. Lean Enterprise is a methodology that focuses on reducing cycle time and waste in processes. Lean Enterprise originated from the Toyota Motor Corporation as the Toyota Production System and increased in popularity after the 1973 energy crisis. The term "Lean Thinking" was coined by James P. Womack and Daniel T. Jones in their book, Lean Thinking (Womack and Jones, 1996). The term "Lean Enterprise" is used to broaden the scope of a Lean program from manufacturing to embrace the enterprise or entire organization (Alukal, 2003).

Six Sigma uses a structured approach to solving problems using the DMAIC cycle:

- Define – Define Six Sigma projects to resolve operational issues.
- Measure - Measure performance of the Six Sigma project.
- Analyze – Analyze project performance in relation to operational goals.
- Improve – Improve Six Sigma project management system.

- Control – Control inputs to project management system (Harry and Schroeder, 2000).

2.1.1 Statistical Meaning of Six Sigma

The Six Sigma metric focuses on defects per million opportunities (dpmo) defined as follows:

dpmo = DPU X 1,000,000/opportunities for error

Where:

DPU = Defects per unit = Number of defects discovered / Number of units produced

Six Sigma represents a quality level of at most 3.4 defects per million opportunities. Six Sigma is defined in the context of a manufacturing specification. The stretch goal of Six Sigma represents six standard deviations from the process mean to the specification limits, when the process is centered. A 1.5 standard deviation shift from target toward either specification limit would provide the maximum of 3.4 defects per million.

2.1.2 Six Sigma Toolkit

Six Sigma's toolkit includes many tools that can be used to measure and improve quality, such as:

- Affinity Diagrams – A tool to organize large groups of data, complex ideas or issues.
- Analysis of Variance (ANOVA) – Typically used in conjunction with Design of Experiments to analyze the impact of variables on a process.
- Benchmarking – A tool that enables an organization to measure their performance against best-in-class organizations. There are typically three types of benchmarking: 1) process

benchmarking, where best practices are compared across targeted organizations; 2) competitive benchmarking where competitors' data are compared to compare product features, pricing, and quality of products and services; and 3) strategic benchmarking compares the strategies that have led to competitive advantage and market success. (Evans and Lindsay, 2002)

- Brainstorming – A tool to generate ideas in a creative manner without evaluation of the ideas as they are generated. The brainstorming can be structured such as in a Nominal Group Technique format or unstructured as in free-form or free-wheeling brainstorming.
- Capability Analysis and Capability Indices (Cp and Cpk): A capability analysis involves performing a process capability study to understand whether the process is capable of producing products within specifications. Two capability indices that are typically generated after the process is found to be in control with respect to the variation, are the process capability index, Cp and Cpk. Cp measures the capability in relation to specification limits. (Evans and Lindsay, 2002), (Wadsworth, Stephens and Godfrey, 2002). The formula is

  Cp = (USL – LSL) / 6 σ;

  Where USL = Upper Specification Limit; LSL = Lower Specification Limit; and σ = measure of standard deviation.

  Cpk measures shifts in the process mean. The formula is

  Cpk = min (CPU, CPL)

  Where CPU = $(USL - \bar{x})/3\sigma$ and CPL = $(\bar{x} - LSL)/3\sigma$,

Where $\bar{x}$ = process mean.

- Cause and Effect/Fishbone Diagrams: Graphical tools used to investigate and organize cause and effect relationships of problems.
- Check sheets: Tools used to collect data pertaining to a process to understand process problems, and measure the impact of process improvements.
- Scatter diagrams: A graph used to understand the relationship between two variables.
- Design of Experiments, Taguchi Methods: A test or series of tests designed to understand the factors that effect the outcome or response variable of a process.
- Evolutionary Operation (EVOP): EVOP is a statistical procedure that involves experimenting on a process without upsetting quality or throughput. (Stephens, 1997).
- Failure Mode and Effect Analysis (FMEA): FMEA is a team-based problem solving tool that helps users identify and eliminate, or reduce the negative effects and potential failures before they occur in systems. The FMEA is typically performed during product and process design. (Benbow, Berger, Elshennawy, and Walker, 2002).
- Histograms: A statistical tool used to understand the nature of a process' distribution.
- Measurement system assessment (Gage R&R): Studies that measure the accuracy, repeatability and reproducibility (R&R) of a measurement system. (Evans, and Lindsay, 2002).
- Pareto Chart and 80/20 rule: A graphical tool based on the Pareto principle that most effects result from only a few causes. The tool helps to categorize and summarize the causes for further investigation.

- Process Mapping: A graphical flowcharting tool that helps to document and understand the processes for investigation, problem identification and improvement. The process maps identify the sequence of activities or the flow of materials and information in a process. (Evans, and Lindsay, 2002).
- Process Performance Metrics (DPMO, DPU): Performance metrics that measure the quality of a process or product. These metrics were defined earlier.
- Quality Function Deployment (QFD): A set of matrices used to gather and understand the voice of the customer (VOC) and relate the VOC to the product's technical requirements, component requirements, process control plans, and manufacturing operations. It is a customer-driven planning process to guide the design, manufacture and marketing of goods. (Evans, and Lindsay, 2002).
- Regression Analysis: Regression analysis is a statistical tool for finding estimates of the parameters in a regression model. The regression model is used to predict future observations of the mean response variable. (Montgomery, Runger, and Hubele, 2001)
- Response Surface Methodology (RSM): Response Surface Methodology (RSM) is a statistical technique for modeling and analysis in applications where a response of interest is influenced by several variables, with the objective to optimize this response. (Montgomery, Runger, and Hubele, 2001)
- Run Charts: A run chart is a line graph that helps to understand the level and variation of a quality characteristic over time. (Evans, and Lindsay, 2002).

- Statistical Process Control: statistical process control uses one of the basic quality improvement tools, a control chart, to monitor a process to identify special causes of variation and signal the need to take corrective action. (Evans, and Lindsay, 2002).

2.1.3 Lean Toolkit

Some of the tools in the Lean tool kit are:

- 5S: The 5S process helps to bring organization and order to the workplace to support other Lean initiatives. The 5 components are: seiri (sort), seiton (set in order), seiso (shine), seiketsu (standardize) and shitsuke (sustain). (Monden, 1993)
- Balanced work flow and production smoothing: Balanced work flow across the production facility helps to smooth work to reduce inventory and bottlenecks. (Monden, 1993)
- Cellular manufacturing and multi-functional/flexible workforce: Reorganizing production in work cells consisting of groups of machines to smooth the production flow. This would require workers to handle multiple machines within a cell instead of just one type of machine. (Monden, 1993)
- Continuous improvement and Kaizen: Continuous improvement and Kaizen include the continuous implementation of smaller improvement activities through Kaizen blitzes, or short focused improvement sessions. (Monden, 1993)
- Demand based planning and Just-in-time (JIT) Production using Kanban and Pull Systems: These principles and tools incorporate the concept of providing products or

services in accordance with market demand. It is a critical component of a Lean system. (Monden, 1993)

- Inventory reduction occurs as a result of smoothing production and eliminating waste. (Monden, 1993)
- One piece flow ("takt" time): One piece flow includes the ability to flow smaller numbers or one piece of product at a time through the system to meet customer demand. "Takt" time is the time to product one unit. It is the regular operating hours divided by the salable quantity of products. (Monden, 1993)
- Set up reduction: Single minute exchange of dies (SMED) and set up reduction includes being able to reduce the time it takes to set up a machine for a product variety change to smooth production and meet demand. (Monden, 1993)
- Standardization of operations to attain line balance: Operations are standardized to produce the required quantity of product to meet customer demand. (Monden, 1993)
- Total Productive Maintenance: "Total Productive Maintenance (TPM) is a maintenance program which involves a …concept for maintaining plants and equipment. The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction." (Roberts, 1997). TPM includes tools to perform maintenance in a preventive manner based on the cost of preventing equipment break down through a planned maintenance program, versus incurring the cost of downtime and lost sales due to product not being produced on time.

- Visual control, mistake proofing (Jidoka), and good housekeeping: Visual control is the ability to control the processes through visual techniques. This may include among other techniques, Kanban cards or Kanban boards. Mistake proofing (Jidoka) is designing processes and machinery to eliminate the opportunities for error. Good housekeeping, which is also included in the concepts of the 5S's includes organization and cleanliness of the workspace to be able to find tools and materials easily and be able to work in a safe environment. (Monden, 1993)
- Waste identification and elimination: A critical concept to Lean Enterprise is the identification and elimination of wasteful activities that do not add value to the product or service being provided.

2.2 Lean Six Sigma Defined

Lean Six Sigma is a methodology that maximizes shareholder value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed and invested capital. (George, 2002) Lean helps to reduce the waste, but cannot reduce variation alone. Six Sigma can help to reduce variation, but alone does not reduce waste or reduce cycle time. Lean Six Sigma can be used on any process to eliminate waste and attain statistical control and reduce variation. (George, 2002)

2.3 Lean Six Sigma Approaches in the Literature

The concept of combining Lean manufacturing and Six Sigma principles began in the middle to late 1990's, and has quickly taken hold. There are many examples of manufacturing companies implementing a combined effort of Lean and Six Sigma.

An early example, starting in 1997 was by an aircraft-engine-controls firm, BAE Systems Controls, in Fort Wayne, Indiana. They blended Lean-manufacturing principles with Six Sigma quality tools. Their "Lean Sigma" strategy was "designed to increase velocity, eliminate waste, minimize process variation, and secure its future in the evolving aerospace market". (Sheridan, 2000) They started with implementing Lean initiatives and then identified a synergy between Lean and the Six Sigma quality program that had been launched while the company was a part of General Electric. BAE Systems Controls implemented the following Lean initiatives: 1) Kaizen events, 2) takt-time-driven one-piece-flow product cells, 3) Kanban pull system and point-of-use storage bins on the plant floor, 4) Lean production cells, 5) mistake proofing, and 3) use of a multi-skilled workforce. As part of the Six Sigma program, they implemented statistical methods and team leadership with the use of Black Belts. The primary focus of BAE's Six Sigma program was to reduce variation within their processes. To blend Lean and Six Sigma, they incorporated the Six Sigma Black Belts within the Kaizen teams. The Black Belts used the statistical techniques to help solve problems. They found that the Six Sigma tools helped to generate the data needed to justify major improvements, such as equipment upgrades. They also used cause and effect analysis to understand the underlying causes of the process variation that allowed the Lean improvements. In BAE Systems Control's implementation of Lean Six Sigma, they improved productivity by 97% and customer lead time by 90%. Their value-added

productivity increased 112% in five years, work in process was reduced by 70%, product reliability improved by 300%, and there were zero lost workdays in 1999. (Sheridan, 2000)

Another early innovator combining Lean and Six Sigma was Maytag Corporation. It implemented Lean Sigma in 1999. They designed a new production line using the concepts of Lean and Six Sigma. (Dubai Quality Group website, 2003). Maytag reduced utilized floor space to one third of that used by Maytag's other product lines. Maytag also cut production costs by 55%. Their Lean sigma effort helped Maytag to achieve savings worth millions of dollars. (Dubai Quality Group website, 2003).

TBM Consulting Group implemented their LeanSigma ^{SM} methodology at Pease Industries. (Smith, and Adams, 2001) The basic approach included first implementing Lean principles. The consultants established one-piece flow, eliminated waste and redeployed operators no longer needed on the line. Once the hidden factory or waste was exposed, they implemented Six Sigma principles to reduce variation and improve quality. The company performed a LeanSigma Event as follows: 1) a one day Measure phase applying a quality map, cause and effect analysis, Pareto analysis and a Chi Square analysis on defects, 2) A two day Analyze and Improve phase using Comparative Analysis, quality tools and hypothesis testing, Jidoka-Failure Mode and Effect Analysis (FMEA), Poka-Yoke (mistake proofing) and Realistic Tolerancing, 3) A 30-day Control follow-up phase. They found that they were able to complete projects faster, and generate quality with less capital. They also identified the root cause of a problem instead of implementing a $30,000 solution to a perceived problem. LeanSigma has saved Pease Industries over a million dollars a year in scrap and manpower reductions. In another LeanSigma implementation, TBM Consulting Group first performed LeanSigma

training. The project champions received one week of training. The Black Belts received four weeks of LeanSigma training. The Green Belts received two weeks of training, plus on-going mentoring. The LeanSigma improvement process of Measure, Analyze, Improve and Control (MAIC) was used to implement LeanSigma project. The typical MAIC project timeline consisted of 1) a Measure phase including a four to five day Kaizen event, 2) Analyze and Improve phase with a 5 day Kaizen event, and 3) a Control phase with a 30 day follow up. The improvement process also includes a few weeks between each phase for data collection and testing. Some of the successful LeanSigma implementations that TBM was part of achieved significant results, including: 1) capital reduction of 20 to 30% per year, 2) productivity improvement of 15 to 20% per year, and 3) quality improvement of 50% per year. In other case studies reported in the literature by Bonnie Smith the approach to LeanSigma depends on the problem to be solved. In a LeanSigma implementation with a playground equipment manufacturer the company had implemented Lean techniques and then implemented Six Sigma when a problem arose that needed Six Sigma Quality techniques. Another TBM Consulting Group LeanSigma implementation with a commercial refrigeration equipment manufacturer used the best of Lean and Six Sigma. (Smith, 2003)

Goyal presents how Lean Six Sigma was implemented in a company that converted paper documents to electronic copies. (Goyal, 2002) The company first improved the consistency of the product quality through the application of Six Sigma quality tools. They used a modified DMAIC improvement process. They first performed a Define and Measure phase. Brainstorming was used to identify over 30 problems. They then affinitized the problems into two categories and then prioritized the problems using a weighted voting consensus system. A

second brainstorming session further defined the problems. They then collected data to measure the problem. The second phase performed was the Analyze phase. They flowcharted the process and identified the value added and non-value added activities. Principles of Lean manufacturing were introduced during the Analyze phase including: 1) zero waiting time, 2) zero inventory, 3) scheduling using pull techniques, 4) reducing batch sizes, and 5) line balancing. They used Pareto Analysis within the Lean solutions. They performed an Idea Generation phase to develop an implementation plan. They performed a pilot test of the new process, and then implemented the change and checked the result. To control the processes they implemented control charts (a Six Sigma technique) and standard operating procedures (a Lean tool). The Lean Six Sigma implementation reduced the error rate by 98% when converting paper documents to electronic copies, increased productivity over 50%, reduced costs, improved quality, and improved the ability to handle peaks of input data within customer specified turnaround limits. (Goyal, 2002)

Lean Six Sigma has been implemented at Northrop Grumman, an Aerospace Company. They had already begun to implement Lean Thinking when they embarked upon their Six Sigma program. They integrated the WorkOut events (a problem solving process developed at GE) with the Lean Thinking methods and Kaizen events. They used Six Sigma's strategy and methods within their Product Teams, not as a stand-alone program. Their formal process integrated WorkOut, Kaizen and DMAIC into the Six Sigma Breakthrough WorkOut. They use subject matter experts and a Black Belt on their project team. They perform a four to five day Define/Measure phase. They then performed the Measure, Analyze and Improve phases of roughly thirty days each. The final activities included a post-WorkOut phase as the Control,

Integrate and Realize phase. They used the Lean improvements "to change some things that are obvious and save the Six Sigma tools for the High Fruit – the harder problems". (McIlroy, and Silverstein, 2002) They also used Six Sigma tools to validate proposed solutions statistically prior to implementing the solutions.

Lockheed Martin Aeronautical Systems reduced costs, improved competitiveness, customer satisfaction and the first-time quality of all its manufactured goods. They had separate Lean and Six Sigma projects, depending on the objective of the project and the problem that needed to be solved. (Kandebo, 1999)

Rockwell Automation Power System has used a program called Power Lean. Power Lean combines the structured problem solving and training structure of Six Sigma programs with the Lean concepts and Kaizen teams. The Power Lean approach uses value stream mapping to identify improvement opportunities and Kaizen events to implement smaller focused improvements. They used the Six Sigma problem solving structure and Black Belt leader concept to facilitate larger improvement projects and to implement Lean flow. (Illing, 2001)

Six Sigma and Cycle Time Reduction (CTR) have been implemented together in Citibank, an international financial company. They first trained the employees in Six Sigma defect reduction and Cycle Time Reduction. They used process mapping to understand and improve processes to eliminate wasteful steps. They implemented process improvement teams and focused on customers and defects through application of Six Sigma principles and techniques. Citibank improved total customer satisfaction, improved processes and reduced process timelines through application of Six Sigma and CTR. (Rucker, 2000)

Lean Six Sigma has also been implemented in distributors. K.J. Electric, a distributor of Syracuse New York, first implemented Lean principles and then Six Sigma techniques. (Trombly, 2002). Kaman Industrial Technologies, another distributor, implemented the Rockwell Automation Power Lean System which combines the Lean manufacturing philosophy with Kaizen and Six Sigma tools. They used the Kaizen events to develop improvement plans. Their Lean Six Sigma implementation reduced process steps by up to 50 percent, improved throughput and cycle time and reduced the use of resources. (Trombly, 2002).

In "The Perfect Engine" (Sharma, and Moody, 2001) Anand Sharma and Patricia E. Moody suggest that most companies first implement Lean principles and then implement Six Sigma techniques. (Drickhamer, 2002) In the book, "Leaning into Six Sigma", the authors describe implementing Lean Six Sigma in a manufacturer first by applying Lean principles, such as: first impressions, basic housekeeping, work cells, and preventive maintenance. The manufacturer then applied Six Sigma tools such as: gage repeatability and reproducibility, Design of Experiments and Analysis of Variance. (Mills, Wheat, and Carnell, 2001) Most of the companies reviewed in the recent literature also approach the application of Lean Six Sigma first by implementing Lean principles and tools and then, once the waste is exposed, variation is reduced and quality is improved by implementing Six Sigma tools. There are a few applications in the literature where the two methodologies are closely integrated into one methodology. In Michael L. George's "Lean Six Sigma, Combining Quality with Lean Speed", (George, 2002) the recommended methodology follows the Six Sigma DMAIC improvement process, interspersing Lean and Six Sigma tools within the framework. TBM Consulting Group's LeanSigma^{SM} methodology uses the Lean Kaizen improvement tool coupled with the Six Sigma

DMAIC improvement process to shorten the timeframe of a typical Six Sigma implementation of four to six months to one to two months. (Smith, 2002)

In an article by Paul A. Keller, he suggests defining a Six Sigma project to implement Pull scheduling, a Lean tool. The DMAIC improvement process would be used to implement Lean concepts. (Keller, 2001)

In reviewing the literature the two approaches to implementing Lean Six Sigma can be summarized as follows:

1) Using Lean and Six Sigma as complementary approaches. First implement Lean Thinking to identify and eliminate waste through the use of Kaizen events, then implement Six Sigma to reduce variation and improve quality using the DMAIC improvement process. Within this approach, Lean Kaizen and other Lean tools are typically applied on less complex problems, while Six Sigma and statistical tools are applied on more complex problems.
2) Use the Six Sigma DMAIC improvement process framework in a more integrated approach with Lean Thinking to focus on cycle time reduction and Lean tools and projects. The DMAIC improvement process is used to implement Lean projects, such as pull scheduling, set up reduction or cellular manufacturing.

2.4 Application of Lean Six Sigma in Local Government

The majority of the applications of Lean Six Sigma in the literature have been in the private sector, mostly in the manufacturing industry and typically in larger companies. Many experts in Lean and Six Sigma suggest that the tools can be used in non-manufacturing settings

including: software development, service industries such as customer service call centers, education, in administrative functions such as accounting and order processing, material procurement, and new product development. (Bossert, and Grayson, 2002)

From a review of the literature, there was no evidence found of local governmental entities using a combined approach of Lean Enterprise and Six Sigma. There are some examples of local governmental entities applying Six Sigma principles and tools. An example of a city government applying Six Sigma principles to improve customer service and increase the effectiveness of their services is the City of Fort Wayne Indiana. Fort Wayne began its Six Sigma implementation in the February of 2000, by first training city employees in the concepts and tools of Six Sigma. They have trained 23 Black Belts in a little less than 2 years, 6 of the Black Belts have been certified. In May 2001, Green Belt training began. Thirty-two Green Belts had been trained. Training was provided in-house by the Northeast Indiana TQM Network, which is a "collaboration of area organizations who are committed to improving their quality, productivity, competitiveness and profitability". (Northeast TQM Network, 2002) They have improved services in at least 14 different City departments, including: police, fire, parks, community development, water pollution control, city utilities, right of way, human resources, street, transportation engineering services, contract compliance, public information, Mayor's office and solid waste. (City of Fort Wayne, 2002) The city claims over $2.5 million dollars in savings or cost avoidance related to the Six Sigma problem solving tools. As a reference point, the City's 2002 revenue budget was $6.1 million dollars. The City of Fort Wayne appears to be one of the first local government entities to apply the Six Sigma problem solving tools, however, they have not combined Lean Thinking tools together with Six Sigma.

The City of Coral Springs Florida won the Florida Governor's Sterling Award in 1997. The Florida Governor's Sterling Award is based on the Malcolm Baldrige criteria of leadership, strategic planning, customer and market focus, information and analysis, human resource focus, process management and business results. The Malcolm Baldrige criteria are nationally recognized as standards of organizational excellence. The City of Coral Springs has implemented many components of a Quality management system, such as strategic planning, a mission and vision, continuous process improvement, a structured problem solving method and performance measures. The Quality management program appears to be a critical component of their organizational management system and a part of their culture. However, they have not implemented a formal Lean Six Sigma program or a formal Six Sigma program. (City of Coral Springs, Florida, 2003)

The City of Jacksonville Florida won the Florida Governor's Sterling Award in 2001. Their website did not provide information related to the award or to how they have incorporated Quality principles and tools, or give an indication that they have implemented a formal Lean Six Sigma program or a formal Six Sigma program. (City of Jacksonville, Florida, 2003)

The City of Kingsport Tennessee received a Good Works Initiative grant from the American Society for Quality (ASQ). The goal of the Good Works Initiative is to transfer Quality knowledge to not-for-profit, community-based organizations. A grant was provided to the City of Kingsport to reduce costs and improve the service reliability of trash collection. The City of Kingsport uses the Six Sigma DMAIC process. The City formed a Six Sigma team in June 2002 to focus on improving the delivery of trash services to constituents. (American Society for Quality, 2002)

One of the early implementers of Deming's principles and quality and productivity tools was the city of Madison, Wisconsin, under the direction of the then mayor, Joseph Sensenbrenner, who was the mayor from 1983 to 1989. They made improvements in the city garage that reduced average vehicle turnaround time from nine days to three and resulted in savings of $7.15 in downtime and repair for every $1 invested in preventive maintenance, an annual net savings to the city of Madison of about $700,000. The police department tested an experimental police district that focused on peacekeeping as the department's primary role and law enforcement second. They realized dollar savings related to overtime reductions. Customer surveys showed that citizens were satisfied with police service and that 85% of officers in the special district had higher levels of job satisfaction than in their previous assignments. By 1988 they had trained 75 team leaders and had implemented over 24 project teams. They implemented continuous quality improvement and training for all employees in quality-improvement skills and data-gathering techniques. (Sensenbrenner, 1991)

Although the literature does not provide cases of Lean Six Sigma programs in local governments, there is evidence in the literature of applications of Quality principles and tools in the public sector. In a study by Boyne and Walker, they studied how TQM was used in private and public organizations and whether TQM helped to improve performance in these organizations. They found that there was no systematic evidence of TQM helping to improve performance in public organizations. Even though TQM has been promoted by governments throughout the world and forms a central aspect of many public organizations' improvement strategies, the available evidence does not support that TQM is positively related to organizational success. The study identified three principles that were the focus of the TQM

efforts in the organizations, including having a customer focus, using continuous improvement and teamwork. (Boyne, and Walker, 2002) A study by Hellein and Bowman investigated the impact of implementation of quality management in four Florida state government agencies. They found that leadership, sophisticated organization structure, planned strategy, and department-wide communication helped to implement an effective quality management effort. They found that leadership was the most important implementation factor due to the ability of upper management to assign the required resources, and provide legitimacy for the improvement effort. Leadership also is able to create the vision to transform the agency and apply pressure on staff to change. Deliberate cultural change had little impact on successful implementation. Implementation styles that contrasted too strongly, or too quickly with existing cultures were rejected by the organization. Centralized quality offices are most critical in communications functions and as a depository for institutional learning. Teams were seen as a tool for quality, not an end in themselves. Successful initiatives were top-down rather than bottom up. Management needed to stress individual benefit for the program. Communication was essential to spread information, to coordinate reform and to generate enthusiasm. Although only four agencies were studied, the research demonstrated that even though it may be difficult to deploy quality management in public organizations, it is possible. (Hellein, and Bowman, 2002)

The literature also includes cases and studies related to implementing quality management tools in governmental entities. A case study in Northern Ireland studied the application of quality principles and tools in the Government Purchasing Agency. The Government Purchasing Agency (GPA) is an agency in Ireland whose role is to establish contracts on behalf of customers for the procurement of goods and services, and provide advice

and support to enable them to achieve value for money improvements in procurement generally. The case study showed the importance of performance measurement to involve both employees and consumers fully as is required in total quality. They have put in place processes and a purpose which are linked with total quality and have been willing to act upon areas for improvement that emerged in line with the ideas of continuous improvement. (Erridge, Fee, and McIlroy, 1990)

A study in the UK investigated the use of quality management in the public sector and in the private service sector. Quality management efforts in the public sector in the UK appear to be widespread within the public organizations that they surveyed. Half of the respondents reported that their organization had a formal TQM program. Some of the quality management tools used more frequently in the public sector were mission statements (87% of the respondents), customer satisfaction surveys (76%), quality awareness training (76%), customer needs surveys (68%), customer care training (69%), quality improvement projects (64%), quality steering group/committee (64%), vision statement (59%), quality circles/quality action teams (55%). Statistical Process Control and Just In Time tools were used in only 18% and 11% of the public sector organizations respectively. The public sector lagged the private service sector in the areas which required resources such as rewarding quality improvement and/or technical skills, such as competitive benchmarking. Although there was found to be a significant use of quality management tools in the public sector in the UK, negative results were reported. Over one in ten respondents reported adversely on quality management's effects on the areas of productivity, cost-efficiency, profitability and employee morale. A particular concern to some respondents (including public and private service sector respondents) was a lack of a clearly

demonstrable beneficial impact on financial performance. They felt that hard, "bottom line" indicators were needed to support quality initiatives and without these the momentum was likely to falter. (Redman, Mathews, Wilkinson, and Snape, 1995) Lean Six Sigma addresses the issue of integrating Six Sigma project objectives with bottom line results.

There are few long-term examples in the literature of mature quality programs and the application of quality principles and tools in the governmental sector. Surveys indicate that large numbers of agencies at all levels of government have adopted quality programs, but it is not clear whether many of them have moved beyond the initial stages with a strong commitment to making quality a way of life on an on-going basis. (Poister and Harris, Jr., 2000) (Hyde, 1997) Hyde identified the short-term focus of political appointees in government agencies who want results for which they could take credit in their two-to-three-year stay in office as an obstacle in applying quality management principles in the public sector. (Hyde, 1997) The Poister and Harris study identified several components that helped to make the implementation of quality management principles and techniques successful in the Pennsylvania Department of Transportation (PennDOT) including: creating a bottom-line, results oriented focus; participative management; employee involvement, process improvement and team-based problem solving; use of a standardized methodology; training programs and training as a priority; customer focus; institutionalizing quality into budgeting, and planning; a measurement system; customers and suppliers involved in improving processes; top leadership support and visibility for the Quality program; employee unions as partners in the Quality effort; and employee recognition within the framework of the Quality program. The implementation of

quality principles and tools began in 1982 at PennDOT allowing a view of a more mature quality program in a public agency. (Poister and Harris, 2000)

A critical initial element of any Quality program and also of Lean Six Sigma is the identification and implementation of performance measures. The Government Performance and Results Act of 1993 required government agencies to submit strategic plans and performance measures to justify their budgets. (Chmielewski, and Phillips, 2002) Subsequently, there has been a major effort in the last 5 years to implement performance measures in local governmental entities in the United States. (Government Accounting Standard Board (GASB) website, 2002) The Governmental Accounting Standards Board's (GASB) website describes performance measures as follows: "Performance measures are meant to provide more complete information about a governmental entity's performance than traditional budgets or financial statements and schedules can provide. Performance measures are concerned with the *results* of the services governments deliver, and help provide a basis for assessing the economy, efficiency, and effectiveness of those services." (Government Accounting Standard Board (GASB) website, 2002) Swindell and Kelly studied the linkage between citizen satisfaction surveys and internal local governmental performance measures. The International City/County Management Association (ICMA) created a forum for the first comprehensive benchmarking project. The first report was published in 1996 and included quantitative rankings of participating jurisdictions and information about the practices in high-performing jurisdictions. (Swindell, and Kelly, 2000) Based on a mail survey conducted by Julia E. Melkers and Katherine G. Willoughby of Georgia State University, they found that the use of performance measures by state and local governments is continuing to grow. The surveyed state and local entities responded that the

performance measures were effective in 1) improving communication with parties including executive-level and elected offices, and 2) help with "changing strategies to achieve desired results and changing the questions a legislator or their staff asks government managers". (Government Accounting Standard Board (GASB) website, 2002) Only 20.9% of the respondents in the state and local government category responded that their performance measures were effective in affecting cost savings. Only 33% of the respondents in the state and local government category responded that their performance measures were effective in improving effectiveness of agency programs. Thirty-six percent of the state and local government category responded that their performance measures were effective in improving programs/service quality. The performance measures have not yet proved to be effective for improving processes or reducing the costs of providing services for a large percentage of the respondents surveyed.

2.5 Summary

From a review of the literature, the combination of Lean and Six Sigma principles and tools have not yet been applied to local governmental entities. Six Sigma is just starting to be incorporated as part of local governments' Quality programs and initiatives in cities such as Ft. Wayne Indiana, and Kingsport Tennessee. Much of the literature related to governmental entities and Quality has focused on implementing Total Quality Management principles and tools and performance measures, but not formalized Lean Six Sigma programs.

Over the last several years Lean Six Sigma has increasingly been applied in

manufacturing companies. There have been two implementation approaches to Lean Six Sigma, 1) incorporating Lean and Six Sigma as complementary approaches, typically implementing Lean first applied to less complex problems and then Six Sigma to more complex problems where statistical tools can help to reduce variation; and 2) using the Six Sigma DMAIC improvement process framework to implement Lean tools and projects.

Lean Six Sigma has already been shown in case studies in the literature to be an effective program to help organizations reduce costs, eliminate waste, reduce variation, and improve quality of products and services and improve customer satisfaction. The literature also shows that Quality practitioners believe that Lean Six Sigma can be applied in industries beyond manufacturing, such as governmental entities, to help eliminate waste, reduce or avoid costs of providing service to constituents, and improve quality of the services to enhance customer (citizen) involvement and satisfaction in local governmental entities. (De Feo, 2001) The American Customer Satisfaction Index (ACSI) is a national economic indicator of customer evaluations of the quality of products and services in the United States. The ACSI issues a report on satisfaction of recipients of service from the federal government. The report issued in December 2002 concluded that, "Overall, government workers continue to receive high marks on courtesy and professionalism, but less so on timeliness of delivery of services. To allocate resources efficiently with the objective of improving citizen satisfaction with government services, a focus on timeliness would have the greatest effect." (American Society for Quality website, 2002). An integrated Lean Six Sigma program has shown to improve timeliness of delivery in manufacturing, and could prove useful to local governmental entities.

Dale and Boaden developed a generic framework to implement continuous quality improvement. (Dale, and Boaden, 1993) Dale used this generic framework to develop a framework for Quality Improvement in the Public Sector. The key components of the framework in the public sector were: 1) organizing, 2) systems and techniques, 3) measurement and feedback, 4) changing the culture. The organizing includes the planning, organizing and strategy definition activities to focus the improvement efforts. The systems and techniques include developing the quality management system to provide controls, discipline and standardization of the improvement efforts. The measurement and feedback components include defining performance measures, obtaining input from the voice of the customer, establishing benchmarks, defining a recognition system to celebrate successes and providing a continuous feedback mechanism across the program. The culture change includes planning and focusing on what it takes to change the culture to one that focuses on quality and continuous improvement. (Dale, 1994)

2.6 Rationale for Research

The combination of Lean Enterprise and Six Sigma principles has been applied in private industry, mainly in manufacturing companies. The research literature does not provide a framework for implementing Lean and Six Sigma in local government. The literature and the author's experience clearly show the need for a framework that will enable local governmental entities to take advantage of the many benefits that a Lean Six Sigma program would provide.

The objective of this research is to develop an implementation framework roadmap for implementing Lean Six Sigma principles and tools in local governmental entities. The research

will provide a framework roadmap so that local governmental entities can implement Lean Six Sigma to improve quality, reduce variation, and eliminate waste.

A framework roadmap for implementing Lean Six Sigma in local government is developed that includes the activities, principles, tools, and important component factors that can be used to implement Lean Six Sigma in local government. A case study is developed in order to validate the framework roadmap in a financial department in a local government. Financial process measures will be developed from the case study that can be used to improve the financial processes. Results and conclusions from the case study are presented and limitations and ideas for future research in the area of Lean and Six Sigma are also highlighted.

CHAPTER 3
FRAMEWORK METHODOLOGY

3.1 Framework Development

As the previous chapter shows, from a review of the literature, there was no evidence found of local governmental entities using a combined approach of Lean Enterprise and Six Sigma. There are some examples of local governmental entities applying Six Sigma principles and tools, and also quality management programs. Some of the literature identifies the elements that should be present to successfully implement a quality program, but no detailed framework exists to help local governments implement a successful Lean Six Sigma program.

This research proposes the development of an implementation framework roadmap that can be used by implementers of Lean Six Sigma in local governments to guide them in successfully implementing Lean Six Sigma. The author will develop the framework roadmap based on her knowledge and experience in implementing Lean Thinking and Six Sigma problem solving methods and tools in manufacturing and white collar transactional-based processes, as it applies to local governments. The literature will be used to provide the theory of Lean Enterprise, and Six Sigma, and to validate the framework components based on critical success factors in the literature. The framework components are the building blocks to organize the framework. Once the author defines the framework components, she will develop a detailed framework roadmap that prescribes how Lean Six Sigma can be implemented in local government. Lean Six Sigma is an holistic program that impacts the entire organization. The proposed framework will encompass the major framework components, and a detailed roadmap for implementing a Lean Six Sigma program applied to local governmental processes. The

roadmap will include the methodology and activities to implement the problem solving approach and Quality and Lean tools.

3.2 Framework Validation Through Application of A Case Study in the Financial Administration Department of a Local Government

Lean Six Sigma can improve the efficiency of processes, improve the quality of service delivery to citizens and reduce the costs of providing these services. The author will validate the Lean Six Sigma framework by applying it to the financial administrative processes in a local governmental entity. This will demonstrate how the tools and problem solving approach of Lean Six Sigma can be used to streamline the financial processes and reduce the time to complete the processes in a local government. The author is making the assumption that Lean Six Sigma can be similarly applied to other processes within local government.

The financial processes will include payroll, purchasing and accounts payable, accounts receivable, monthly reconciliation, and budgeting, in a 7,000-citizen municipality. The Finance Clerk generates paychecks for administrative personnel, the police department, the fire department, the public works department and city council. The International Association of Fire Fighters (IAFF) represents the fire fighters, which requires union dues to be held from the members' pay once a month and submitted to the union. The processing also includes pension matching, making pension payments and report generation. The payroll department also processes income tax payments, garnishments, child support and other withholdings to the appropriate agencies. Employees receive paychecks every two weeks. Pension reporting is performed on a monthly basis. The customers of the payroll process are internal city employees

and external agencies that receive withholding payments and reports. The initial processes, defined as current processes with respect to the processes before the Lean Six Sigma program is implemented, are inefficient, error-prone, lengthy, and have an extensive number of non-value added steps. The entire payroll, pension reporting, and withholding payment process takes between thirteen to seventy employee hours per pay period, depending if processing problems occur.

The purchasing and accounts payable processes enable the city personnel to purchase materials, products and services to run the city. Purchase requisitions are generated by personnel, the Finance Clerk generates the purchase order, which is then approved by the city manager, the Finance Director, and City Council, if necessary. Invoices are received by the Finance Director and processed by the Finance Clerk, with the appropriate approvals and signatures. The current state purchasing and accounts payable processes are inefficient, error-prone, lengthy, and have an extensive number of non-value added steps. Payments to vendors are frequently late. Multiple invoices for the same payment are frequently received and must be reviewed to determine if they have been paid. The up front purchasing process takes approximately seven to ten days to generate and approve the purchase orders after the approved purchase requisition is received. The purchase orders are then filed until the invoices are received. The entire accounts payable process takes approximately thirty to forty hours to process a batch from initial invoice receipt to vendor payment.

The Finance Clerk records revenue receipts and deposits revenue checks into the bank. In the current process there is a lag between when the revenue checks are received in the finance

department and when they are entered into the financial system and deposited into the bank, due to process inefficiencies, and workload capacity issues. The Accounts Receivable process can take between forty to eighty hours, depending upon delays and workload capacity issues.

The Finance Clerk is responsible for reconciling the financial records on a monthly basis. Reconciliation includes comparing the bank statements for the payroll account, a general account, and several investment accounts to the financial system entries. Due mainly to either process inefficiencies or workload capacity issues, or both, monthly reconciliation currently is rarely performed in a timely manner. Sometimes the Finance Director reconciles the books, and other times it is outsourced to an accountant. The monthly reconciliation process can take from forty to eighty hours, depending upon problems encountered and problem delays.

The Finance Director is responsible for managing the budgeting process throughout the city. He receives budget requests from department managers, consolidates them into a city budget, prepares budget reports for state and county agencies, and makes budget journal entries. The Finance Director is also responsible for ensuring that expenditures are within the approved budgets, and sharing the budget information with city management. There are some training issues with respect to using the financial system for budgeting, as well as duplicate data entry in various formats and information. The financial information system is also limited with respect to budget reporting.

The Lean Six Sigma problem solving approach known as DMAIC (Define-Measure-Analyze-Improve-Control), along with other quality and Lean tools will be used to improve the financial processes. A successful implementation of the Lean Six Sigma problem solving

approach and Quality and Lean tools will be measured by the reduction of process inefficiencies, the reduction of the time it takes to process the financial transactions, and the assignment of appropriate staffing levels to handle the workload. No quantitative or qualitative measures of process or quality characteristics existed prior to the Lean Six Sigma implementation for any of the financial processes, but will be developed within the case study.

3.3 Significance of the Research

The SITE MAP (Service Improvement for Transaction-Based Entities Lean Six Sigma Framework Roadmap) for implementing Lean Six Sigma in local governments can be used to improve processes that deliver services to internal and external customers of the local governmental entity. The Lean Six Sigma program can reduce cycle time, improve quality and streamline the transaction-based service-related processes of local governments. The Lean Six Sigma framework and the validation of the framework through application of a case study in the financial administration department in a local government can be used by cities to implement Lean Six Sigma. Lean Six Sigma projects can be developed (Define) by city management that will identify processes to be streamlined to ultimately help improve customer satisfaction. Additionally, research has found that Lean Six Sigma principles such as, employee participation, empowerment and teamwork, help improve employee satisfaction, resulting in a positive impact on customer satisfaction (Schneider and Bowen, 1995), (Foster, Howard and Shanna, 2002) Lean and Quality tools, such as process flow charting, Pareto analysis, cause and effect analysis, Kanban, and Kaizen are just a few of the powerful tools that can be used to measure, understand,

and analyze the current state of the processes (Measure, Analyze). Many of the same Lean and Quality tools can be used to improve (Improve) and control (Control) the processes to eliminate and reduce the non-value added activities so that service delivery time and quality can be improved, and controlled.

The SITE MAP will further the body of knowledge and application of Lean Six Sigma principles and tools in local governments and can be potentially used as the basis for a framework for other similar transaction-based process environments.

3.4 Framework Methodology Summary

Figure 3.1 provides a summary of the framework methodology. It identifies the activities that are performed within the research, and the outputs and results of each activity. The literature review, the framework components, the framework roadmap, the mapping of the framework components to existing critical success factors, the case study, the financial process measures, the results and conclusions, the limitations of the framework, and the ideas for future research are the main contributions of the author and this research.

The author performed a literature review to understand the current state of the literature with respect to Lean Six Sigma both in private industry and in local government, as well as application of quality management principles and tools in local government. The output was the summary of the current literature state and the identification of the research gap that no framework exists for applying Lean Six Sigma in local government. The author developed the framework components that are the building blocks of the SITE MAP from her experience and

knowledge. The author reviewed the literature to further understand the critical success factors related to process improvement and quality management programs. These factors help ensure the success of process improvement and quality management programs. The author then mapped the framework components to the critical success factors to ensure that the components are based on sound theory. The author developed the SITE MAP that identifies the activities, principles, tools and important component factors that can be used to implement Lean Six Sigma in local government. The author developed a case study in a local government's finance administration department to validate the framework roadmap by successfully implementing Lean Six Sigma. The author also developed financial process measures that can be used to measure financial process improvement. The author identified the results and conclusions from the case study, and summarized the limitations of the framework. The author then developed ideas for future research that can help to further advance the theory and application of Lean Six Sigma in local government and other transactional-based process environments.

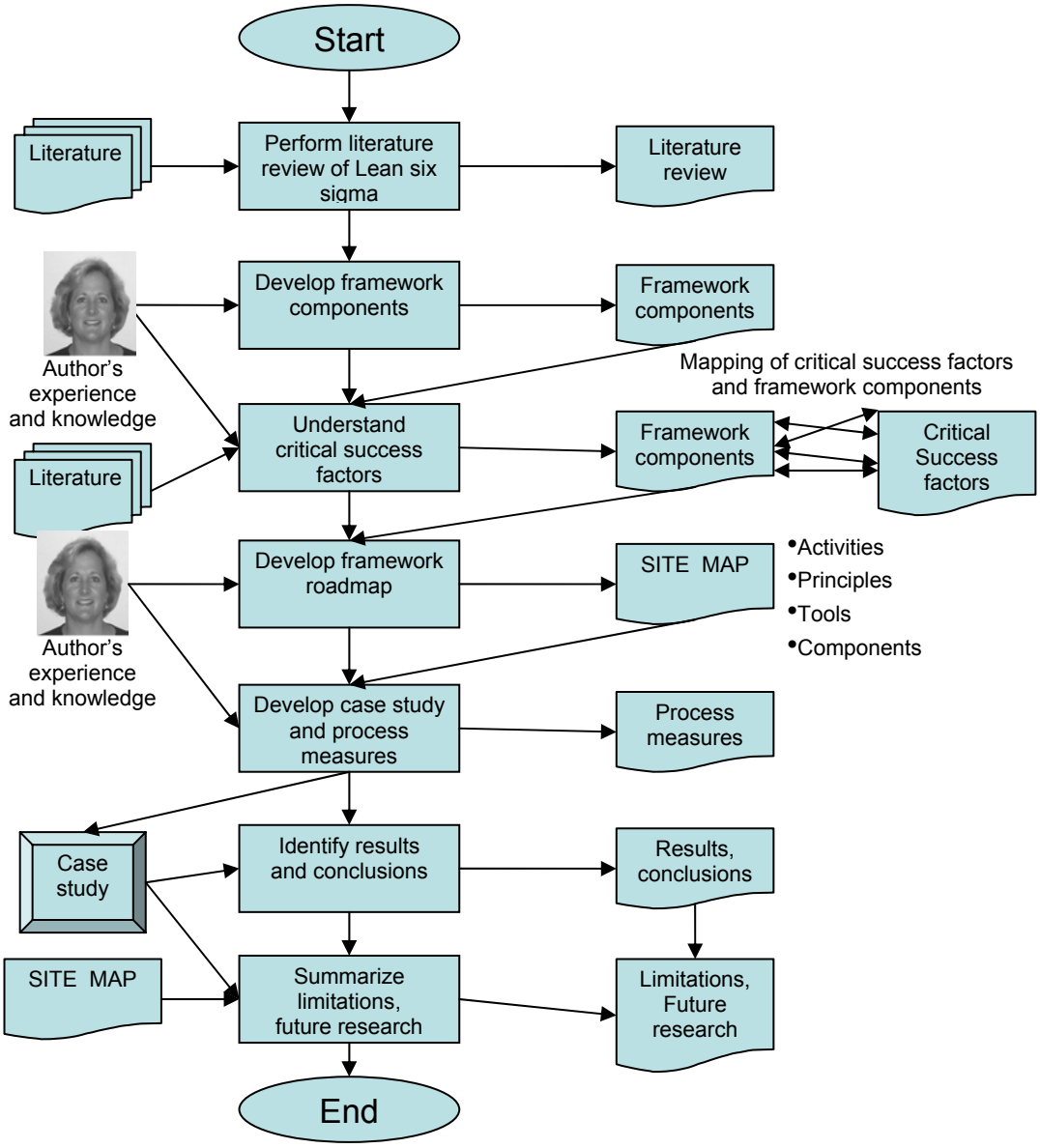


Figure 3. 1 SITE MAP (Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap) Methodology Flow Chart

CHAPTER 4
FRAMEWORK COMPONENTS AND CRITICAL SUCCESS FACTORS

4.1 Introduction

The author identified the framework components that form the building blocks of the SITE MAP (Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap) based on her experience implementing Lean and Six Sigma in manufacturing and in transaction-based processes. She selected the important components that would apply to transaction-based environments and processes, such as in local government. She then mapped the components against the critical success factors identified in quality management and process improvement literature to help ensure that the framework roadmap is based on sound theory. The critical factors help to ensure the success of a quality management oriented program, including total quality management, Six Sigma, a Lean or a Lean Six Sigma program. These programs draw upon similar bodies of knowledge and conceptual frameworks and principles, such as, employee empowerment, participative management, teamwork, training and education, problem solving and improvement. A critical success factor with respect to a Six Sigma program or projects is defined as "… the essential ingredients without which a project stands little chance of success". (Coronado and Antony, 2002) First, the framework components will be presented. The critical success factors from the literature will be presented. Then the critical success factors will be mapped against the defined framework components to ensure that the framework

components are based on sound theory, and that they provide the critical infrastructure of the Lean Six Sigma framework roadmap.

4.2 Description of Framework Components

The author has defined seven framework components that create the infrastructure for the SITE MAP for local governmental entities. The framework is designed to be applied by local governmental entities to improve the quality, reduce costs and variation of service delivered to its customers. Local governmental entities include municipalities, counties and other government agencies that serve customers at the local level. Figure 4.1 presents the framework components for implementing Lean Six Sigma in local government. The following section provides a description of each framework roadmap component and how each framework component applies to transaction-based entities, such as local government.

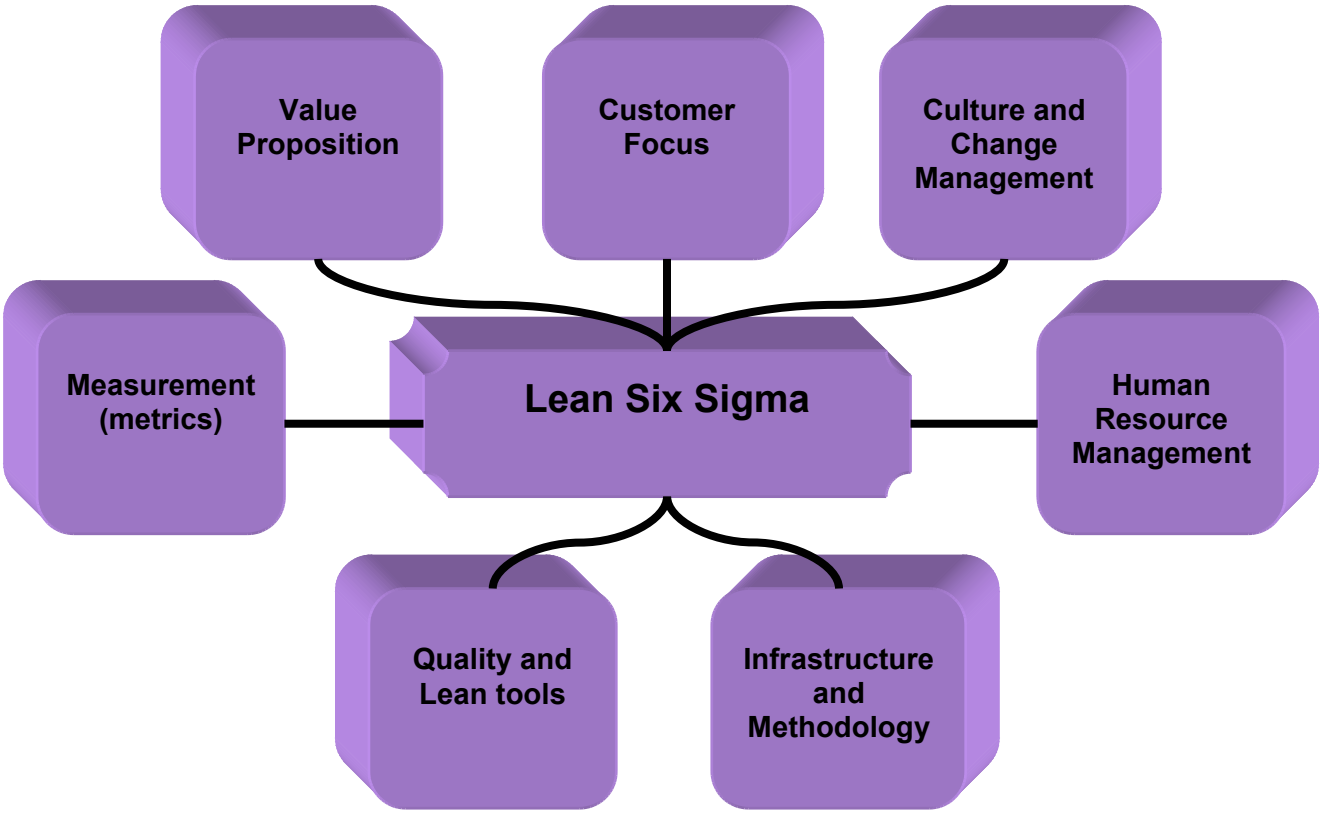


Figure 4. 1 SITE MAP (Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap) Components

4.2.1 Value Proposition

The value proposition is used to "sell", or convince local government management of the value of implementing a Lean Six Sigma program. The value proposition for a Lean Six Sigma program is very different in a local governmental entity versus a manufacturing company in the private sector. In a private sector manufacturing company, profit is the main goal. The goal of improving profit can be realized by reducing costs, improving cycle time, reducing defects and variation, while improving quality and customer satisfaction. Governmental entities do not have a profit component, although they do have a cost component.

There can be many facets related to the Lean Six Sigma value proposition, depending on who is defining the value. For example, a city manager may define the value of a Lean Six Sigma program from a customer perspective of how it can help provide better customer satisfaction to citizens, legislature, and city council customers. The city manager could also define the value from a personal perspective of how it can potentially lengthen his or her tenure as city manager. Another perspective can be from the perspective of reducing or avoiding costs as budgets are becoming increasingly stagnant or even decreasing. There is also increasing pressures to privatize services and even to improve and reinvent government, and the value could relate to these efforts.

Lean Six Sigma can provide value by:

1) Reducing or avoiding costs of providing services to citizens. One example of avoiding costs is the ability to not hire additional staff or resources due to streamlined processes and the release of additional staff capacity.
2) Helping to better understand and satisfy customers' needs, including customers as citizens, legislature and city council.
3) Improving processes to reinvent government, eliminate waste, improve quality and productivity, and reduce variation.

Symptoms of environments where extensive waste and non-value added activities exist can be used to convince management that improvement is needed. Some of the symptoms that are common are:

- My employees complain that they need more staff, or that morale is bad.

- Customers (internal and external) complain that work is always late (vendors don't get paid on time).
- Customers complain that the work is error-prone (my paycheck is wrong).
- Expediting is rampant or the norm.
- Audits (financial, etc.) show non-compliance.
- Citizens complain.

The following function is a relational qualitative function, not a strict mathematical function, but can be used to represent the Lean Six Sigma overall value proposition. It is important to note that if any of the three elements are missing, the value of the proposition is zero.

SITE MAP Value Proposition = Quality of Service Delivery X Trust X Financials

Where:

- *Quality of Service Delivery* is measured by defects in the service delivery process; the ability to meet customers' expectations; the ability to be responsive to customer's service delivery needs, which incorporates process measures related to productivity and cycle time; and variability of processes which can lead to errors and responsiveness issues related to service delivery.
- *Trust* is measured by the relationships built between city government and it's internal and external customers, and can be evaluated through customer and stakeholder surveys.

- *Financials* includes the costs and revenues of providing government services and can be measured by the reduction in costs related to the Lean Six Sigma program, and by the revenues that can be attained by providing government services.

A critical component of a Lean Six Sigma program and the DMAIC problem solving approach encourages defining performance measures that can be used to assess the SITE MAP Value Proposition, which will be discussed in the measurement component.

4.2.2 Customer Focus

Defining the customer of the processes in a local government can be complex. There are potentially many customers of a local government including: 1) the taxpayer, 2) the elected officials, such as the mayor, and city council members; 3) the legislature who allocates resources, and 4) the citizens who directly access government services, such as a person paying their utility bill at the city building. Whether these people are defined as customers or stakeholders is dependent upon how the scope of the Lean Six Sigma project is defined, and which processes are part of the improvement effort. It is important that the project team comes to agreement as to who the customer is, for the different projects and components of the processes.

4.2.3 Culture and Change Management

This framework component incorporates the cultural and political aspects of the local government. It includes developing a change strategy that addresses how to change the culture to focus on continuous improvement and measurement, focusing on the customer, the technical,

political individual, and organizational elements of change. Mapping the political terrain (Bolman and Deal, 1997) can help to identify the stakeholders and their acceptance or resistance to change. A communication plan and strategy can be developed to address how to help the stakeholders become less resistant to change. The inherent structure of the DMAIC problem solving approach, and the focus on data and measurement, helps with the culture and change management component. The project management components of Lean Six Sigma and clearly defining the mission, vision, and goals of the Lean Six Sigma projects also helps with changing the culture to embrace quality, productivity and continuous improvement.

Also important to help change the culture is to thoroughly and continuously communicate the status of the Lean Six Sigma effort and projects. This communication can include formal project kick-off meetings where the mission, vision, and goals of the Lean Six Sigma program and projects are discussed. At the beginning of the program and projects, it is critical to identify and communicate the mission, vision, values, goals, roles and responsibilities of the projects and project teams. Throughout the projects, it is important to provide continuous status of the projects through periodic status meetings and reports so that the organization is aware of the successes and learnings from the projects.

It is also important to show that management (department and/or the city manager) is committed to leading the Lean Six Sigma effort in the city. If the effort is focused across the entire city, the city manager should show their constant and continued commitment and support to the Lean Six Sigma effort. If the effort starts at a department level, the department manager's involvement and commitment is critical. Project champions must also be identified to spearhead the effort and remove obstacles and barriers to successful implementation. Project champions

can be department managers, supervisors, and even the city or assistant city manager. In a council-manager form of government, even though the mayor's position is largely ceremonial, he or she should still be aware and knowledgeable of the Lean Six Sigma effort, so that they can show their support for the program.

The culture and change management component can be the most difficult component of the framework roadmap, and the success of the project can depend to a great extent on the skills of the implementers to be able to manage the culture change

4.2.4 Human Resource Management

Most of the quality and process improvement programs, such as TQM, BPR, Six Sigma, Lean, and Lean Six Sigma incorporate elements to address managing the people in the organization. They advocate empowering employees to make and be accountable for decisions about their processes. They including training, education and providing the right skills for people to do their jobs. The Lean Six Sigma program is based upon a team structure where team members solve problems together.

An important element is to carefully recruit and select new employees, especially in governments where it has been difficult to terminate employees. This component also includes rewarding and recognizing employees for their involvement on project teams, their teamwork and efforts, and their successful implementation of process and financial improvements, and meeting the goals and objectives of the project.

4.2.5 Infrastructure and Methodology

The infrastructure and methodology component provides the structure to support the Lean Six Sigma effort. It includes defining a methodology of how to perform the problem solving and improvement effort (DMAIC). It includes having visionary and committed leadership as a critical element of success. It includes incorporating a project management structure to ensure that the projects are successful and continually move toward a successful implementation. This component also includes developing a communication plan to communicate the mission, goals, objectives, and progress of the Lean Six Sigma program and projects.

4.2.6 Quality and Lean Tools

Quality and Lean Tools are valuable techniques to solve problems and improve the quality and productivity of the processes. Some of the tools that are applicable in a local government are: Process mapping, Kanban, visual control, mistake proofing, waste identification and elimination, one-piece flow, Pareto Analysis, Cause and Effect Analysis, project management, 5S (sort, set, shine, standardize, sustain), process measurement, benchmarking, brainstorming, statistical process control, continuous improvement and Kaizen.

4.2.7 Measurement (metrics)

The measurement component includes defining and applying performance measurements and metrics that can be used to measure improvements in quality, productivity, variability, service

delivery, and financials. The performance measurements should be defined within the problem solving methodology at a process level.

The identified framework components are the building blocks upon which to organize the Lean Six Sigma implementation framework. The components build the shell that will encompass the framework roadmap so that Lean Six Sigma can be successfully implemented in local government. Each component will be addressed again when the Framework Road Map is presented to understand the important factors within each phase of the DMAIC process.

4.3 Critical Success Factors

This section identifies critical success factors from the literature that will be used to ensure that the framework components are based on sound theory.

An article by Sureshchandar, Chandrasekharan, and Anantharaman (2001) identified twelve dimensions that were crucial to a Total Quality Management philosophy in service organizations. These can be applicable to local governments, since they provide citizen services, and can be considered closer to a service organization than to manufacturing companies. The twelve dimensions identified are:

1) Top Management commitment and visionary leadership: In many articles this factor is considered to be the most important to the success of any organization's change effort. Defining a vision of what the organization will look like after implementing Lean Six Sigma and embracing the change is also a critical factor.

2) Human Resource management: There are many components of Human Resource management that are necessary for successful implementation of Quality programs, including: recruitment and selection, training and education, employee empowerment, and employee involvement.
3) Technical System: The technical system includes the design of services and management of key business processes.
4) Information and Analysis System: The Information and Analysis system helps to disseminate information and enable communication of the program goals and successes.
5) Benchmarking: Benchmarking compares an organization against best of class related to processes, products, and financials as well as other issues related to customer and employee satisfaction.
6) Continuous Improvement: Continuous improvement is a critical factor that is a concept of Lean (Kaizen) as well Six Sigma and other Quality Management programs, encouraged by Deming's philosophy.
7) Customer Focus: The customer's needs and satisfaction are critical in a service-oriented organization.
8) Employee Satisfaction: Several studies have found a relationship between employee and customer satisfaction. The more satisfied the employees, the better they provide service to their customers (Schneider and Bowen, 1995) and that improvements and teamwork led to improved employee and customer satisfaction. (Foster, Howard and Shanna, 2002)

9) Union Intervention: Employee relations issues impact the success of a Six Sigma program. This factor encourages union and management to work together to affect change.
10) Social Responsibility: This dimension impacts the organization's image and goodwill and potentially impacts customers' satisfaction.
11) Servicescapes: The servicescape includes the tangible components of the organization providing the services, such as the condition of the City Hall building, the dress of the city employees.
12) Service Culture: The organizational culture that stresses service quality throughout the organization can establish seamless service delivery.

All of these factors were found to be critical for quality improvement.

Hoffman and Mehra (1999) identified six areas that are important to avoid failure in productivity improvement programs, as follows:

1) Top management support through leadership: This factor includes management's setting of goals and providing leadership and direction.
2) Education and training: Educate and train management and the workforce in the concepts and tools for improvement.
3) Empowerment: Empower the employees to make decisions and solve problems.
4) Performance Measurement Systems: Measure the performance and improvement gains.
5) Total employee involvement: All employees should be involved in the improvement effort.

6) Reward systems: The reward system should be tied to and support the improvement program.

Dale (1994) developed a framework for quality improvement in the public sector in Hong Kong. His main components and important factors are as follows:

1) Organizing
2) Planning and awareness
3) Communication
4) Strategy that is complementary and integrated with existing policies and strategies.
5) Departmental definitions and approaches to the program
6) Citizen charter initiatives
7) Vision and mission statements
8) Organizational structure to support the quality efforts
9) Communication
10) Development, training, communication and quality improvement team projects.
11) Identification of customers both internal and external.
12) Systems and techniques:
    - Management and employees appropriate use of tools and techniques
    - Training of the tools and techniques
    - Procedures, working practices and monitoring system.
13) Measurement and Feedback:
    - Voice of the customer
    - Performance measures (both internal and external)

- System for recognizing and celebrating people's achievements
- Continuous feedback mechanisms

14) Changing the Culture:

- Convince management
- Openness
- Planned culture change

One other critical component that was mentioned in the Dale article was that the quality program participants wanted to learn how to apply TQM to their particular environment and that training should be specific to their environment.

Newman (1994) focused on dimensions related to cultural change in the public sector, which is a critical component of any quality or productivity program. She identified several areas to focus on to successfully change an organization:

1) Clear links between strategic goals and the change strategies.
2) Clear leadership including symbols (what is important and valued in the organization) and action (leaders practicing the new values).
3) Systems to manage change and reward the new behavior.
4) Performance management (including standards) and review processes.
5) Training
6) Customer satisfaction focused on responding to users' needs and preferences.
7) Change strategies that build flexibility to respond to customers and the control to ensure consistency of quality in service delivery.

Poister and Harris (2000) identified many factors that helped build a successful quality management program in the Pennsylvania Department of Transportation (PennDOT), as follows:

1) Leadership and support in terms of finance, personnel, greater organizational autonomy and effective oversight; Visible quality champions.
2) Employee unions as part of the process.
3) Communication
4) Participative management and employee involvement
5) Process improvement
6) Team-based problem solving
7) Bottom-line, results-oriented focus
8) Standardized methodology
9) Master policy statements that assigned responsibility for quality improvement activities to managers at all levels in the organization and held them accountable for making progress
10) Training
11) Customer focus, customer service and data
12) Internal benchmarking
13) Outcome-based measurement system
14) Customers and suppliers included in the improvement process
15) Open, employee centered culture
16) Recognition
17) Upward mobility

18) Full-time quality coordinators/facilitators

Robertson and Gill (2000) provided guidelines for successful quality management programs in the public sector, as follows:

1) Customer satisfaction should be the primary goal and the ultimate measure of service quality.
2) The customers, both internal and external should be defined, including vendors, taxpayers, suppliers, council, employees, administration, legislators, and service users.
3) Develop and communicate a common vision.
4) Reward teamwork, encourage innovation and improve processes at all levels of the organization.
5) Training and self-improvement are important.
6) Employee involvement is critical.
7) Acknowledge and reward success at individual and team levels.
8) Eliminate fear in the workplace and empower workers.
9) Make the necessary change to successfully implement the goals.

McAdam and Mitchell (1998) discuss key success factors for change management implementation of business process re-engineering in the public sector. Their model focuses on public sector issues instead of private sector issues. The critical success factors that they identify are: people/staff, culture, structures, processes, information technology, strategy and policy and communication.

Goldstein (2001) identified the following Six Sigma program success factors: existence of a deployment or action plan; active participation of the senior executives; project reviews;

technical support (including the Black Belt structure), full-time resources dedicated to Six Sigma projects; a thorough training program; a communication plan; project selection that focuses on critical to quality and financial benefits, where data can be easily collected, a project has a high probability of success, and can be completed in four to six months; project tracking; incentive program and career paths; safe environment without repercussions; supplier plan; customer "WOWs." (Goldstein, 2001)

4.4 Framework Components to Critical Success Factor Mapping

The critical success factors from the literature were mapped to the Lean Six Sigma framework components to ensure that the framework model infrastructure will be based on sound theory. Table 4.1 shows the framework component and critical success factor mapping. This mapping shows that the critical success factors from the literature map well to the framework components and support the sound use of theory.

Table 4. 1 Framework Component and Critical Success Factor Mapping

Framework Component	Critical Success Factor
Value Proposition	• Convince management of the value of Lean Six Sigma to the customer.
Citizen (customer) Focus	• Customer focused on defining needs and requirements. • Customer-satisfaction as the main goal.
Culture and Change Management	• Top management commitment. • Clear vision and mission. • Values that support the changing culture. • Change strategy that builds flexibility to respond to customers, and focuses on the technical, political, individual and organizational elements of change. • Slow culture change. • Servicescapes that support the culture. • Union as part of the process. • Social responsibility of the organization.
Human Resource Management	• Training and education. • Employee empowerment. • Employee involvement and participation. • Recruitment and selection. • Drive fear from the organization and a safe environment without repercussions. • Reward and recognition systems that support the culture and program. • Encourage innovation. • Upward mobility and well-defined career path. • Teamwork.
Infrastructure and Methodology	• Visionary leadership. • Project management with projects focused on critical to quality characteristics and financial benefits. • Dedicate resources with Black belt structure. • Action plan and awareness. • Top management support through financials, personnel, greater organizational autonomy

Framework Component	Critical Success Factor
	and effective oversight. • Design of services. • Management of key business processes. • Highly disciplined problem-solving approach. • Program methodology. • Continuous process improvement • Communication throughout the program. • Benchmarking of processes, products, financials, customer satisfaction, and employee satisfaction. • Incorporate suppliers into the value chain.
Quality & Lean Tools	• Quality tools • Lean tools
Measurement	• Outcome-based, results oriented performance measurement system. • Measurement and feedback. • Measure customer satisfaction. • Link projects to financial benefits and business strategy.

CHAPTER 5
SERVICE IMPROVEMENT FOR TRANSACTION-BASED ENTITIES LEAN SIX SIGMA FRAMEWORK ROADMAP (SITE MAP)

5.1 SITE MAP Overview

The author developed the SITE MAP (Service Improvement for Transaction-Based Entities Lean Six Sigma Framework Roadmap) from her experience implementing Lean and Six Sigma tools and techniques across a wide variety of industries, including: manufacturing, construction, information systems development, telecommunications, non-profit, higher education, and government. The author helped to improve productivity and quality in the manufacturing, new product development, ordering and fulfillment, financial and support processes of manufacturing companies. The author also helped to improve productivity, quality, and the service delivery processes in transaction-based entities. A transaction-based process includes a process that creates value from processing information through a set of activities and transactions. The types of processes in service and transaction-based entities included: financial, information systems development, data fabrication, member application, accounting, and leasing.

The author's approach in developing the framework roadmap is to seamlessly integrate the Lean and Six Sigma principles, problem solving activities, tools, and components within the framework. The Six Sigma problem solving approach, DMAIC (Define-Measure-Analyze-Improve-Control), and the infrastructure of a problem-solving team led by an experienced quality facilitator (comparable to a Six Sigma black belt) is used in the framework to implement

Lean Six Sigma. The author applied appropriate Lean and Quality tools in an integrated fashion to improve the processes and eliminate waste and non-value added activities. The detailed SITE MAP will be described within the context of the phases of the DMAIC project and problem solving methodology extracted from the Six Sigma body of knowledge. The goals and activities, the Lean Six Sigma principles and tools, and the critical items to include within each framework component, for each DMAIC phase, are discussed in the next section. Figure 5.1 presents the major activities in each DMAIC phase for implementing Lean Six Sigma in local government.

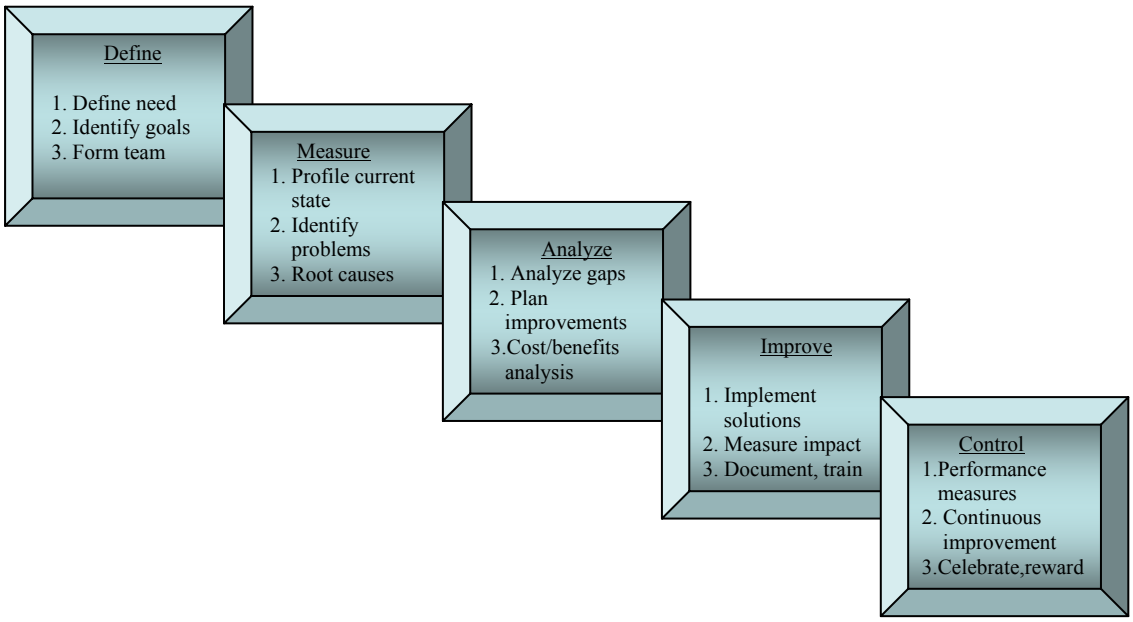


Figure 5. 1 SITE MAP DMAIC in Local Government

5.2 SITE MAP Description

This section describes the goals and activities, the Lean Six Sigma principles, tools and important framework components for each phase of the DMAIC problem solving process. It provides a detailed roadmap for the general case for implementing Lean Six Sigma in local government.

5.2.1 Lean Six Sigma Define Phase

5.2.1.1 Goal and Activities

The goal of the define phase of the DMAIC Six Sigma problem solving process is to define the need for improving the processes.

The following activities are part of the Lean Six Sigma Define Phase:

- Define process improvement need.
- Identify improvement goals, project scope, objectives and project plan.
- Form Lean Six Sigma improvement team.

5.2.1.1.1 Define Process Improvement Need

The first step is to define the need for process improvement. Many of the stakeholders, including the customers and suppliers, can identify that there are problems delivering services to the customers. Local government management, the employees involved in providing services or the customers who receive the services can identify that there are problems with delivering the services to the customers or with the quality of the service delivery process. If the customers

have not already been identified, the customers of the processes that need improvement are defined. The customers can be internal employees that receive services from other internal departments, or they can be external citizens, or vendors. Other critical stakeholders should also be identified that can impact the successful implementation of improvements.

5.2.1.1.2 Identify Improvement Goals, Project Scope, Objectives and Project Plan

The project champion and knowledgeable employees will identify the improvement goals. The goals should be quantifiable, measurable, reasonable and attainable. It may be difficult to identify quantifiable goals if process measures are not currently in place. The project scope and objectives help to focus the project. The project plan is developed with activities, estimated durations of the activities, the resources necessary to complete the activities, the relationships of the activities, and identified project risk factors.

5.2.1.1.3 Form Lean Six Sigma Improvement Team

The Lean Six Sigma team members are identified, including a project champion that will provide resources and provide the management commitment needed to successfully implement improvements; the process owner who has knowledge of the process and is responsible for delivering services; the Black Belt that has knowledge of the Lean and Quality tools and experience with implementing Lean Six Sigma; other technical and process-related team members, as appropriate to help meet the project team goals.

5.2.1.2 Lean Six Sigma Principles

The Lean principle of value is incorporated into the Define phase. The value will be defined with respect to the value that the customer receives from the process. For example, a payroll process has both internal and external customers. The internal customers are employees of the city. The external customers are tax and pension reporting authorities that receive the income tax and pension payments and reports outside of the city government. The Six Sigma principles incorporated into the Define phase are empowering teams, building and training teams, and building the infrastructure necessary to manage the project, including clearly defining the project goals, mission and vision of the teams.

5.2.1.3 Important Framework Component Factors

5.2.1.3.1 Value Proposition

The value proposition in the Define phase should be defined with respect to the project goals, and the value that the project will provide to the customer, such as, delivering the government services that the customers want, in a timelier manner, with less errors. It also can include reducing costs of delivering government services through implementing process, quality and productivity improvements, as they relate to the project goals. The measurement component will define measures that can be used to measure the customer value proposition.

5.2.1.3.2 Customer Focus

The customer and stakeholders for the project should be clearly defined in the Define phase. Once the processes are defined that will be improved, the customers will be defined from

the process, at a high level, during the Define phase. The SIPOC (Supplier-Inputs-Outputs-Customer) can be used to define the customers of the processes. The customers can be internal, for example, employees of other departments, and external, such as, citizens, or vendors that supply products or services to the city.

5.2.1.3.3 Culture and Change Management

Factors that should be considered in the Define phase related to culture and change management are clearly defining how the project(s) will be managed, especially with respect to status reporting and tracking and resolving project issues. Top management commitment must be clearly communicated to all team members in the Define phase. Holding a formal project kick-off meeting is important to communicate that management wants Lean Six Sigma to be part of the culture. The formal project kick-off meeting should include sharing the project teams' mission, visions, goals, members' roles and responsibilities; how the success of projects will be measured; how projects will be controlled and managed; how process improvement will be measured; the problem solving methodology; team building and team work concepts and goals; and an overview of Lean Six Sigma principles.

5.2.1.3.4 Human Resource Management

City and department management must be committed to the Lean Six Sigma effort and show this commitment by being involved in critical meetings. Management must decide how they will empower and hold employees accountable for improvement efforts. Training in Lean Six Sigma principles and tools, along with teambuilding should be delivered to involved

employees. Just-in-time training that can be immediately applied to improvement activities is usually most appropriate. Also within the Human Resource Management component, it is important to define the project team members' roles and responsibilities, and the mission, vision and goals of the project team.

5.2.1.3.5 Infrastructure and Methodology

In the Define phase, it is important to clearly define the methodology that will be used. The Six Sigma DMAIC problem solving methodology is recommended, with the tasks being applied specifically to local government processes. The infrastructure also includes building the project team, defining a steering committee to oversee the project teams' efforts, and assigning a project champion for each project. The project champion should be a high level manager, such as a department head, or the City Manager, if feasible.

5.2.1.3.6 Quality and Lean Tools

The Lean Six Sigma tools that are used in the define phase are project management tools such as defining a project charter, mission, vision, goals, team members' roles and responsibilities, project status reporting and issues tracking mechanisms. Brainstorming and interviewing techniques can also be used to collect information to define the projects and problems to be eliminated and the processes to improve.

5.2.1.3.7 Measurement

The team and management should define how project success will be measured. The measures should be in the context of the project goals, and if possible, should be defined in dollars, such as costs avoided or reduced, or additional revenues realized. Also within the measurement component, process measures should be defined to enable measuring whether the processes are improved.

5.2.2 Lean Six Sigma Measure Phase

5.2.2.1 Goals and Activities

The goal of the measure phase is to understand and document the current state of the processes to be improved, identify the process problems that are causing inefficiencies and errors, and identify the root causes of the problems.

The following steps are part of the Lean Six Sigma Define Phase:

- Profile the current state.
- Identify problems that contribute to process inefficiencies and errors.
- Identify root causes of problems.

5.2.2.1.1 Profile the Current State

The first step of the measure phase is to profile the current state. Process mapping and process flow charts are excellent tools to document the current process steps, the information that is used, the people who perform the work, and the internal and external customers of the services. It is also important to identify any process measures and related metrics that are used to

measure quality and productivity of the processes. The current profile of the people and cultural state should be understood, including the level of skills and training of the employees, and their resistance or acceptance levels to change. Additionally, the project stakeholders, who have a vested interest in the outcome of the project should be identified and profiled. A political terrain map can be used to assess the interests of each stakeholder and their acceptance or resistance to change. Figure 5.2 presents a proposed political terrain map derived from the concepts of Bolman and Deal (1997).

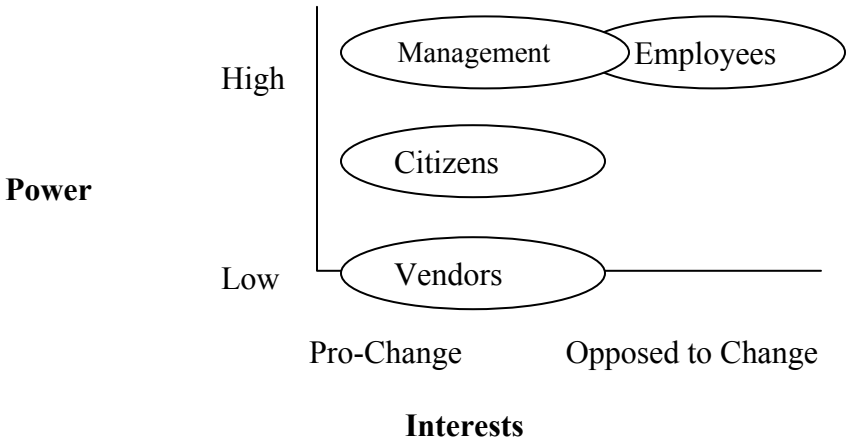


Figure 5. 2 Political Terrain Map

5.2.2.1.2 Identify problems that contribute to process inefficiencies and errors.

Lean and Six Sigma tools, such as waste identification and elimination, standardization of operations, Pareto analysis, and the 5S' are useful in helping to identify process inefficiencies that can cause longer cycle times and process errors.

5.2.2.1.3 Identify Root Causes of Problems

Cause and Effect analysis is used to identify root causes of process problems related to people (such as lack of training, skills, and motivation), methods (lack of standardized procedures), information technology (information system human factors and processing requirements), and hardware.

5.2.2.2 Lean Six Sigma Principles

The value stream principle is the main Lean principle applied in this phase. The transformation of information is the most important management task for an administrative service process such as typically found in local government. The value stream is identified using process flow analysis to identify the inputs, outputs, customers, suppliers, and information flowing throughout the process. This will help to streamline the entire value stream, not just those activities within the walls of the local government. The Six Sigma principles that are incorporated in this phase are those of training and transferring knowledge to the involved team members. Concepts and principles of systems thinking, variability, process focus, and statistical thinking should be included in the training at the start of this phase, so that the problem solving can include these principles. The principle of empowering the team members to identify and solve the problems is important. The customer and the value provided to the customer from the value stream is also an important principle to understand and apply within the Measure phase.

5.2.2.3 Important Framework Component Factors

5.2.2.3.1 Value Proposition

In the measure phase, the value proposition should be applied at a lower level to capture the measurement of process cycle times, the costs of providing services, and measuring quality of the service delivery process through responsiveness to the customer, and errors in the delivery process.

5.2.2.3.2 Customer focus

In the Measure phase, the voice of the customer information should be collected to define the customers' expectations and requirements with respect to the service delivery process. Examples of requirements are their expectations for responsiveness, such as turnaround time on vendor (customer) invoices, or error-rates, such as employee (customer) expectations of no errors on their paycheck. The voice of the customer can be captured through interviewing and focus groups with the customers. Quality Function Deployment can be used to organize the voice of the customer information.

5.2.2.3.3 Culture and Change Management

The project sponsors and the team leaders should assess the customers' and stakeholders' resistance or acceptance to change and embracing the Lean Six Sigma program. The political map discussed under the goals and activities section can be used to summarize the resistance to change. It is also important to hold a formal kick-off meeting to start each project to show top management support and commitment to the Lean Six Sigma program, if this was not already

done in the Define phase. Continual communication is important so that project status can be communicated, and issues that are barriers to the project can be identified and resolved as early as possible. The skills of the team members should be assessed and training should be given on the Lean Six Sigma principles and tools to be applied in the Measure phase on a just-as-needed basis. The tools training should be applied to the project so that the training will be better understood.

5.2.2.3.4 Human Resource Management

Training the team members in team-building concepts and how to empower the employees is important. The training should be specific to how management wants to empower the employees. An important responsibility of the team leader and/or Black Belt quality facilitator is to coach the team members to help them understand and apply the problem solving tools and to work effectively on a team. Some employees, especially when empowerment and problem solving are completely new to them, freeze when faced with solving a problem. Starting with small and focused problems can help to ease the team members into problem solving.

5.2.2.3.5 Infrastructure and Methodology

Building a project plan and applying project management techniques such as project status reporting and issues tracking mechanisms are important in the Measure phase to move the project forward. The training on principles and tools, and team-building and teamwork are important to successfully move through the activities identified in the goals and activities

section, and transferring knowledge of these principles and tools. Having an experienced Six Sigma Black Belt that has implemented Lean Six Sigma in a 'white-collar' and transactional-based process environment is especially critical early in the project.

5.2.2.3.6 Quality and Lean Tools

Process flow analysis and charts is a vital tool while measuring and assessing the current state of the processes. Interviewing one-on-one with the people involved in the processes, or holding facilitated sessions with a group of people that perform the processes, including customers and suppliers, to document the process flow charts can be used. The technique used to capture process information depends on the resources and time available. Brainstorming can be used to identify process problems. Cause and Effect analysis and Ishikawa diagrams can be used to identify root causes. Pareto analysis and charts can be used to identify, categorize, and prioritize problem areas. If performance metrics have not yet been defined, check sheets can be used to capture process measurement data, such as the number of errors found in the process, or the process cycle time, for how long it takes to complete the process. Histograms, Statistical Process Control, and capability analysis can be used understand the variability in the processes. In transaction-based processes, either moving range and individuals charts (x-chart), or attribute charts (p, np, c, or u charts) are the most common and useful types of statistical process control charts. Affinity diagrams are useful to organize large amounts of data to define the current state. Benchmarking can also be used to compare how the processes are performed compared to best-in-class, not necessarily in the same industry. For example, financial processes in other industries can be compared to understand how best-in-class financial processes are performed.

State Auditor web-sites can be used to identify other local municipalities that received clean financial audits, and interviews can be held with these municipalities to understand their best practices to see if they can be applied to improve the processes. Some capacity and resource benchmarks are available in some of the performance measurements being collected across local governments, such as the number of police officers or fire safety personnel in comparable municipalities. Care must be applied when using any benchmark information to understand the demographics and process characteristics behind the benchmark information so that valuable information is used. When possible, it is important to collect and analyze data on your specific processes, instead of blindly applying benchmark information collected from a website or report that may not apply to your own processes and characteristics.

5.2.2.3.7 Measurement

As already discussed in the value proposition section, process measurement information should be collected to understand process cycle times, quality of the service delivery process, and costs of providing the government services. This information will be used throughout the project to assess the current state and whether process improvements had a positive impact on the processes.

5.2.3 Lean Six Sigma "Analyze" Phase

5.2.3.1 Goals and Activities

The goal of the analyze phase of the DMAIC Lean Six Sigma problem solving process is to analyze the problems and process inefficiencies and define improvement opportunities.

The following steps are part of the Lean Six Sigma Analyze Phase:

- Analyze gaps from best practice.
- Identify improvement opportunities and develop an improvement plan.
- Perform a cost benefit analysis.

5.2.3.1.1 Analyze Gaps From Best Practice

Process mapping, Pareto analysis, benchmarking to best practices, waste identification and elimination, Kanban, visual control, mistake proofing, one-piece flow, 5S, and Statistical Process Control are some of the Lean Six Sigma tools than can help to analyze the current processes to understand where the gaps exist from best practice.

5.2.3.1.2 Identify Improvement Opportunities and Develop an Improvement Plan

The improvement opportunities are developed and then incorporated into an improvement plan. Improvement projects can be identified and sequenced based on available resources for implementation.

5.2.3.1.3 Perform a Costs and Benefits Analysis

Potential costs and benefits of implementing the process improvements should be identified so that management can determine which are the most feasible and beneficial to implement.

5.2.3.2 Lean Six Sigma Principles

The main Lean principles to be applied are flow and pull in the Analyze phase. Some transaction-based processes inherently have pull created in the system, but it is traditionally ignored by designing batch-processing into the system. For example, an accounts payable process could easily be built on responding to the pull signal of receiving an invoice from the vendor, by reducing batch sizes, and processing the invoices more frequently, weekly or even daily, by vendor due date, instead of once or twice a month, which can require extensive processing and validation efforts. However, there could be conflicting objectives with managing cash flow, and paying invoices later rather than sooner. The concept of one-piece flow or "takt" time includes the ability to flow smaller numbers of product at a time through the system to meet customer demand. This also provides the capacity to switch more easily between different tasks of an employee's responsibilities. For example, a finance clerk in a city government could process smaller batches of accounts payable and accounts receivable, being able to switch more easily between the two processes.

The Six Sigma principles that are important in the Analyze phase are focusing on the process and system, understanding and reducing variability, understanding and thinking statistically, and defining process measures to measure the current state of the processes. Just-in-time training and application of these principles and analysis tools are important. Empowerment, teamwork and participation are concepts that remain important throughout the program, but particularly in the Measure and Analyze phases where the synergy of team-based problem solving and empowered employees create exciting out-of-the-box thinking. Problem solvers that

are knowledgeable in the best practices of the processes to be improved are important to the Analyze phase as proposed solutions are designed.

5.2.3.3 Important Framework Component Factors

5.2.3.3.1 Value Proposition

The value proposition remains similar to the Measure phase. The team should continue collecting data to define process measures that will help identify improvements.

5.2.3.3.2 Customer focus

The focus of the customer remains important in the analyze phase. Process improvements that are identified should be reviewed with the customers and suppliers to understand the potential impact of the improvement opportunities.

5.2.3.3.3 Culture and Change Management

It remains important to continue the communication of project status, identification and resolution of issues, and any quick successes that have been discovered and implemented so far.

5.2.3.3.4 Human Resource Management

Empowerment, team building and coaching remain important factors within the Human Resource Management component of the framework during the Analyze phase. Coaching by the team leader or Black Belt quality facilitator is important to keep the level of morale up during the middle part of the Lean Six Sigma problem solving cycle.

Team members should include problem solvers that are knowledgeable in the best practices of the processes to be improved, as proposed solutions are designed. If the team members don't have this type of expertise, consultants can be used to generate some of the improvement opportunities. However, it is important that the team members feel that they own the solutions.

5.2.3.3.5 Infrastructure and Methodology

Detailed project plans should continue to be built and revised in the Analyze phase. Sometimes optimistic project plans are built at the start of the project, before knowledge of the scope and vastness of the work is realized. These plans need to be made realistic from a time, task, and resource perspective and communicated to team members, management, and project sponsors. First drafts of improvement plans for each main improvement area should be developed that include activities, resources needed, estimated costs and benefits of the improvements.

5.2.3.3.6 Quality and Lean Tools

Waste identification and elimination are critical tools in the Analyze phase. The process flow charts can show wasteful activities in the processes. Extensive decision loops can show error-prone activities that are cycled through numerous times. Extensive wait periods can indicate waste. The inability for the employee to get their assigned work activities done day-after-day, week-after-week, indicates a high degree of non-value added activities. Having to repeat activities and do rework of errors indicates that waste exists. Extensive validation steps,

such as checking large batch totals in financial processes, indicate non-streamlined activities. Extensive problems being encountered with the information systems may indicate the need for additional training or streamlining of the process flow. Many information systems are implemented with a generic process that was not designed for the specific characteristics of the process, and may need to be redesigned to be adapted to the specific needs of the environment. Variation in the time it takes to complete work activities indicates process problems. Frequent use of temporary employees indicates resource capacity issues and process problems. Extensive numbers of vendors or suppliers can be a potential area for improvement. By reducing the number of vendors the number of processing steps can be greatly reduced.

Poor or no documentation of how to perform work activities can identify the need for standardized, and written work procedures. Standardization of work activities helps to reduce variation by performing the activities the same way each time. The 5S' can be applied to help standardize, and organize the work activities. Having files and a place for all the materials, and paperwork going through a process can reduce waste.

Kanban and visual control can be implemented in transaction-based processes by identifying the activities that must be completed, and by whom, in a visual manner, such as posting activities on a bulletin board, or creating a filing system that mimics the steps of the process and is able to hold the documents for each step in the order of the process flow.

Reducing batch sizes and increasing the frequency of batches can help to move the processes closer to one-piece continuous flow where service can be delivered to the customers on demand.

5.2.3.3.7 Measurement:

The collection of process measurement data for the performance measures defined in the Measure phase should be continued, related to cycle times, quality of the service delivery process, and costs of providing the government services. The measures can be refined in the Analyze phase based on the deeper knowledge of the processes and the problems.

5.2.4 Lean Six Sigma Improve Phase

5.2.4.1 Goals and Activities

The goal of the improve phase of the DMAIC Lean Six Sigma problem solving process is to implement the improvement opportunities, measure the impact of the improvements and standardize the procedures.

The following steps are part of the Lean Six Sigma Improve Phase:

- Implement improvement solutions.
- Measure impact of the improvements.
- Document procedures and train employees on the improved procedures.

5.2.4.1.1 Implement Improvement Solutions

The process improvements will be implemented following the projects and projects plans defined in the Analyze phase. Project management should be used to monitor the status of the projects, and any issues that are impeding progress.

5.2.4.1.2 Measure Impact of the Improvements

The impact of the improvements should be measured from both a quality and a productivity perspective. If process measures are not in place, they should be designed and implemented along with the improvements.

5.2.4.1.3 Document Procedures and Train Employees on the Improved Procedures

It is critical to document the revised procedures and ensure that the employees are trained on the improved procedures. This will help the employees' buy-in to and understanding of the process improvements.

5.2.4.2 Lean Six Sigma Principles

The Lean principles of flow, pull, and standardization are implemented in the Improve phase. Statistical thinking, process focus, measurement and education are important Six Sigma principles in the Analyze phase. Once improvements are made, they need to be standardized, the new procedures should be documented and appropriate employees should be trained on the improved activities.

5.2.4.3 Important Framework Component Factors

5.2.4.3.1 Value Proposition

In the value proposition for the Improve Phase, the cost and benefits of each improvement should be tied to the project goals. The process measurements should also help to tie the costs and benefits to the project goals.

5.2.4.3.2 Customer Focus

The impact of the improvements to the customers should be measured after they are tested and implemented, through customer surveys and other appropriate means.

5.2.4.3.3 Culture and Change Management

Communication of the improvement plans and the success of the improvements that are implemented should be made across the entire organization. A summary report should be created that will become the project record of success. After the improvements are implemented, a post-project review should be held with the team, to help identify project learnings that can be transferred to the next Lean Six Sigma projects.

5.2.4.3.4 Human Resource Management

A reward system should be designed and implemented that rewards teamwork, and successful implementation of the improvements. If the employees belong to a union, management should work closely with union management to design a satisfactory reward system.

5.2.4.3.5 Infrastructure and Methodology

The improvement plans should be used as the guide for implementing the improvements. Project management techniques including developing project work plans, tracking status, and open issues should be used to successfully implement the planned improvements.

5.2.4.3.6 Quality and Lean Tools

Cost and benefit analysis is an important tool in the improve phase, so that the costs and benefits of each improvement area are documented. The improvement plans are critical to plan the activities and priorities of the improvements. Standardized procedures and training of the procedures are also critical tools in the Improve phase.

5.2.4.3.7 Measurement

The process measurement data should be collected before and after the improvements, and the improvements in cycle time, quality of service delivery, and costs of providing services should be evaluated. The feasibility of the improvements should be measured from a cost and benefit standpoint. The cost of many of the improvements can be quite small compared to the benefits of improved capacity, reduced cycle time, and improved quality of service delivery. The costs related to improvements can include the costs of training, and documentation of the standardized procedures. Many of the improvements include redesigning and streamlining work activities, and eliminating redundant non-value added activities that have crept into the processes just because they were never challenged before. Large information systems improvements or extensive capital investment is not usually needed for the first improvement efforts, since there is typically so much opportunity for improvement.

5.2.5 Lean Six Sigma Control Phase

5.2.5.1 Goals and Activities

The goal of the control phase of the DMAIC Lean Six Sigma problem solving process is to implement performance measures and other methods to control and continuously improve the processes.

The following steps are part of the Lean Six Sigma Control Phase:

- Design and implement process performance measures.
- Implement a continuous process improvement approach to always improve.
- Celebrate the successes, reward and recognize the project team members.

5.2.5.1.1 Design and Implement Process Performance Measures.

Process performance measures should be designed and implemented along with the improvements to be able to assess the impact of the improvements. Outcome-based, results-oriented measures are most helpful to understand the impact of the improvements on the quality and productivity of service delivery.

5.2.5.1.2 Implement a Continuous Process Improvement Approach to Always Improve

A structured process for continuous process improvement should be implemented to instill a culture of continual and continuous improvement.

5.2.5.1.3 Celebrate the Successes, Reward and Recognize the Project Team Members

It is important to celebrate the successful implementation of the process improvements not only at the end of the Lean Six Sigma project, but throughout each phase of the project. The team members should be rewarded and recognized for their efforts in learning new tools, embracing change, and implementing improvements that will help provide improved quality and productivity of service delivery to their customers.

5.2.5.2 Lean Six Sigma Principles

The Lean principles of perfection, Kaizen, and standardization are important in the Control phase. They correlate to the Six Sigma principles of continuous improvement, education, and continual learning. Other important Six Sigma principles are statistical thinking and measurement to help maintain control and continuously improve.

5.2.5.3 Important Framework Component Factors

5.2.5.3.1 Value Proposition

The value proposition for the Control Phase relates to the measures of cost, quality and productivity. For the improved processes, expected standards can now be created related to cost, quality and productivity. In the cost area, the major cost components are related to the resources needed to perform the processes, and the cost of poor quality and waste. The quality measures relate to responsiveness to customer's expectations for delivery time and error rates. Productivity measures relate to process cycle time, and resources needed to complete the activities.

5.2.5.3.2 Customer Focus

The satisfaction of the customer can be measured using customer surveys to ensure that the customers' needs are being met, and the improvements are improving, not reducing customer satisfaction.

5.2.5.3.3 Culture and Change Management

Project reports of the project successes and learnings should be communicated across the organization. A rollout strategy should be developed so that Lean Six Sigma can be implemented across other departments and processes in the government. A communication plan should be developed that includes how to communicate to other departments within the city government, to city council, to the city manager, the employees, to the unions, and even to the media.

5.2.5.3.4 Human Resource Management

A human resource management plan should be part of the continuous improvement plan, specifically with respect to empowerment, rewards and recognition, teamwork and participation, employee training, and employee hiring and retention.

5.2.5.3.5 Infrastructure and Methodology

On-going controls and performance measures should be developed within the Control phase. A structure and plan for incorporating continuous improvement should be developed, which would include elements related to all of the components of the framework.

5.2.5.3.6 Quality and Lean Tools

Statistical Process Control is a powerful tool to help control processes. Check sheets can be used to collect process measurement data. One-piece flow, Kanban, visual control, and the 5S' can all be used to continually control the processes. Continuous improvement and Kaizen are important to instill a culture that forever and continually improves.

5.2.5.3.7 Measurement

The performance measurements should be continually refined to provide value in controlling and further improving the processes with respect to cost, quality and productivity.

5.3 SITE MAP Summary

Table 5.1 summarizes the SITE MAP (Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap). It summarizes the important ingredients that should be applied from the Lean and Six Sigma bodies of knowledge (vertically in the table) for each phase of the problem solving approach (Define-Measure-Analyze-Improve-Control). It includes the principles, activities, value proposition, customer-focus, culture and change management, human resource management, infrastructure and methodology, quality and lean tools, and measurement.

Table 5. 1 SITE MAP (Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap)

	Problem Solving Phase				
Framework Element	**Define**	**Measure**	**Analyze**	**Improve**	**Control**
Principles	• Customer value, • Empowerment • Team building • Teamwork and participation • Project definition and scope	• Value stream • Training • Systems thinking • Empowerment • Process focus • Customer focus • Statistical thinking and variability	• Continuous one-piece flow • Pull • Statistical thinking • Variability • Process focus • Empowerment • Teamwork and participation • Measurement • Training • Theory of knowledge	• Continuous one-piece flow • Pull • Standardization • Statistical thinking • Measurement • Education	• Perfection • Continuous improvement and Kaizen • Standardization • Statistical thinking, • Education • Learning • Knowledge transfer
Activities	• Define need • Identify goals • Form team	• Profile current state • Identify problems • Investigate root causes	• Analyze gaps • Plan improvements • Perform cost/benefit analysis	• Implement solutions • Measure impact • Document, train	• Define performance measures • Continuously improve • Celebrate, reward
Value Proposition	Tied to project goals: • quality • cost • productivity	• Cycle time • Cost • Quality of errors • Meeting customer expectations	• Process measures	• Process measures • Cost/benefits	Process measures: • Cost (people, resources) • Quality (errors, delivery time) • Productivity (cycle time, capacity)
Customer-Focus	• Define customers and stakeholders • Voice of the customer	• Collect customer requirements and expectations	• Analyze customer data	• Improve and measure impact of improvements to customers	• Responsiveness expectations and cycle time • Customer surveys

	Problem Solving Phase				
Framework Element	**Define**	**Measure**	**Analyze**	**Improve**	**Control**
Culture and Change Management	• Project scope • Top management commitment • Formal communication plan	• Identify resistance to change • Formal kick-off • Project status • Communication plan • Identify skills and training needed	• Project status and reporting • Continual and frequent communication	• Project status • Issues management • Communication • Improvement plans • Leadership commitment • Reports	• Communicate success and learnings • Project reports • Rollout strategies to other departments • Communication plan
Human Resource Management	• Empowerment • Training • Team • Rewards	• Empowerment • Skill sets • Training	• Empowerment • Celebrate interim successes	• Teamwork • Project planning • Improvement planning	• Teamwork • Continuous improvement structure • Rewards • Celebrate
Infrastructure and Methodology	• Project charter • Mission • Vision • Goals • Roles and responsibilities	• Project work plan • Teamwork • Training • Knowledge transfer	• Project planning. • Improvement plans	• Implement improvements	• Continuous improvement structure • Controls/measures
Quality & Lean Tools	• Project definition, mission, and scope • Brainstorming • Interviewing • Facilitated sessions	• Process flow charts • Waste identification and elimination • Standardization of operations, • Good housekeeping • 5S's • Brainstorming • Cause and Effect • Pareto Analysis • Check sheets	• Cost/benefit analysis • Waste identification • Standardization of operations • Good Housekeeping • Kanban and visual control • SPC • Improvement plans • One-piece flow	• Cost/benefit analysis • Improvement plans • Standardized procedures • Training, pull, one-piece flow	• Statistical Process Control (SPC), • One-piece flow • Kanban and visual control • Continuous improvement and Kaizen • 5S's • Check sheets

	Problem Solving Phase				
Framework Element	**Define**	**Measure**	**Analyze**	**Improve**	**Control**
		• SPC • Histograms • Performance metrics • Capability analysis • Affinity diagrams • Benchmarking • QFD	• Pull		
Measurement	Tied to project goals: • Cost • Quality • Productivity	• Estimates of processing time • Error rates • Costs	• Process Measures	• Cost/benefit • Project feasibility • Process measures tied to project objectives	• Process measures: cost, quality, productivity.

CHAPTER 6
CASE STUDY

6.1 Introduction

Lean Six Sigma can improve the efficiency of processes, improve the quality of service delivery to citizens, and reduce the costs of providing these services. To validate the SITE MAP (Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap), the author implemented Lean Six Sigma in a local government's financial administration department. The goal of the project was to streamline the processes and subsequently reduce the financial process cycle time. The city is a 7,000-citizen municipality in the state of Ohio. It is a city-manager form of government where the city manager manages the city employees and implements policy defined by the mayor and city council members. The Finance Director reports to the City Manager, and is responsible for developing and managing the financial budgets, managing the financial processes, the mayor's court processes, the income tax collection, and utility billing and collection processes.

The financial processes include payroll, purchasing and accounts payable, accounts receivable, monthly reconciliation, and budgeting. The Finance Clerk generates paychecks for administrative personnel, the police department, the fire department, the public works department and city council. The International Association of Fire Fighters (IAFF) represents the fire fighters, which requires union dues to be held from the members' pay once a month and submitted to the union. The processing also includes pension matching, making pension payments and reporting. The payroll department also processes income tax payments, garnishments, child support and other withholdings to the appropriate agencies. Employees

receive paychecks every two weeks. Pension reporting is performed on a monthly basis. The customers of the payroll process are internal city employees and external agencies that receive withholding payments and reports. The current processes, with respect to the processes before the Lean Six Sigma program is implemented, are inefficient, error-prone, lengthy, and have an extensive number of non-value added steps. The entire payroll, pension reporting, withholding payment process takes between thirteen to seventy employee hours per pay period, depending if processing problems occur.

The purchasing and accounts payable processes enable the city personnel to purchase materials, products, and services to run the city. Purchase requisitions are generated by personnel, the Finance Clerk generates the purchase order, which is then approved by the city manager, the Finance Director, and city council, if necessary. Invoices are received by the Finance Director and processed by the Finance Clerk, with the appropriate approvals and signatures. The current state purchasing and accounts payable processes are inefficient, error-prone, lengthy, and have an extensive number of non-value added steps. Payments to vendors are frequently late. Multiple invoices for the same payment are frequently received and must be reviewed to determine if they have been paid. The up front purchasing process takes approximately seven to ten days to generate and approve the purchase orders after the approved purchase requisition is received. The purchase orders are then filed until the invoices are received. The entire accounts payable process takes approximately two weeks to process a batch from initial invoice receipt to vendor payment.

The Finance Clerk records revenue receipts and deposits revenue checks into the bank. In the current process there is a lag between when the revenue checks are received in the finance

department and when they are entered into the financial system and deposited into the bank, due to process inefficiencies, and workload capacity issues.

The Finance Clerk is responsible for reconciling the financial records on a monthly basis. Reconciliation includes comparing the bank statements for the payroll account, a general account, and several investment accounts, to the financial system entries. Due mainly to either process inefficiencies or workload capacity issues, or both, monthly reconciliation currently is rarely performed in a timely manner. Sometimes the Finance Director reconciles the books, and other times it is outsourced to an accountant.

The Finance Director is responsible for managing the budgeting process throughout the city. He receives budget requests from department managers, consolidates them into a city budget, prepares budget reports for state and county agencies, and makes budget journal entries into the financial information system. The Finance Director is also responsible for ensuring that expenditures are within the approved budgets, and providing budget information to city management. There are some training issues with respect to using the financial system for budgeting, as well as duplicate data entry into multiple information systems. The financial information system is also limited with respect to a user friendly ad-hoc budget reporting system.

The Site MAP which includes the Lean Six Sigma problem solving approach, along with Quality and Lean tools, was used to improve the financial processes. A successful implementation of the Lean Six Sigma problem solving approach and Quality and Lean tools will be measured by the reduction of process inefficiencies, the reduction of the time it takes to process the financial transactions, and the assignment of appropriate staffing levels to handle the

workload. No quantitative or qualitative measures of process or quality characteristics exist for any of the financial processes.

6.2 Application of Lean Six Sigma in Local Government

The DMAIC (Define-Measure-Analyze-Improve-Control) problem solving methodology from the Six Sigma approach was used to improve the financial processes. Figure 6.1 presents the DMAIC problem solving methodology used in the local government's Finance Department. Application of each phase of the DMAIC to improving the financial processes will be presented in the following sections. The case discussion mirrors the framework roadmap developed in chapter 5 to show how Lean Six Sigma was applied in a particular local government's Finance Department.

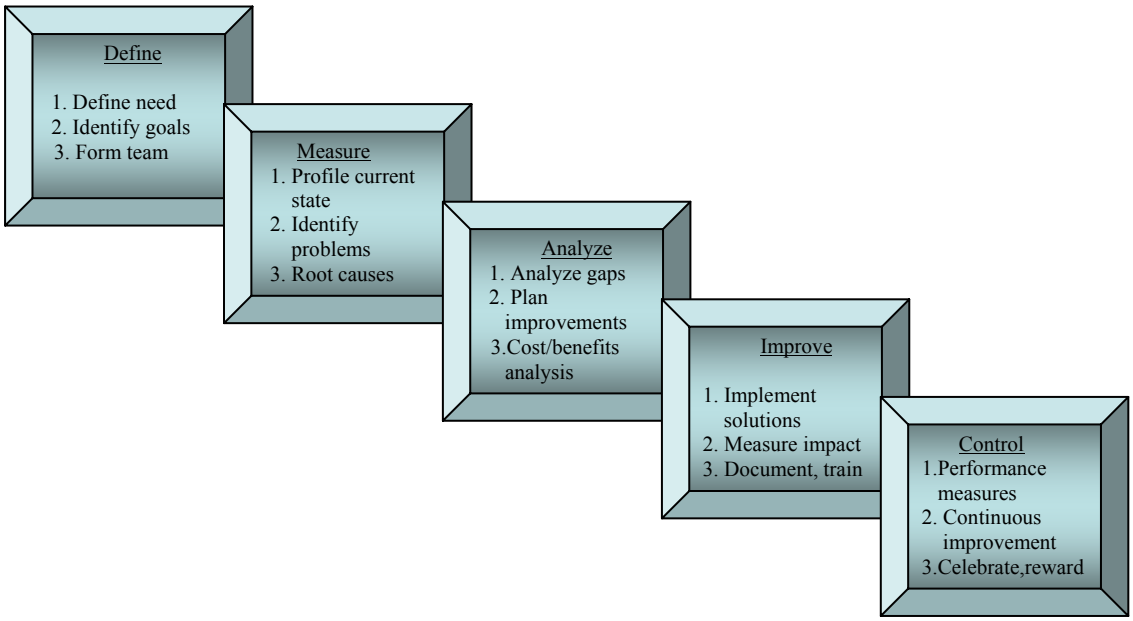


Figure 6. 1 SITE MAP DMAIC in Local Government

6.2.1 Define

The goal of the define phase of the DMAIC Six Sigma problem solving process is to define the need for improving the financial processes. The following activities were performed during the define phase.

6.2.1.1 Define Process Improvement Need

The Finance Director identified the need to streamline the financial processes. The Finance Clerk complained of needing additional staff and not being able to complete her work. She was responsible for the purchasing, accounts payable, accounts receivable, payroll and monthly reconciliation and closing. The vendor payments were frequently late, resulting in vendors constantly calling the Finance Department requesting payment. The revenue receipts

were frequently held in the finance department for over a week before processing and depositing. The estimated current payroll processing time ranged from thirteen to seventy hours, with a mean time of 40 hours. Employees frequently complained about payroll paycheck errors. The monthly reconciliations were not performed on a regular basis. Adjustment journal entries were frequently made months after the error should have been discovered.

6.2.1.2 Identify Department Goals, Project Scope, Objectives and Project Plan.

The Lean Six Sigma Quality Facilitator, the Process Analyst, and the Consulting Manager interviewed the Finance personnel to understand the financial department goals, the project scope and objectives. The Quality Facilitator created a letter of understanding to document the roles and responsibilities of the team members. The team created a project plan with activities, a timeline, and resources. Table 6.1 identifies the team mission, and team members' roles and responsibilities. In creating the team mission, it is important to realize that the mission reflects the essential purpose of the organization, concerning particularly why it is in existence, the nature of the business it is in, and the customers it seeks to serve and satisfy (Kanji, 2002)

Table 6. 1 Team Mission, Roles and Responsibilities

Team Mission	
Document the current financial processes to create desk-top procedures and to identify and implement financial process improvements.	
Role	**Responsibility**
Finance Clerk as Process Owner	Provides process knowledge and identifies and implements improvement opportunities
Finance Director as Project Champion	Establishes team mission and goals. Provides project team resources and support.
Team Quality Facilitator as Black Belt	Provides team facilitation. Provides technical Quality and Lean tool knowledge. Provides best practice for financial processes.
Process Analyst	Prepares documentation. Collects process data. Identifies improvement opportunities.
Consulting Manager	Provides business knowledge and direction. Manages consultants.

6.2.1.3 Form Process Improvement Team

The Lean Six Sigma team consisted of the Finance Clerk who performed the accounts payable, accounts receivable, payroll and pension reporting, and monthly reconciliation processes within the finance department; the Finance Director who managed the financial processes, the mayor's court processes, income tax collection, and utility billing and collection, and also performed the budgeting preparation and tracking for the city; a Team Quality Facilitator (the author) who developed the implementation plan and the SITE MAP for

implementing Lean Six Sigma in local government, and who provided technical Quality and Lean principles and tools knowledge; a process analyst who helped to collect and prepare process documentation; a consulting manager who provided business knowledge and direction, and maintained the formal business relationship between the city and the consulting firm. The Team Quality Facilitator, the Process Analyst and the Consulting Manager were hired from an external consulting firm.

6.2.2 Measure

The goal of the measure phase of the DMAIC Six Sigma problem solving process is to understand and document the current state of the processes to be improved, identify the process problems that are causing inefficiencies and errors and their root causes. The following activities were performed during the measure phase.

6.2.2.1 Profile Current State

The team used process flow chart analysis to map the current state processes. These flow charts identified the steps involved in the Finance Department activities related to budgeting/investments, purchasing/accounts payable, accounts receivable, monthly reconciliation, and payroll. Various system functions were identified in the process flows that were used to perform the financial processes. The process flows identified the written (of which few existed) and unwritten policies that governed the processes. No process measures existed for the financial processes. The Finance Clerk estimated the average and range of the

processing times based on her experience with the processes. The estimated processing times are displayed in Table 6.2. The detailed process flow charts are included in Appendix A.

Table 6. 2 Estimated Processing Times

Process	Estimated Processing Time Range	Estimated Average Processing Time
Payroll and Pension Reporting	13 to 70 hours	60 hours
Purchasing/Accounts Payable	30 to 40 hours per batch (only about half of the due invoices are processed every other week).	40 hours
Accounts Receivable	40 to 80 hours (including delay due to workload capacity issues)	60 hours
Monthly Reconciliation	40 to 80 hours (if performed)	60 hours
Budgeting	No estimate available	No estimate available

The team profiled the people and cultural state to understand the level of skills and training of the employees, and their resistance or acceptance levels to change. At the start of the project, the Finance Clerk was very resistant to change. As the project progressed, she became very receptive to the improvement ideas because she saw how it would help her get her work done more quickly and with fewer errors. She also enjoyed getting the attention related to the improvement effort. The Finance Director was very receptive to change and the improvement effort. He embraced the vision of improved and streamlined financial processes.

The team also profiled the technology to determine if the financial system was meeting their needs. They had implemented the system about six months prior to the project starting, and there were many training issues related to the software. There were also some inefficient

information system flows required by the software applications. Ad-hoc financial reporting capability was difficult, time consuming, and required extensive knowledge of data tables and query ability.

6.2.2.2 Identify Problems that Contribute to Process Inefficiencies and Errors

The project team used the process flow charts and several Lean tools including waste identification and elimination, standardization of operations to identify and eliminate non-valued added activities, and good housekeeping (part of the 5S') to identify process problems, such as, inefficient sorting and filing of purchase orders and invoices. The team used brainstorming techniques to identify problems.

6.2.2.3 Identify Root Causes of Problems

The team used Cause and Effect analysis to identify root causes related to people (such as lack of training, and skills), methods (lack of standardized procedures), information technology (information system human factors and processing flow was confusing and inefficient), and hardware (broken and inefficient printers). A Cause and Effect diagram is presented in Figure 6.2.

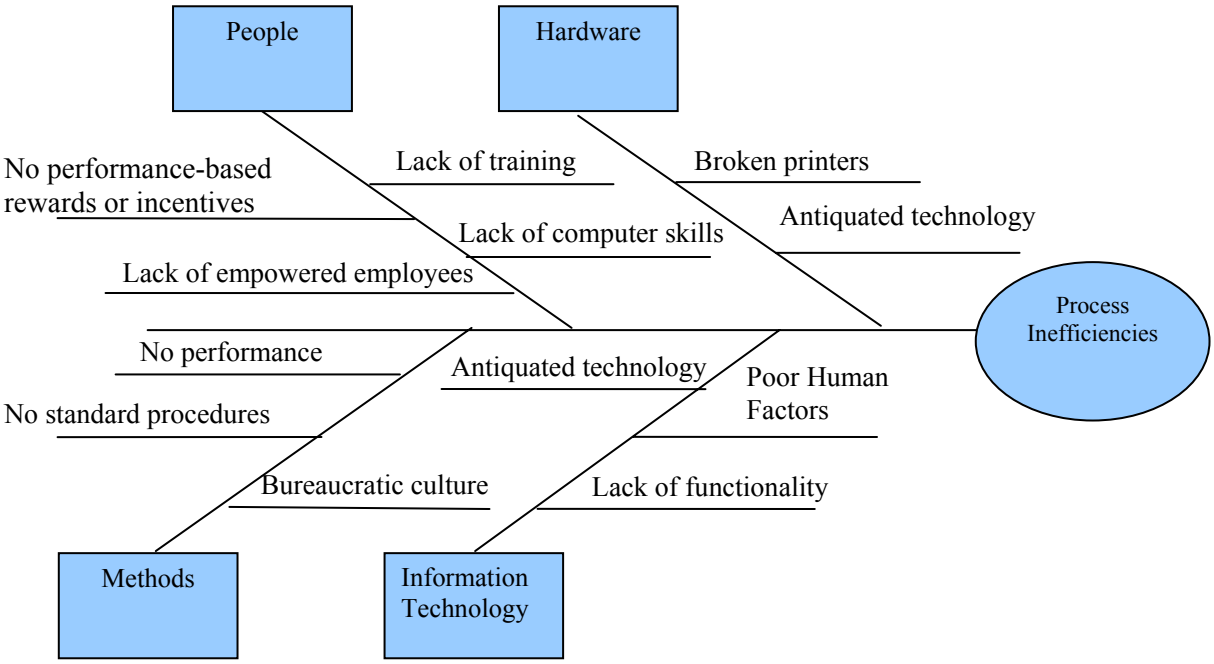


Figure 6. 2 Cause and Effect Diagram

6.2.3 Analyze

The goal of the analyze phase is to analyze the problems and process inefficiencies and define improvement opportunities. Also part of the analyze phase is to perform a cost and benefit analysis to understand whether the improvements are too costly compared to the estimated benefits to improve productivity and quality.

6.2.3.1 Analyze Gaps from Best Practice

The team identified gaps comparing the current state processes to best practice financial processes. The team used Pareto Analysis to understand the vendor purchase patterns to potentially streamline the number of vendors across city departments. Figure 6.3 shows the

number of vendors by the year-to-date dollar volume. There are over 250 vendors with year-to-date (through August of the current year) dollar volume of activity of less than $500. The Team Quality Facilitator and the process analyst used their understanding of financial processes and the concepts of Lean principles and the process flow charts to identify non-valued added activities, especially related to unnecessary work and rework. The team used the concept of implementing improvements that would prevent problems and rework due to printer jams, and inefficient use of the technology to reduce the financial processing time. The Team Quality Facilitator performed an analysis of reported financial information system problems using Pareto Analysis and Statistical Process Control Charts, across the finance and administration department. The purpose was to identify employee training and knowledge gaps with respect to the financial and administrative information system. Figure 6.4 shows the reported information system problems organized by resolution category. The data was provided by the software vendor from their problem tracking information system, specific to the problems reported by the City to the software vendor. The software vendor categorized the problems by software module. They tracked the time and date when the problem was reported and when it was resolved. The Pareto root cause categories were defined by the Finance Clerk and the Team Quality Facilitator. This chart shows that training problems contributed to 54% of the reported problems. Figure 6.5 shows the moving range control chart of the time (in hours) that it took the software vendor to resolve reported information system problems for the city. Figure 6.6 shows the individual x-chart for the time to resolve problems. This showed that problems with the system contributed to process inefficiencies.

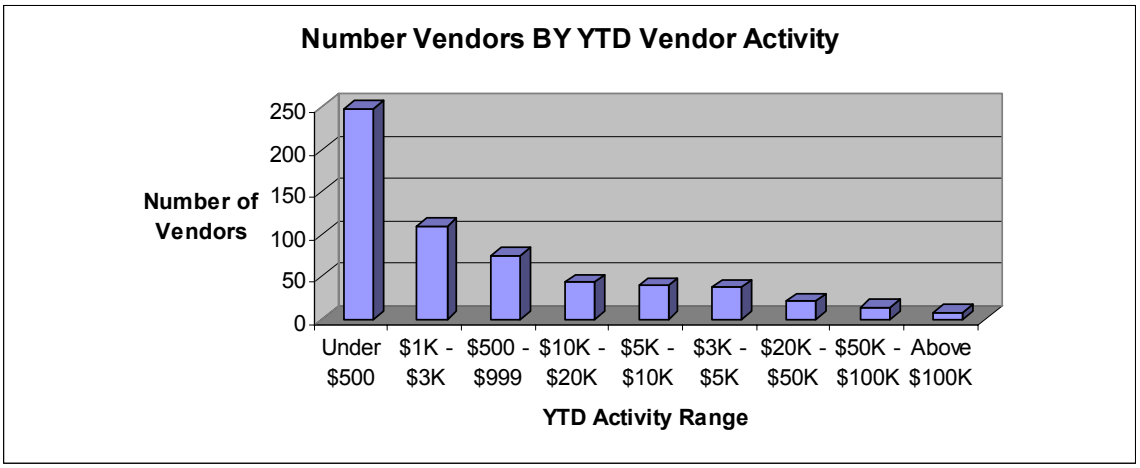


Figure 6. 3 Vendors By Year-to-Date Dollar Volume

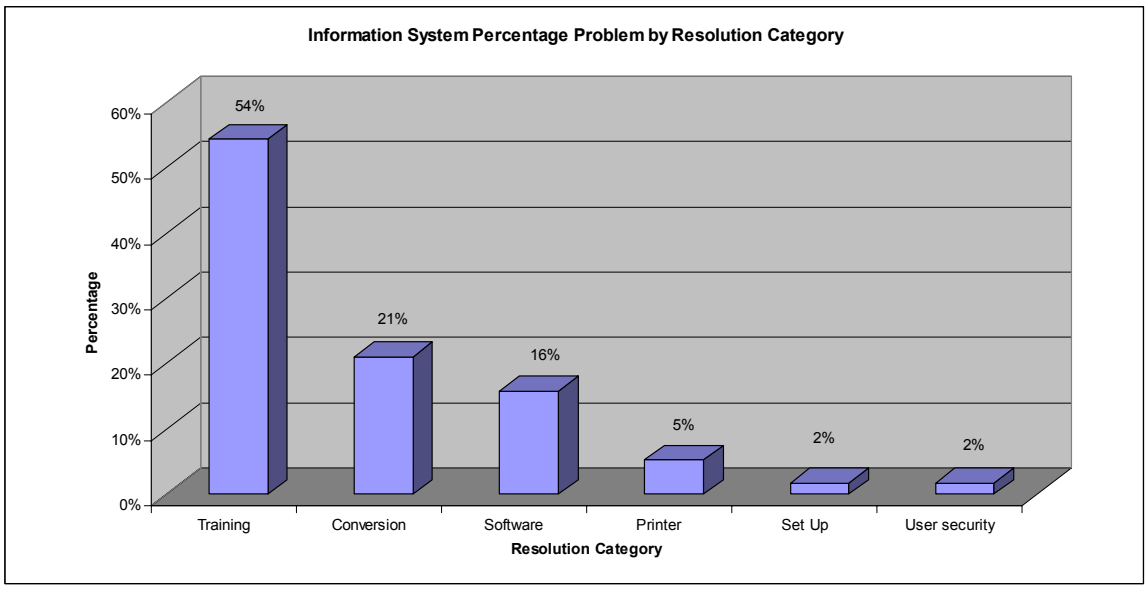


Figure 6. 4 Pareto Chart of Information Systems Problems

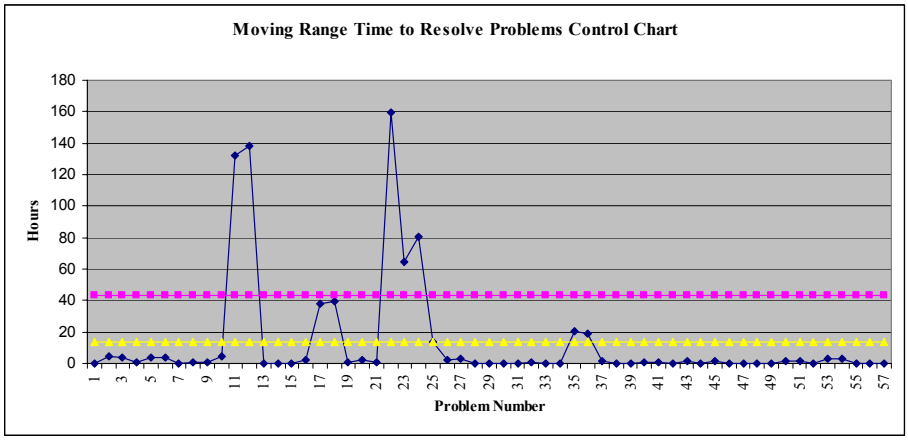


Figure 6. 5 Moving Range Control Chart for Time to Resolve Problems

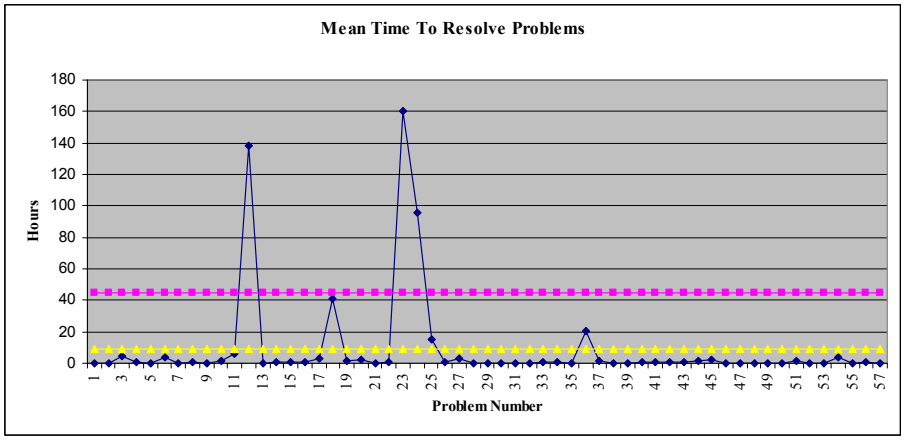


Figure 6. 6 Mean Time to Resolve Problems Control Chart

6.2.3.2 Identify Improvement Opportunities and Develop an Improvement Plan

The team identified improvement opportunities that were grouped in the following Lean categories: Standardized processes and procedures, good housekeeping, Kanban and visual control, waste identification and elimination, and one piece flow.

6.2.3.2.1 Standardized Processes and Procedures

The team suggested that the Finance Department develop standardized desk-top procedures. No written procedures existed in the current state. The Finance Clerk would keep handwritten notes, but this did not lend to standardization and repeatability.

Another improvement area was to use an Excel spreadsheet to standardize batch calculations for matching, and dividing repeating invoice amounts across different account numbers.

The fire department had converted from an association to a city department during the improvement effort. The team encouraged the Finance Department to integrate the fire department into the standardized payroll and accounts payable procedures.

The team recommended that the employees who used the financial system get training from the software vendor tailored specifically to their streamlined financial processes. Initially, when the city implemented the new financial system, the software vendor would train a generic process that encouraged printing of lengthy reports that the city did not need to print. The software vendor was able to provide additional understanding on the more extensive software functionality and tailor the processes better to the city's needs.

The team recommended that the city standardize the time sheets across all of the departments to help reduce payroll data entry errors and the time to enter the timesheets. The team also recommended that the Finance Clerk use timesheets in Excel spreadsheets to calculate the total timesheet hours by department, to compare to the payroll reports, instead of using a calculator.

6.2.3.2.2 Kanban and Visual Control

The team created a Kanban and used visual control for the accounts payable processing. The Kanban was a file hanging system that was easily visible to the Finance Clerk and the Finance Director. In the current process, the invoices, purchase orders, and requisitions that needed to be either assigned account numbers or approved by the Finance Director were frequently lost in the piles of work. The Kanban was organized in the order of the process steps. The documents that needed to be assigned account numbers were placed in a red folder in the first slot of the filing system. The purchase orders that needed approvals were placed in the next slot, so that the Finance Director would easily see them and quickly process them. The appropriate documents for each step were placed in the bin, so that the Finance Clerk and the Finance Director would have visual cues for the work that needed to be done. This greatly reduced the purchasing and accounts payable processing times. Figure 6.7 graphically depicts the Purchasing and Accounts Payable Kanban.

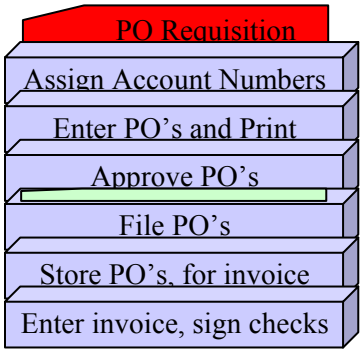


Figure 6. 7 Purchasing and Accounts Payable Kanban

6.2.3.2.3 Waste Identification and Elimination

The team identified unnecessary steps in the processes, such as printing lengthy reports that were never used. The team encouraged either eliminating the printing of unnecessary reports, or printing them to an electronic file, which took seconds, instead of hours.

The team encouraged the use of new accounts receivables technology that automatically transferred journal entries, instead of requiring redundant data entry.

The team identified direct deposit as an improvement opportunity to eliminate printing of payroll checks. They suggested having a payroll direct deposit contest between departments to encourage use of direct deposit. This was after identifying and eliminating problems with the direct deposit process.

The team recommended extensive information technology improvements that further streamlined the processes, and eliminated redundant data entry.

6.2.3.2.4 One Piece Flow

Another improvement idea that the team identified was to reduce the batch sizes of the accounts payable and accounts receivable batches. This would help to move closer to one piece flow, and enable vendors to get their payments quicker by processing smaller batches more frequently. This was also dependent upon other improvements for both of the processes, so that the batches could be processed more quickly. The team recommended that the accounts receivable (revenue) batches be processed daily, instead of holding them for one to two weeks. This would increase the potential revenue from interest received by depositing the checks more quickly at the bank.

The team used the vendor Pareto Analysis to identify duplicate vendors and recommended that the number of vendors be reduced. The duplicate vendors were mainly due to each department choosing their own vendors for similar purchases across the city. This would also help the accounts payable processing to move closer to one-piece flow, or smaller batch sizes, by reducing the number of vendors and invoices.

6.2.3.3 Perform a Cost and Benefit Analysis

The Team Quality Facilitator and Process Analyst identified potential costs and proposed benefits of each proposed improvement to determine if the estimated benefits are greater than the costs to implement. They also provided advantages and disadvantages to each solution, so that the Finance Director could make an informed and data-oriented decision. Most of the costs were related to training, and resources needed to implement and document the standardized procedures. The largest costs were related to consulting fees, and obtaining laser printers for

check printing. A cost benefit analysis for automating the processing of payroll timesheet hours is presented in Appendix B. Four alternatives were identified that could automate the timesheet payroll hours entry and verification activities. The first solution was to create a Microsoft Access program that would allow entry of timesheet data and perform automated verification and summing of hours by department. Alternative two was to implement an existing module from the financial information system vendor to automate the timesheet data, allow remote entry by each department and allow automated integration of the timesheet data into the payroll system. The next alternative was to implement custom design and development of scanning and optical character recognition software to enable scanning or input from Microsoft Excel timesheet data. Alternative four was to develop Excel timesheets that would enable automated entry of timesheet data within each department, and allow automated verification and summing of the timesheet data. The entered payroll hours data could then be compared to payroll hour reports to ensure payroll data accuracy. Alternative three would require the highest cost, the longest implementation time, and the highest level of technology skills needed by the department employees. Alternative four required the lowest cost, the shortest implementation time, and a lower level of technology skills needed by department employees. An economic analysis was performed to determine which alternative was the most economically attractive alternative.

The net present worth of the costs and benefits over a five-year project life for the projects were:

- Alternative 1, Net Present Worth: -$15,349
- Alternative 2, Net Present Worth: -$12,542

- Alternative 3, Net Present Worth: - $74,961
- Alternative 4, Net Present Worth: $ 7,289

Only alternative 4 had a positive net present worth, or a benefit/cost ratio greater than one. The internal rate of return for alternatives 1, 2, and 3 were all negative. The internal rate of return for alternative 4 was 48%. The payback period for alternative 4 was 2.02 years.

The city implemented alternative four, which reduced the time needed by the Finance Clerk to enter and verify timesheet data. It also pushed accountability of timesheet data to the originating department, who had the most knowledge about whether the data was accurate. Alternative four also eliminated the cumbersome, time-intensive, off-line calculator-based payroll hours verification step. This alternative also standardized the timesheet format and process across all of the city departments. The timesheet errors and payroll processing time was reduced by automating and standardizing the payroll timesheet entry and verification process.

6.2.4 Improve

The goal of the improve phase is to implement the improvements, measure the impact of the improvements and document procedures and train employees on the improved procedures.

6.2.4.1 Implement Improvement Solutions

The team implemented the initial financial process improvements to the payroll and pension reporting, purchasing and accounts payable processes across a four-month period. They implemented improvements to accounts receivable, and monthly reconciliation throughout the next year, as time and resources permitted. They did not implement budgeting process

improvements, because the Finance Director wanted to focus only on the processes performed by the Finance Clerk. The team first collected further information to validate the feasibility of the process improvement ideas presented in the analyze phase. They created an implementation plan for any improvements that would take more than one week to implement or that required significant expenditures, and defined the associated costs and benefits at a finer detail than in the analyze phase. The team gained approval from the Finance Director to proceed with the implementation of the improvement opportunities. The team implemented the improvements and redesigned the appropriate processes to incorporate the improvements. As part of the project management of the implementation the Team Quality Facilitator provided weekly status reports to the team that included the tasks that were completed and the status and estimated completion date. A sample status report is presented in Appendix C. The Team Quality Facilitator documented any outstanding unresolved issues on an items for resolution form (IFR). The IFR form included a description of the issue, the owner who was responsible for ensuring that the issue was resolved, the estimated resolution date, the priority of the issue, the status, the date the issue was opened and resolved, the impact of the issue to the project, and a description of the resolution. A sample IFR template is presented in Appendix D.

6.2.4.2 Measure Impact of the Improvements

The team measured the impact of the improvements after the majority of the improvement opportunities were implemented for each financial process. The payroll processing time was reduced by approximately 60%. Although the errors were not measured prior to the improvement implementation, no paycheck errors were found while migrating the Fire

Department into the Finance Department procedures and financial systems, using the revised and improved payroll processes.

The purchasing and accounts payable processing time was reduced by approximately 40%, and all the vendors started getting paid on a consistent and timely basis. The accounts payable improvements also completely eliminated some of the non-value added processing steps such as, no longer having to verify that duplicate invoices had been paid, due to paying invoices on time.

The Accounts Receivable processing time was reduced by approximately 90%. Revenue checks were getting deposited into the bank daily. The monthly reconciliation processing time was reduced by approximately 87%. Additionally, the monthly reconciliation process was performed on a consistent monthly basis, due to providing more capacity for the Finance Clerk. The increased capacity was a result of the elimination of non-value added tasks, and reducing the payroll, accounts payable and accounts receivable processing times.

The financial processes were able to be performed by one person working forty hours per week, instead of one-and-a-half employees prior to the Lean Six Sigma implementation.

Another significant improvement related to the improved processes and subsequent training was that the number of financial system problems reported to the software vendor greatly decreased from an average of about 13 problems reported per month by the Finance Clerk to about 6 per month.

Table 6.3 summarizes the estimated prior processing times, the estimated processing times after the improvements, and the percentage reduction of processing times. More specific

performance measures to measure actual cycle times per batch, and quality of the processes were recommended to the City, but were not implemented prior to the end of the initial project.

Table 6. 3 Percentage Reduction in Processing Time

Process	Average Estimated Processing Time Prior to Improvements	Average Estimated Processing Time After Improvements	Percentage Reduction of Processing Times
Payroll and Pension Reporting	60 hours	24 hours	60%
Purchasing/Accounts Payable	40 hours	24 hours	40%
Accounts Receivable	60 hours	6 hours	90%
Monthly Reconciliation	60 hours	8 hours	87%

6.2.4.3 Document Procedures and Train Employees on the Improved Procedures

The process analyst documented the improved and standardized desk-top procedures, which included detailed process steps and computer screen shots populated with representative process data. The procedures were developed based on our detailed knowledge of the financial information system acquired during the project. The desk-top procedures were so thorough, that on several occasions when the Finance Clerk was not available, the Finance Director, and the Income Tax Clerk were able to perform the payroll process with limited advanced training. A sample desk-top procedure is included in Appendix E.

The Finance Clerk was trained on all of the improved processes using the detailed desktop procedures. She also received process-specific training on the financial information system from the software vendor.

6.2.5 Control

The goal of the control phase is to implement performance measures and other methods to control and continuously improve the processes.

6.2.5.1 Design and Implement Process Performance Measures

Several process performance measures were recommended to help assess the productivity and quality of the financial processes. Table 6.4 lists the proposed process measures for each financial process. The process measures had not yet been implemented by the end of the project. A sample process measurement check sheet that was designed to be used to collect process measurement data is included in Appendix F.

Table 6. 4 Proposed Process Measures

Proposed Process Measure	Data Collection Mechanism
Payroll and Pension Reporting	
Number and type of payroll problems encountered per number of employees	• Payroll Check sheet • Payroll metric log • Moving range and individual control chart of problems per employee
Payroll processing time by payroll period	• Payroll Check sheet • Moving range and individual control chart of payroll processing time
Purchasing and Accounts Payable	
Number of problems per invoice	• Accounts Payable Check sheet • Moving range and individual control chart of A/P problems per invoice
Time per invoice	• Accounts Payable Check sheet • Moving range and individual control chart of time per invoice
Percent invoices without purchase orders	• Accounts Payable Check sheet
Percent invoices paid within discount period	• Accounts Payable Check sheet
Accounts Receivable	
Time per receipt	• Accounts Receivable Check sheet • Accounts Receivable Metrics Log • Moving Range and Individual Control Chart of time per receipt
Number of problems per receipt	• Accounts Receivable Check sheet • Accounts Receivable Metrics Log • Moving Range and Individual Control Chart of problems per receipt
Monthly Reconciliation	
Number of problems by type	• Monthly Reconciliation Check sheet • Monthly Reconciliation Problem Pareto Chart

6.2.5.2 Implement a Continuous Process Improvement Approach to Always Improve

The consultants encouraged the Finance Department to implement a continuous improvement process to continue to improve both the productivity and the quality of the financial processes. This would be especially important if turnover occurred, so that the culture would change to one that continually and always improved.

6.2.5.3 Celebrate the Successes, Reward and Recognize the Project Team Members

One of the last, but very important steps of the control phase is to take the time to celebrate the improvement effort, even if it was something as simple as going out to lunch to celebrate, which the team did. The Finance Department had not yet changed their reward and recognition system to accommodate continuous improvement and performance-based metrics.

The entire Lean Six Sigma implementation in the Finance department took about one and a half calendar years. The Define phase took three months, the Measure and Analyze phases took two months each. The Improve and Control phases took about one year together.

6.3 Validation Results

6.3.1 Impact to Productivity and Capacity

Through implementing a Lean Six Sigma program, the city's Finance Department was able to significantly reduce the time to process payroll, purchasing and accounts payable, accounts receivable and monthly reconciliation. Payroll processing time was reduced by 60%. Purchasing and accounts payable processing time was reduced by 40%. Accounts Receivable

processing time was reduced by 90%. Monthly reconciliation processing time was reduced by 87%.

The Finance Department migrated the Fire Department into the city's standardized and improved financial processes and systems when they became a city department. The migration was seamless. No paycheck errors occurred during the first pay period when the Fire Department's payroll was processed by the Finance Department using the improved procedures.

Additionally, the monthly reconciliation process was performed on a consistent monthly basis, due to providing more capacity for the Finance Clerk. The increased capacity was a result of the elimination of non-value added tasks, and reducing the payroll, accounts payable and accounts receivable processing times.

The financial processes were able to be performed by one person working forty hours per week, instead of one-and-a-half employees prior to the Lean Six Sigma implementation.

Another significant improvement related to the improved processes and subsequent training was that the number of financial system problems reported to the software vendor greatly decreased from an average of about thirteen problems reported per month by the Finance Clerk to about six per month.

Combining the principles and tools of Lean Enterprise and Six Sigma and using the SITE MAP, provides an excellent way to improve the productivity and quality of providing financial services in a local government. Although the majority of Lean Six Sigma applications have been in private industry, focusing mostly on manufacturing applications, this case study is an excellent example of how Lean Six Sigma tools can be applied in a service-oriented, transaction-based entity, such as a local government.

6.3.2 Framework Component Results

6.3.2.1 Principles

The principles defined in the SITE MAP were applied and incorporated in the Finance Department throughout the Lean Six Sigma project. Focusing on the value that the customer receives from the Finance Department became more important. The employees were more empowered, and began working better together across departments in informal teams. The concepts of systems and process thinking were applied by using the process flow analysis techniques, which helped the department employees better understand the value stream. The financial procedures that were developed incorporated the principles of standardization, continuous flow (reducing batch sizes), and visual control (Kanban). Raising the bar to focus on perfection and continuous improvement were also positive effects of the Lean Six Sigma project in the Finance Department.

6.3.2.2 Value Proposition

The value proposition used to convince the Finance Director to embark on the Lean Six Sigma effort focused on the aspects of productivity, capacity, and reducing costs, as well as better satisfying both internal and external customers. The process improvements that were implemented did have a positive impact on productivity, freeing up the Finance Clerk's capacity, and reducing costs by avoiding hiring additional staff, and being able to move a part time person to another department. The improvements also had a positive impact on the customers, as will be discussed under the customer focus section. These factors impact the quality of service delivery, trust and the financials. Our Lean Six Sigma Value Proposition function defined in

Chapter 4 included these factors, and our case study supported that these factors influenced the Finance Director, and lack of focus on these factors caused significant pain to encourage him to take action.

6.3.2.3 Customer Focus

The Lean Six Sigma project was able to help the Finance Department employees better focus on satisfying the customers' needs, both internal and external to the city. The improvements had a positive impact on customer satisfaction. The internal employees complained less about paycheck errors and late or missing paychecks. The City was able to reduce the number of errors submitted to external customers, including tax and pension reporting authorities. Other external customers, such as vendors who submitted invoices and received payments were able to receive them on a much more timely basis, and did not have to continue sending duplicate invoices, and making numerous phone calls to receive payment.

Since the Finance Director kept a low profile on the Lean Six Sigma project outside of the Finance Department, the case could not validate the impact to other stakeholders such as the City Council, citizens and taxpayers in general, or county or state legislators.

6.3.2.4 Culture and Change Management

The case study showed that the Lean Six Sigma project had a very positive impact on changing the culture of the employees and the software vendor who supported the Financial System application. The Finance Clerk was at first highly resistant to change, but through consistent and continual coaching by the Team Quality Facilitator and Process Analyst, and

through implementation of process improvements that helped to ease her workload and reduce employee and vendor complaints, she became very receptive to the program. After the Finance Clerk left her position, a new Finance Clerk was even more receptive to the program and the improvements that were made in the position. The new employee was from the Utility Department that interfaced with the Finance Department to process utility payments and reconcile the utility department accounts. She was able to understand the value of the program through the positive impact to her job activities in the Utility Department. She spent less time reconciling her accounts, due to less financial processing errors. It was a positive result of the Lean Six Sigma program that further process improvements were made after a personnel change, and a culture of continuous improvement was being embraced. The culture change impact was positive and validated through the case study. The culture of continuous improvement remained after several personnel changes, including the Finance Clerk, the Finance Director and the City Manager. This culture change did not happen over night. It took continual focus, energy, commitment and time from all resources involved.

6.3.2.5 Human Resource Management

The Lean Six Sigma project helped to empower the employees, helped them to be more accountable for their job duties, and helped them to understand the impact that their actions had on customers and suppliers. The Finance Director did not make changes to the formal human resource system with respect to rewarding and recognizing employees, so that aspect of the framework could not be validated. However, the employees did work better together and began

solving problems in teams across the Income Tax, Utility, Mayor's Court, and Planning and Development departments.

6.3.2.6 Infrastructure and Methodology

The DMAIC and detailed steps that were followed during the Lean Six Sigma project had a positive effect on the success of the project. The attention to detail and use of project management techniques, including status reporting and tracking issues by formal processes helped to ensure the success of the project. The cost and benefit analysis also proved valuable in helping the Finance Director prioritize improvements and decide which ones to implement.

6.3.2.7 Quality and Lean Tools

Some of the more applicable and valuable tools used in the case study were: process mapping, Kanban, visual control, mistake proofing, waste identification and elimination, one-piece flow, Pareto Analysis, Cause and Effect Analysis, project management, the 5S' (especially good housekeeping, sorting, and standardization), brainstorming, statistical process control, and continuous improvement.

6.3.2.8 Measurement

Process metrics were proposed by the Team Quality Facilitator but not embraced during the project control phase. Additional validation and research is needed in this area, which will be discussed in Chapter 7. More general areas of assessing the impact on productivity were used by estimating financial processing times for each process area (purchasing and accounts payable,

payroll, accounts receivable, and monthly reconciliation and close), as discussed in section 6.3.1. The Finance Department did become more aware of errors and the impact of the errors to the suppliers and customers, but they did not implement a formal measurement tool to assess quality and Six Sigma levels.

6.4 Framework Roadmap Validation Assessment

The SITE MAP proved to be a valuable framework for implementing Lean Six Sigma in a local government's Finance Department. The SITE MAP principles applied, the value proposition used, the focus on the customer, the ability to change the culture through communication and focused change management techniques, using a detailed infrastructure and the DMAIC problem solving approach, and using Quality and Lean tools were successful and validated in the financial process case study.

The areas of the framework that were not yet validated through this initial case study were in the areas of human resource management with respect to rewards and recognition, and implementing process performance measurements. These areas will be discussed in the future research section in the next chapter.

CHAPTER 7
CONCLUSIONS, LIMITATIONS, AND FUTURE RESEARCH

7.1 Introduction

The literature does not provide a framework for implementing Lean Six Sigma in local government. Quality Management principles and tools have been applied with some success to local, state and federal government agencies over the last decade or so. There are some examples of Six Sigma being implemented in local government. This research has provided a framework roadmap for implementing Lean Six Sigma in local government. The SITE MAP (Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap) provides the activities, principles, tools, and important component factors to implement Lean Six Sigma in a transaction-based environment, such as local government. The framework components that are important to consider when implementing Lean Six Sigma in local government are: Value Proposition, Customer Focus, Culture and Change Management, Human Resource Management, Infrastructure and Methodology, Quality and Lean Tools, and Measurement. Figure 4.1 in chapter 4, presents the framework components defined as the building blocks to successfully implement Lean Six Sigma in local government.

7.1.1 Framework Components

7.1.1.1 Value Proposition

The value proposition is used to "sell", or convince local government management of the value of implementing a Lean Six Sigma program. Lean Six Sigma can provide value by:

1) Reducing or avoiding costs of providing services to citizens, including freeing up staff capacity by eliminating non-value added activities and waste, and avoiding hiring additional staff.
2) Helping to better understand and satisfy customers' needs, including customers such as citizens, legislature, and city council.
3) Improving processes, eliminating waste, improving quality and productivity, and reducing variation.

The following relational qualitative function can be used to represent the Lean Six Sigma program's value proposition:

SITE MAP Value Proposition = Quality of Service Delivery X Trust X Financials

Quality of Service Delivery is measured by defects in the service delivery process; the ability to meet customers' expectations; the ability to be responsive to customers' service delivery needs, including productivity and cycle time; and variability of processes. Trust is measured by the relationship between city government and both internal and external customers. Financials include the costs and revenues of providing government services.

7.1.1.2 Customer Focus

There are potentially many customers of local government services including taxpayers, elected officials, legislature, and citizens who directly access government services. The customer must be defined with respect to the processes that are targeted for improvement by the Lean Six Sigma projects.

7.1.1.3 Culture and Change Management

Probably the most difficult component in implementing Lean Six Sigma in a local government is culture and change management. Many stakeholders are resistant to change, especially if it requires learning new tools and doing their job's differently. Additionally, special interest groups exist that may have agendas that conflict with the objectives of the Lean Six Sigma projects.

It is critical to define a change strategy that addresses how to change the culture to focus on continuous improvement and measuring, focusing on the customer, the technical aspects, the political individual, and the organizational context of change. A communication plan should be developed to ensure that communication is maintained throughout the Lean Six Sigma projects and program. All stakeholders should understand the mission, goals, and objectives of the Lean Six Sigma projects, as well as the roles and responsibilities of the team members, and continual project status. Local government management's support and commitment and communication of that commitment is also critical, since most employees will not change the way they perform their work unless encouraged by management.

7.1.1.4 Human Resource Management

Human Resource Management in a Lean Six Sigma program includes empowering employees and holding them accountable for decisions about their processes. Training, education, and providing the right skills for people to do their jobs is critical. Team training, team-building, and team-based problem solving are part of the Lean Six Sigma Human Resource Management component. It is critical to carefully recruit and select employees, especially in governments where it can be difficult to terminate employees. The Human Resource Management component also includes rewarding and recognizing employees for their involvement and team efforts on the Lean Six Sigma projects.

7.1.1.5 Infrastructure and Methodology

The DMAIC problem solving approach is used to improve the processes. It provides the basic infrastructure and methodology to eliminate waste. A sound project management structure should be implemented that includes tracking and communicating project status and issues that may impact successful implementation of project improvements.

7.1.1.6 Quality and Lean Tools

Many Quality and Lean tools are especially applicable in local governments to improve processes and eliminate waste, such as: process mapping, Kanban, visual control, mistake proofing, waste identification and elimination, one-piece flow, Pareto Analysis, Cause and Effect analysis, project management, the 5S', process measurement, benchmarking, brainstorming, statistical process control, continuous improvement and Kaizen.

7.1.1.7 Measurement

Performance measurement should be defined within the problem solving methodology at a process level. Metrics should be used to measure improvements in quality, productivity, variability of service delivery and financials.

7.2 SITE MAP

A summary of the SITE MAP for Implementing Lean Six Sigma is presented in table 5.1, in chapter 5. The SITE MAP provides the principles, activities, and components that are important to apply across each phase of the DMAIC problem solving approach.

7.3 Framework Validation

The literature provides critical success factors that help organizations better implement process improvement and quality management programs. The author reviewed the literature to understand these factors and to ensure that her framework components for implementing Lean Six Sigma are based on sound theory. Table 4.1, in chapter 4, presents the framework components and critical success factor mapping. This mapping ensures that the framework components are supported by the research literature.

A case study was used to validate the framework roadmap developed by the author. Lean Six Sigma was successfully implemented in the Finance Department of a 7,000 citizen, city-manager form of local government, using the SITE MAP framework roadmap as a guide.

The city's Finance Department was able to significantly reduce the time to process payroll, purchasing and accounts payable, accounts receivable and monthly reconciliation. Payroll processing time was reduced by 60%. Purchasing and accounts payable processing time was reduced by 40%. Accounts Receivable processing time was reduced by 90%. Monthly reconciliation time was reduced by 87%. The financial processes were able to be performed by one person working forty hours per week, instead of one-and-a-half employees, prior to the Lean Six Sigma implementation.

7.4 Conclusions

The application of Lean Six Sigma in local government using the SITE MAP is a powerful guide to successfully improve the processes, reduce variation, and eliminate waste. The Quality and Lean tools that were applied in the case study were effective in helping to identify and eliminate wasteful activities. Process mapping, Pareto Analysis, and Cause and Effect analysis, helped to collect detailed information that was critical to understand the processes and identify the gaps compared to best practice. Having process analysts with experience in implementing Quality and Lean tools and principles, knowledge of financial processes, and information systems was important to identifying improvements that eliminated root causes and waste.

It was also important to have an experienced quality facilitator and process analyst that were not afraid to challenge the status quo and ask "why" more than five times. It was valuable to have a quality facilitator who acted as a coach, on the team to work with the employees to

transfer knowledge and provide ideas from outside local government and also provide moral support and guidance throughout the project. The coaching helped to empower the employees in a non-threatening manner. The nature of providing the customer-focus was helpful to get the employees to understand how their activities impact their customers, such as the ramifications of not paying an employee on time, or when a small vendor, who relies on the payment for a living, is not paid on time.

The framework provides for clearly defining the project infrastructure and methodology before the Lean Six Sigma project begins. This clearly helps to gain funding from city council to embark on the projects, and will be helpful in any local government that must justify, as most do, how they spend the taxpayers' dollars.

The detailed cost/benefit analysis created during the implementation phase provides for the ability to gain funding for the implementation activities. Even though the majority of the improvements implemented required very little capital investment, if consultants are used, their fees will need to be justified.

The author's major contributions to the research are:

- Performed a literature review to understand the need for developing an implementation framework for Lean Six Sigma in local government.
- Developed framework components, the building blocks of the framework roadmap.
- Reviewed the literature to understand the critical success factors related to process improvement and quality management programs to ensure that the framework components were based on sound theory.

- Developed the SITE MAP (Service Improvement for Transaction-based Entities Lean Six Sigma Framework Roadmap) that provides the activities, principles, tools and important component factors to implement Lean Six Sigma.
- Developed a case study to validate and successfully implement Lean Six Sigma in a local government's Finance Department.
- Developed financial measures within the Finance Department's case study.
- Derived conclusions from the case study to identify improvements to the framework and provide additional areas of research.

The major conclusions are summarized as follows: (Furterer and Elshennawy, 2004)

- The SITE MAP helped to reduce variation, improve the financial processes, improve capacity, enhance customer satisfaction, and eliminate waste in a local government's financial administration department.
- The Quality and Lean tools helped to identify and eliminate wasteful activities, especially process flow analysis, Cause and Effect analysis, Pareto Analysis, statistical process control, brainstorming, Kanban and visual control, the 5S', waste identification, standardization, mistake proofing, and one-piece flow.
- Process analysts with experience in Lean and Quality tools and knowledge of financial processes and best practice, helped to identify improvements that eliminated root causes and waste.

- A coach from outside the local government was critical to asking "why", challenging the status quo, and helping transfer knowledge.
- It was important to help the employees focus on the customers, both internal and external to the city and finance department.
- The Lean Six Sigma framework provided a critical project infrastructure and methodology to help identify the value proposition, provide continual status, provide cost and benefits of implementing improvements, and communicating project success.
- It may not be important to change the reward and recognition system to successfully make improvements, but it is important to celebrate success.
- The culture change to embrace a culture of continuous improvement can take a long time, easily one-and-a-half years or more.
- The culture change can be transferred to other employees across the city, and survive even after personnel changes.
- It is not important to name the program as Lean Six Sigma, but to transfer knowledge and provide an infrastructure for change.
- The value proposition to convince management to embrace Lean Six Sigma includes focusing on aspects of productivity, capacity, reducing costs, and customer satisfaction.
- It is important to assess the stakeholders' resistance and acceptance to change at the beginning of the program, so that culture and change strategy can be incorporated to help reduce resistance to change.

- Some type of measurement of process performance is important to help understand the impact of the Lean Six Sigma project.

7.5 Limitations of the SITE MAP

Combining the principles and tools of Lean Six Sigma is a powerful program to improve the productivity and quality of providing services in local government. Although implementing Lean Six Sigma provided stunning improvements in cycle time of delivering services to internal and external customers of one local government, it cannot solve all of the problems in any organization. One of the issues that Lean Six Sigma does not directly address is dealing with the political elements of special interest groups within and outside the local government. After the Lean Six Sigma project was finished, the Finance Clerk was charged with giving herself an unauthorized pay increase. Even though financial controls and good processes can help identify fraudulent activities, if an employee is intent on committing fraud, Lean Six Sigma will not prevent it. Some time after the Lean Six Sigma project, the City Manager and Finance Director were terminated. Again, Lean Six Sigma is limited from the standpoint of being able to cure or address all of the human resource and political issues that exist and occur in a local government.

The SITE MAP does not explicitly provide guidance for how to roll out the Lean Six Sigma program across the city. Broader issues may need to be addressed such as: how to communicate internally to all employees, and externally to citizens and even to the media. The development of a public relations or media plan may need to be incorporated into the framework roadmap's tools and activities.

The success of implementing Lean Six Sigma can be dependent upon the skills of the implementers, especially when dealing with the culture and change management components of the framework.

Lean Six Sigma was successfully implemented in a 7,000 citizen local government. However, their may be scalability limitations of the framework for some variables, such as size of the government entity, complexity of the processes, and level of political interest group activity. As the governmental entity becomes more complex, the framework may need to be adapted for the increased size and complexity.

The framework may also be limited in an environment that has extreme budget distress, due to the potential need of laying people off from their jobs. The framework would potentially be more successful in a more stable environment.

The framework did not directly address how to present the program from a naming or labeling perspective. In the specific case study, the Lean Six Sigma principles, tools, and framework were applied, but the Finance Director did not advertise the program as Lean Six Sigma, and kept a low profile on the project. He communicated very little information or status outside of the Finance Department. The framework does not directly address these issues, and future research could be performed to understand whether naming the program and how it is communicated impacts the success of the program.

Even though the program was successful within the Finance Department, since the success was not communicated outside of the department to a great extent, the momentum was lost that could have been used to implement Lean Six Sigma and continuous improvement across the city.

The framework roadmap provides for measurement at a process level, additional research is needed to understand how the measures can help with the improvement efforts and also with selling the project to management by clearly defining the Lean Six Sigma value proposition in terms specific to the processes and environment of the local government.

The framework components and roadmap were developed by the author from her experience and knowledge, and mapped to the critical success factors for similar productivity and quality management programs from the literature. However, the framework may be limited from the perspective of "how do we know that the critical success factors and framework components are the correct factors and components?" that will ensure successful implementation of a Lean Six Sigma program. Additional research will be needed to help answer this question, and will be discussed in the future research section.

7.6 Future Research

There are many areas of future research related to the Lean Six Sigma roadmap. The framework roadmap can be validated against other processes and in other local governments. An exciting process area in local government is in urban planning and development. The urban planning and development area crosses many more departmental boundaries than the finance department's processes which can add to the complexity and challenge when implementing Lean Six Sigma. Additional applications of Lean Six Sigma using the framework roadmap in entities with varying size, and complexity, will help to understand the issues of scalability related to the size and complexity of the governmental entity.

The framework could also be adapted to other "white collar" or transaction-based processes outside of local government, such as in manufacturing companies in the non-manufacturing processes, or in software-development processes, and also in the service industry. The industries that have not yet been touched by Lean Six Sigma provide a rich and almost infinite spectrum of future research opportunities.

The area of performance measures in local government is fairly recent, and still requires a great deal of research that can augment the Lean Six Sigma framework roadmap in the area of process and performance measurement. Additional research is needed to validate the financial process measures, and develop and validate other process measures in local government outside of the financial area. Benchmarking with respect to process measures is also an area in great need of research in local government, which ties nicely into the measurement component of the Lean Six Sigma framework.

The entire area of culture and change management in implementing Lean Six Sigma and other process and quality management programs is in great need of additional research to understand how best to implement these types of programs in local government and other transaction-based environments.

Future research will need to be performed to help answer the question of whether the framework components from the author's knowledge and experience, and the critical success factors from the literature will help ensure the successful implementation of Lean Six Sigma. The framework components and roadmap can be reviewed by experts in the field to build consensus on the validity of the framework. The Delphi technique could be used to survey experts in the productivity and quality improvement field to identify the critical success factors

that they deem are important to implementing improvements and change programs. Quality Function Deployment and the House of Quality matrix could be used to organize the critical success factors and map them to the components of the framework and prioritize the critical factors. Additional application of the framework roadmap to additional case studies should be performed to further validate the framework roadmap across a wider variety of governmental entities.

The suggested areas of future research outlined above are indeed rich and exciting, and will provide many researchers with challenging and rewarding work.

APPENDIX A
PROCESS FLOW CHARTS

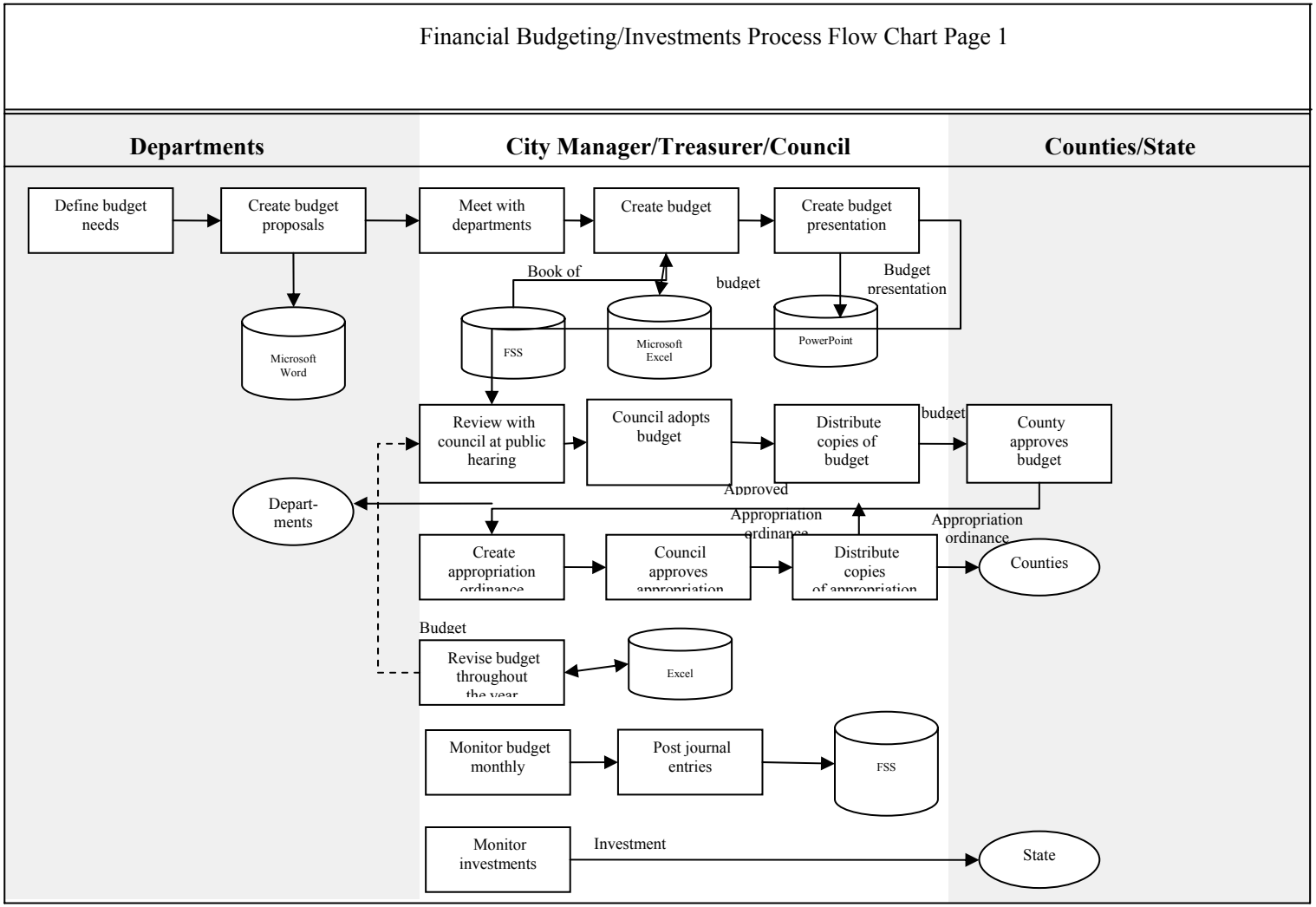


Figure A. 1 Financial Budgeting/Investments Process Flow Chart Page 1

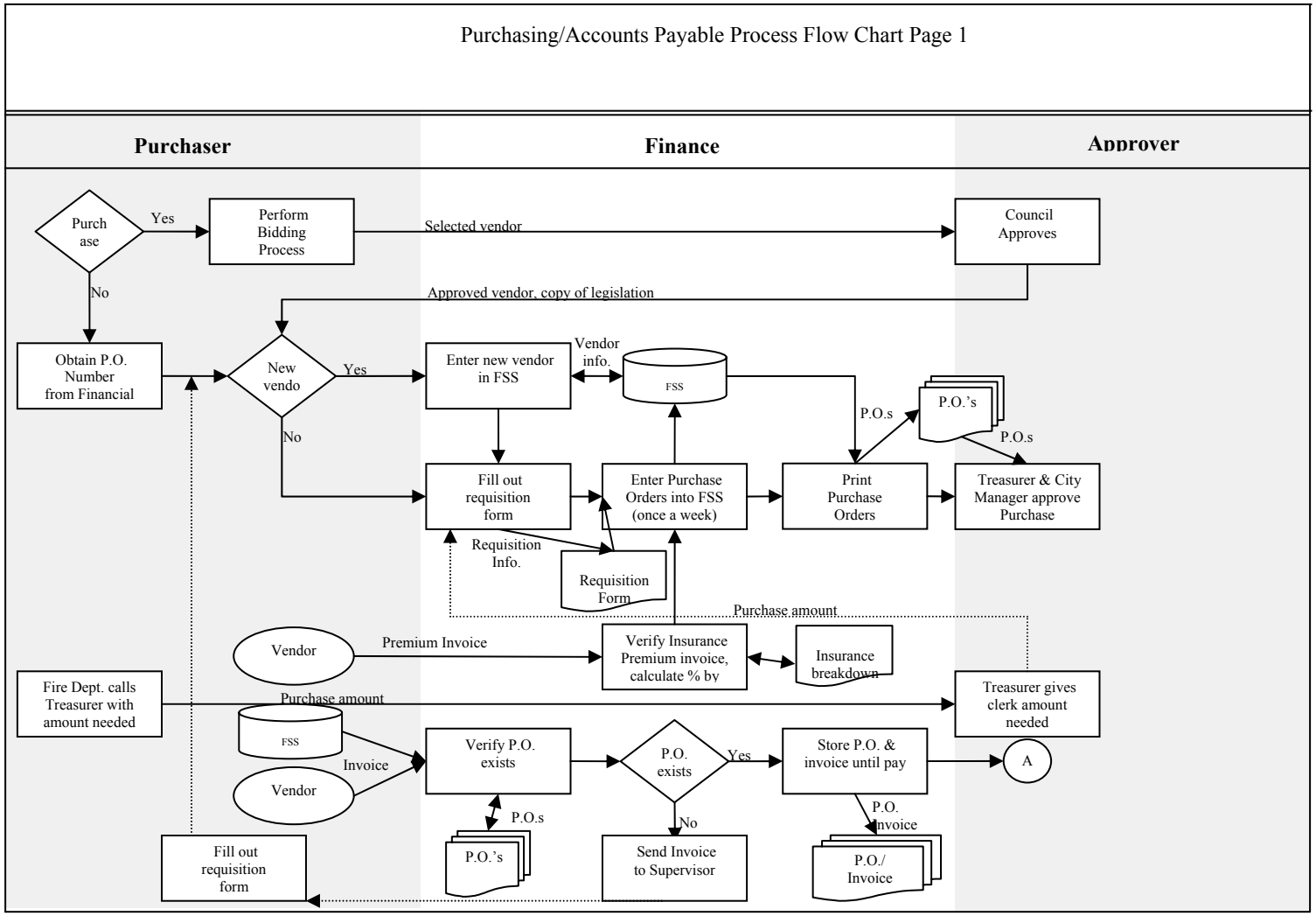


Figure A. 2 Purchasing/Accounts Payable Process Flow Chart Page 1

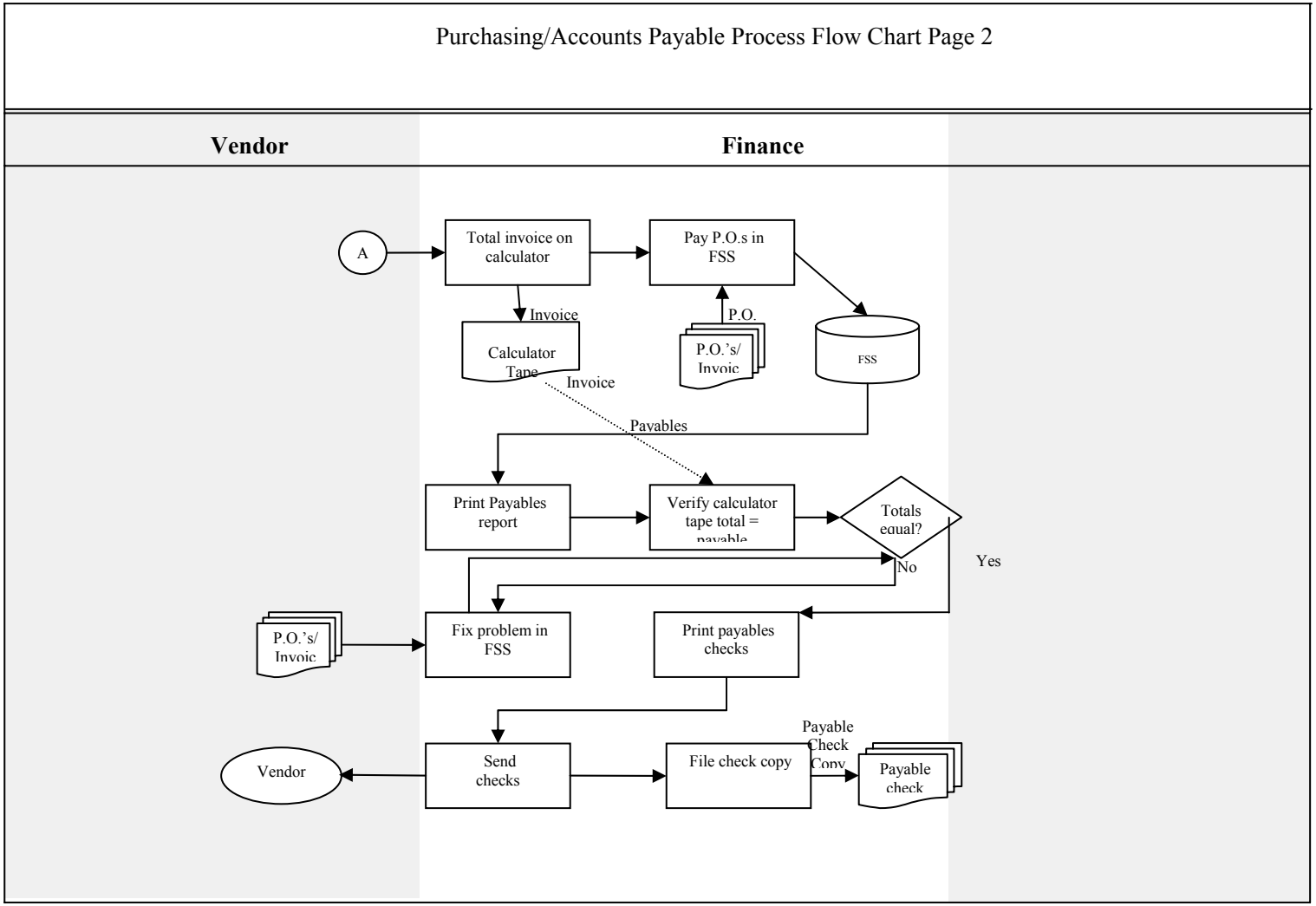


Figure A. 3 Purchasing/Accounts Payable Process Flow Chart Page 2

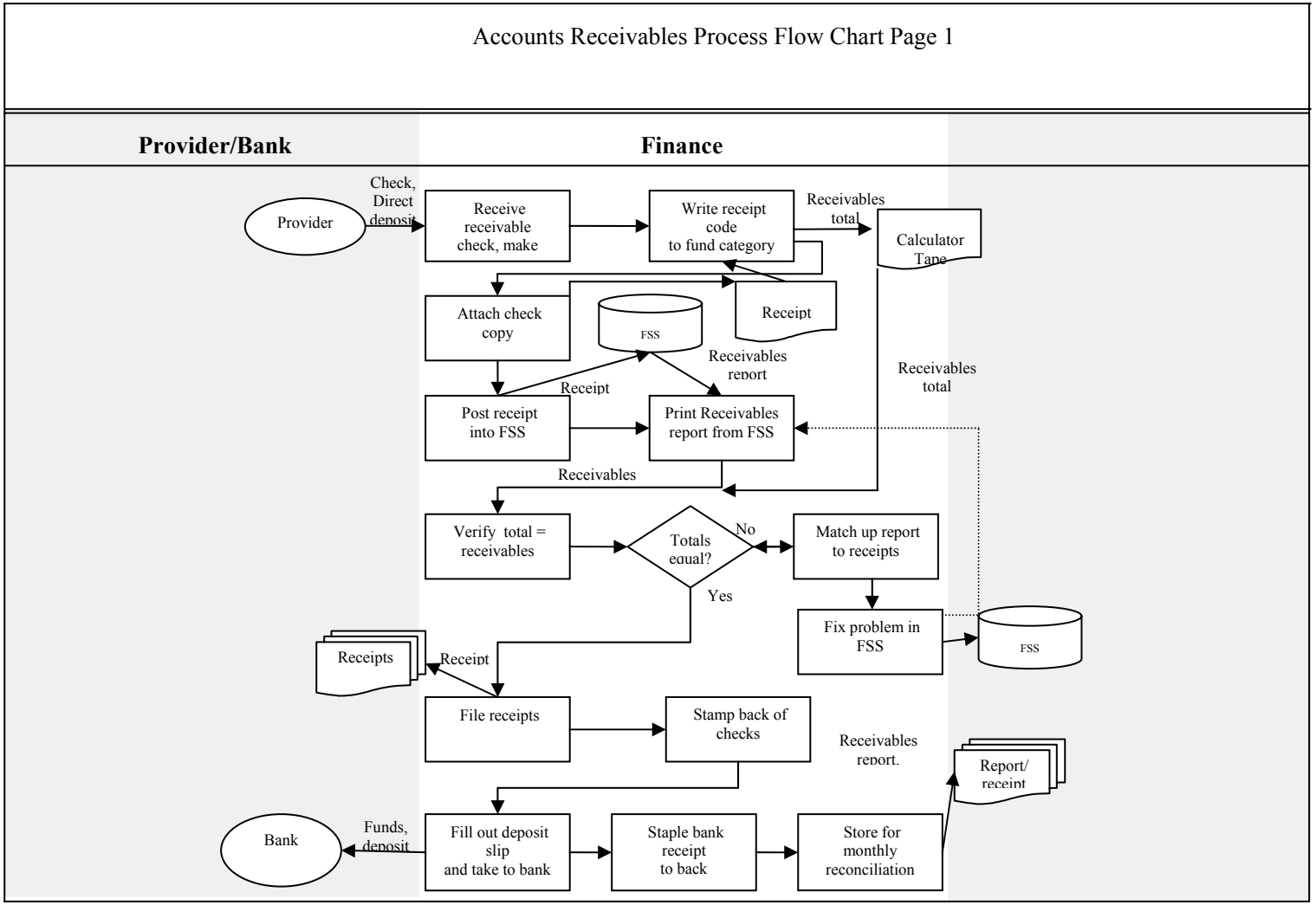


Figure A. 4 Accounts Receivable Process Flow Chart Page 1

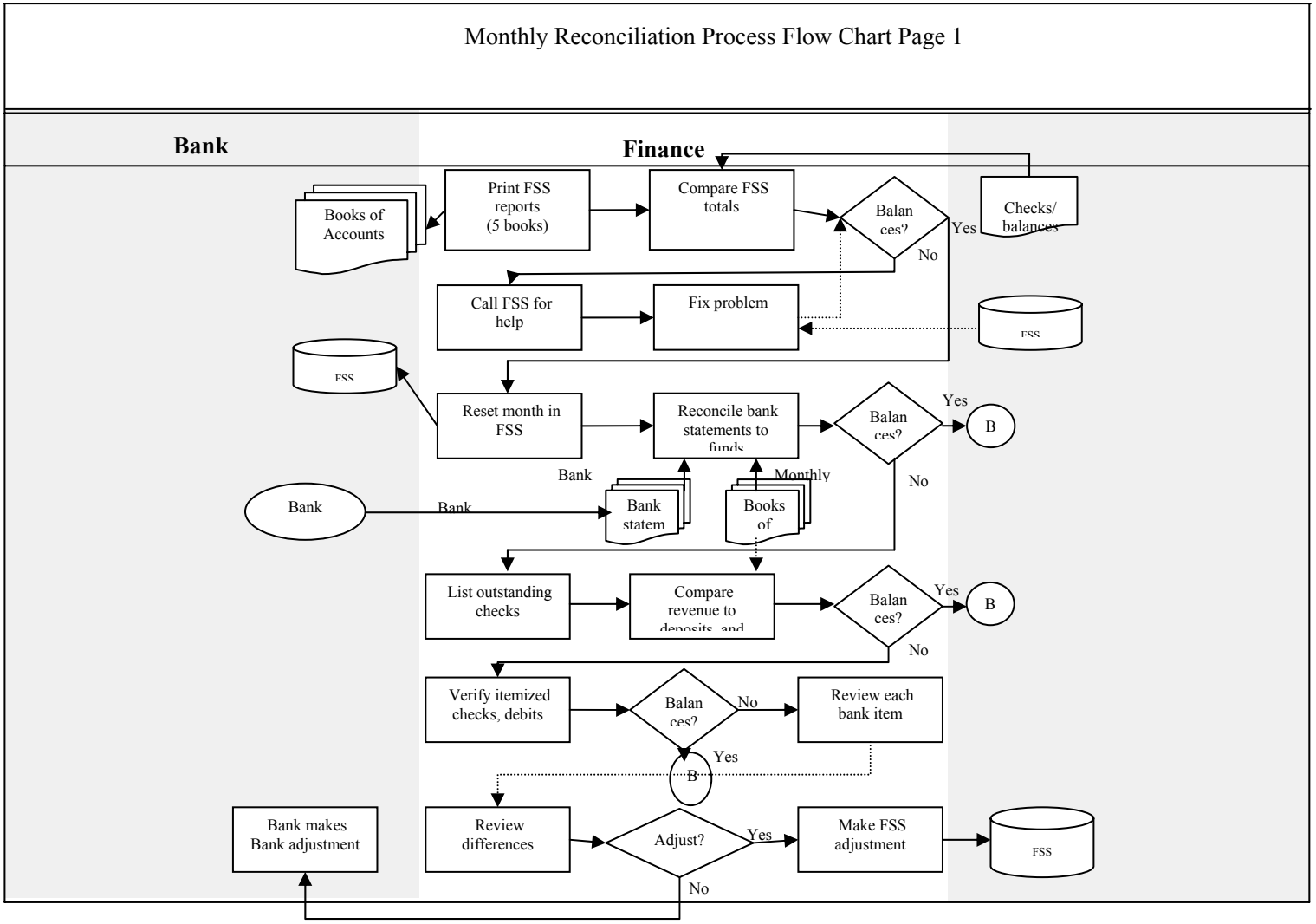


Figure A. 5 Monthly Reconciliation Process Flow Chart Page 1

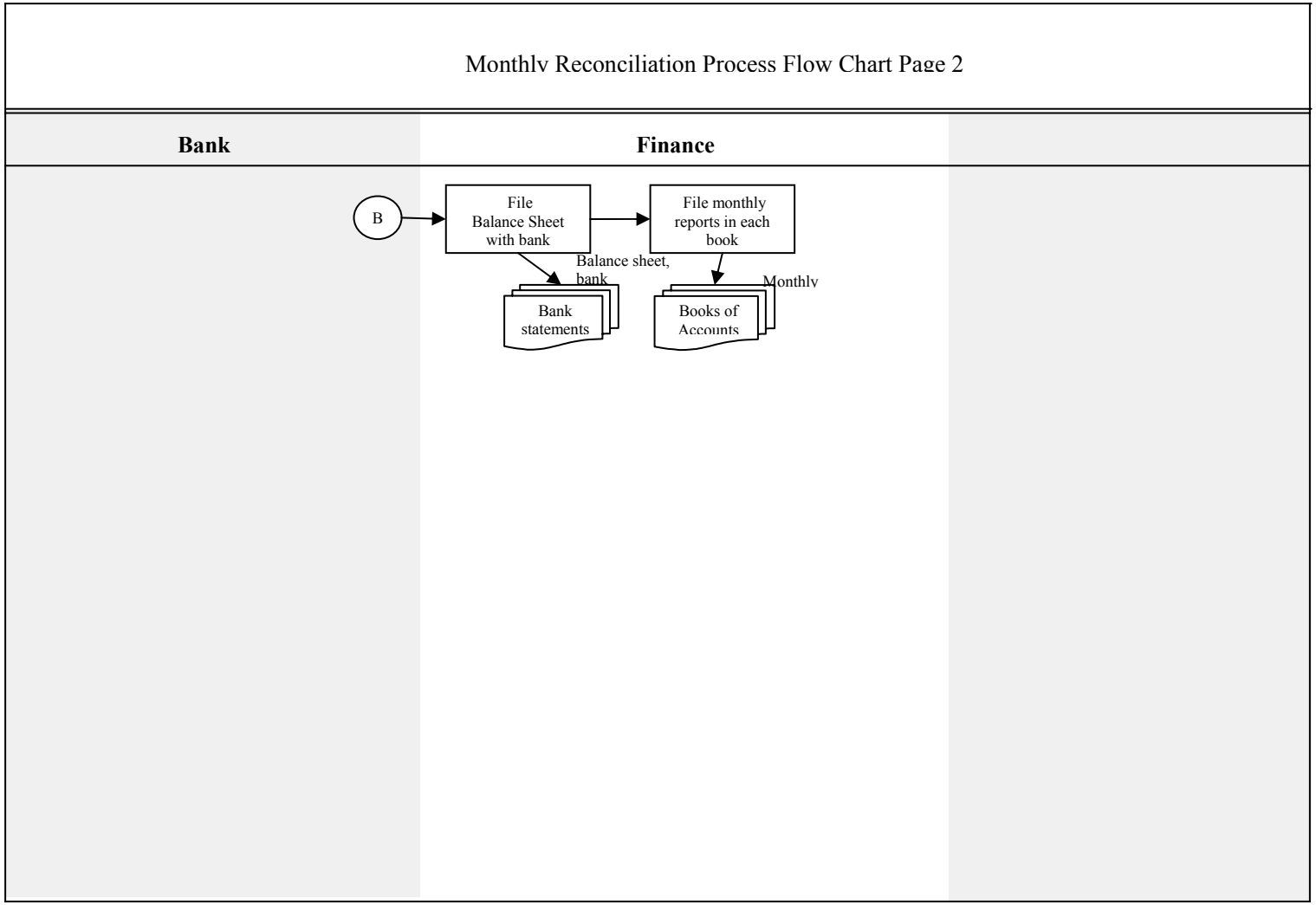


Figure A. 6 Monthly Reconciliation Process Flow Chart Page 2

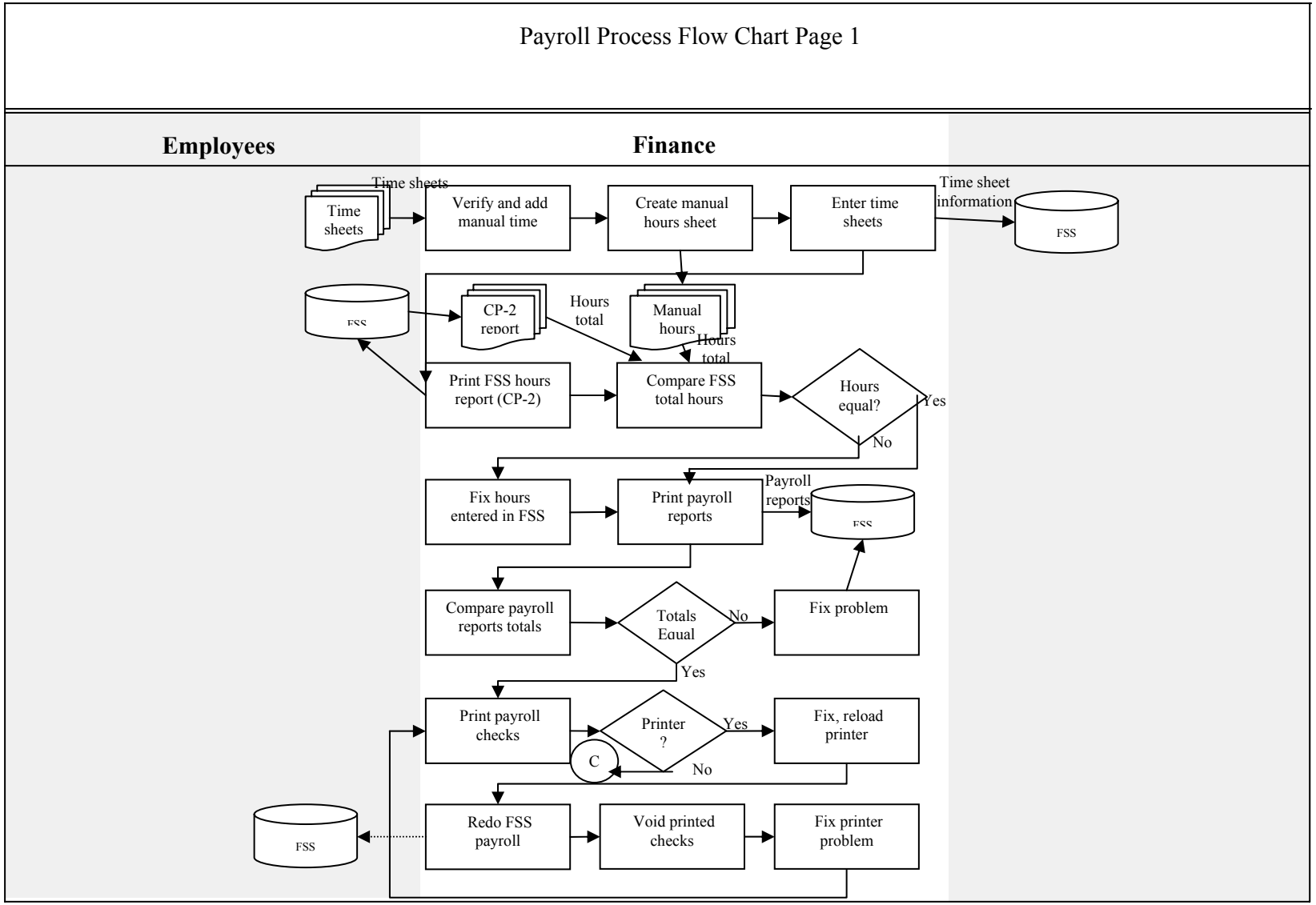


Figure A. 7 Payroll Process Flow Chart Page 1

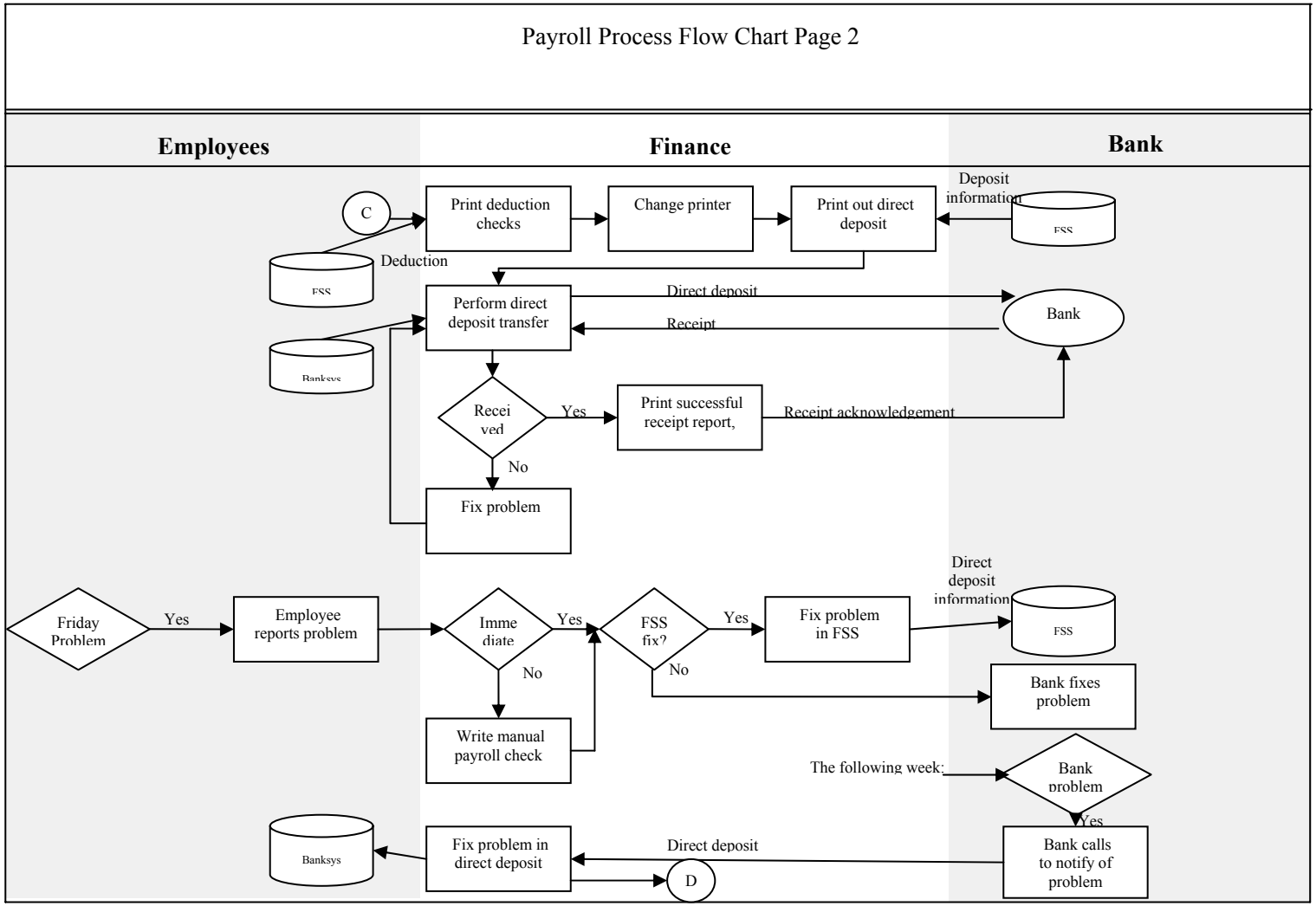


Figure A. 8 Payroll Process Flow Chart Page 2

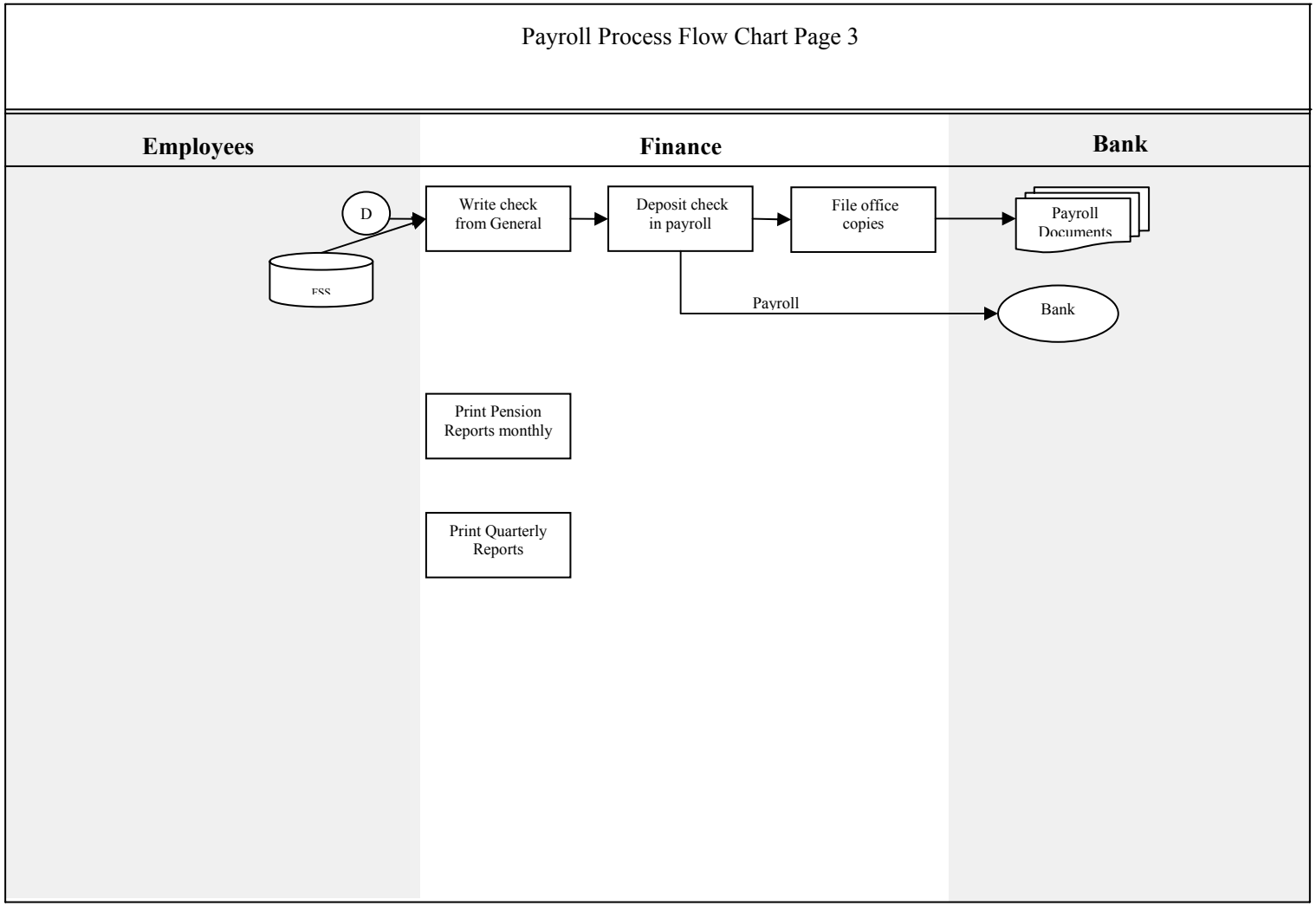


Figure A. 9 Payroll Process Flow Chart Page 3

APPENDIX B
COST BENEFIT ANALYSIS

The following table summarizes four potential solutions for automating the processing of payroll timesheet hours. The table provides a description of each potential solution, the advantages and disadvantages of each approach, and the estimated costs and benefits for each solution.

Table B. 1 Cost and Benefit Analysis for Payroll Timesheet Hours Processing

Solution Name	Alternative 1 – Access Program	Alternative 2 – FSS Remote Payroll	Alternative 3 – Scanning and OCR	Alternative 4 – Develop Excel Timesheets
Solution Description	Create an Access program that contains calculations needed for entry into the financial system's payroll time card program. Verification rules would also be written to verify time sheet data.	Use the Remote Payroll module in the financial information system to enter time sheet data.	Implement a Scanning and OCR (Optical Character Recognition) system to scan either manual timesheets or accept Excel spreadsheet timesheet entry input.	Develop Excel Timesheets that would standardize the timesheets across all of the departments, enable the departments to enter their own timesheet data, and eliminate the need to verify data off-line with a calculator.
Advantages	• Would provide rule verification and calculations of payroll time data. • Would potentially reduce the manual calculator-based verification	• Allows entry of time sheet data directly into the format that is accepted by the payroll system. • No custom programming	• Allows for input of time sheet data either from manual time sheets or Excel time sheets. • Does not require additional computers for data	• Low cost • Enables standardization of the timesheet format and process across city departments • Enables each

Solution Name	Alternative 1 – Access Program	Alternative 2 – FSS Remote Payroll	Alternative 3 – Scanning and OCR	Alternative 4 – Develop Excel Timesheets
	processing time.	would be needed.	entry. • Does not require additional data security for remotely located departments. • Does not require additional computer expertise across city departments. • The OCR and scanning software and hardware have already been implemented in the Income Tax department.	department to enter their own timesheet data. • Eliminates the off-line calculator verification steps. • Would reduce the time needed by the Finance Clerk to enter and validate the payroll timesheet hours data. • Would provide additional capacity for the Finance Clerk by eliminating the timesheet entry and validation activities by the Finance Clerk. • Would enable accountability at the source of the timesheet hours (within each city department) • Short

Solution Name	Alternative 1 – Access Program	Alternative 2 – FSS Remote Payroll	Alternative 3 – Scanning and OCR	Alternative 4 – Develop Excel Timesheets
				implementation time frame.
Disadvantages	• Requires a certain level of expertise on Access across the city departments for entering and verifying time data. • If the Finance Clerk enters the time data, it would potentially reduce data calculation and entry errors but not necessarily reduce data entry time for the Payroll Clerk. • Requires custom development of time sheet entry Access programs. • Requires maintenance and development if time sheet data	• Would require a certain level of expertise for the department supervisors or appointees to enter and approve time sheet data in the payroll system. • Would also require additional computers and data security for remote data entry of time sheet data.	• Does require additional software (OCR and scanning), hardware (scanner) and data security, and software licensing fees. • Requires custom development of OCR and scanning programs. • Requires maintenance and development if time sheet data requirements change. • High cost • Long implementation time frame.	• Require training by other departments to learn how to use the Excel timesheets. • Would require other departments to buy-in using the Excel-based timesheet process.

Solution Name	Alternative 1 – Access Program	Alternative 2 – FSS Remote Payroll	Alternative 3 – Scanning and OCR	Alternative 4 – Develop Excel Timesheets
	requirements change.			
Estimated Costs	Initial investment: • Consulting fees: 120 hours * $150/hour = $18,000 • Total: $18,000. Annual maintenance: $1,000	Initial investment: • Software module: $10,000 • Consulting and training fees: 8 * $150/hour = $1200: • Total = $11,200. Annual maintenance and license: $2,000	Initial investment: • Software development and consulting: $35,000 • Hardware: $10,000 • Total: $45,000. Annual maintenance and license: $10,000	Initial investment: • Consulting fees: 40 hours * $150/hour = $6,000 • Total: $6,000.
Estimated Benefits	• Reduced payroll processing time • Annual Benefit of 4 hours per payroll period * $16/hour * 26 pay periods = $1664 • Reduce data entry errors	• Reduced payroll processing time. • Annual Benefit of 4 hours per payroll period * $16/hour * 26 pay periods = $1664 • Reduce data entry errors	• Reduced payroll processing time • Annual Benefit of 6 hours per payroll period * $16/hour * 26 pay periods = $2496 • Reduce data entry errors	• Reduced payroll processing time • Annual Benefit of 8 hours per payroll period * $16/hour * 26 pay periods = $3328 • Reduce data entry errors
Economic Analysis	• Net Present Worth: -$15,349 • Internal Rate of Return: Negative • Payback period: > 5 years	• Net Present Worth: -$12,542 • Internal Rate of Return: Negative • Payback period: > 5 years	• Net Present Worth: - $74,961 • Internal Rate of Return: Negative • Payback period: > 5 years	• Net Present Worth: $7,289 • Internal Rate of Return: 48% • Payback period: 2.02 years

Economic Analysis Assumptions: 5-year project life, Minimum Attractive Rate of Return is 8%

Results: Alternative 4 was implemented. It had a positive net present worth of $7,289 compared to negative values for the other alternatives. It had a positive internal rate of return of 48%, and a 2.02 year payback period.

APPENDIX C
STATUS REPORT

Table C. 1 Status Report

Priority	Area	Activity	Owner	Comments	Status	Estimated Completion Date
7	Payroll	Create a direct deposit letter, and program that can encourage City employees to use direct deposit.	Reggie	Complete: Reggie created a letter and gave to Dave TO DO: 1) Dave to obtain approval from City Manager. 2) Sandy to obtain restaurant gift certificates.	In progress	10/30
	Payroll	Investigate other FSS programs that can enable department supervisors to enter and approve time sheets.	Sandy	TO DO: 1) Work with FSS to compare options to further streamline the data entry of the time sheets. 2) Working with software vendors to help them to understand the requirements. 3) Create requirements document	In progress	

APPENDIX D
ITEMS FOR RESOLUTION (IFR) FORM

#	Issue	Priority	Status	Owner	Open Date	Resolved Date	Change Order Number	Resolution

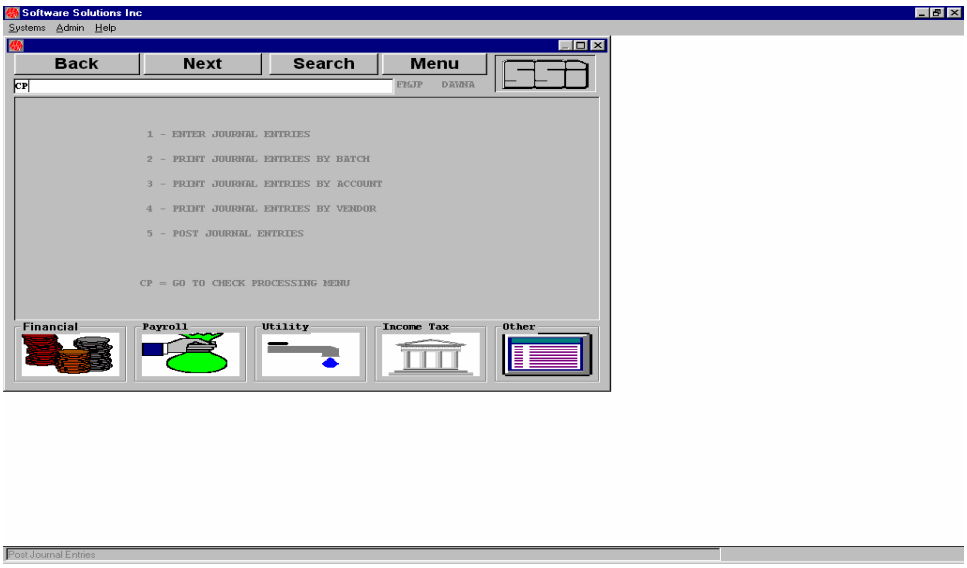
Figure D. 1 Items for Resolution Template

APPENDIX E
SAMPLE DESK TOP PROCEDURE

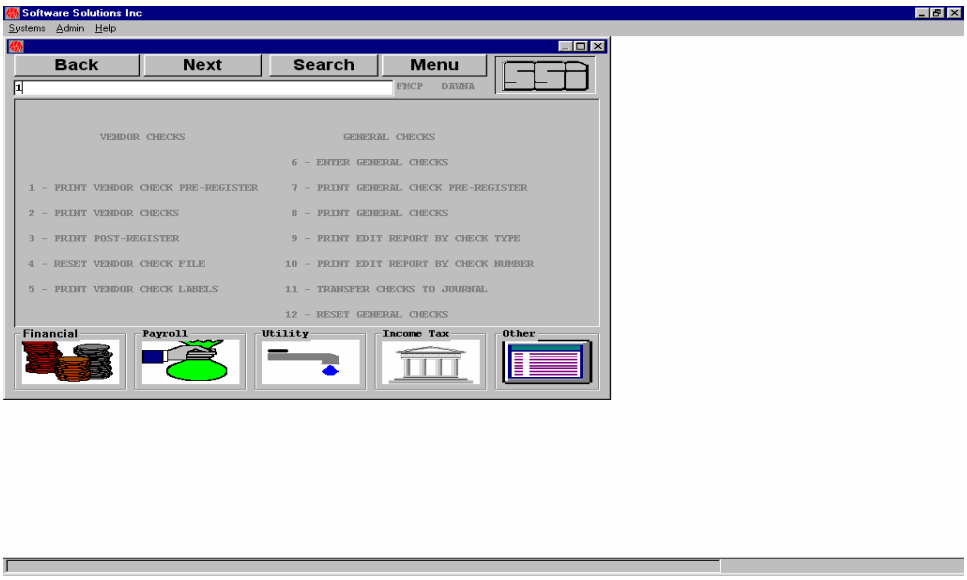
Finance Department
Accounts Payable Procedure

Check Processing

1) Type CP (Check Processing)<enter>.

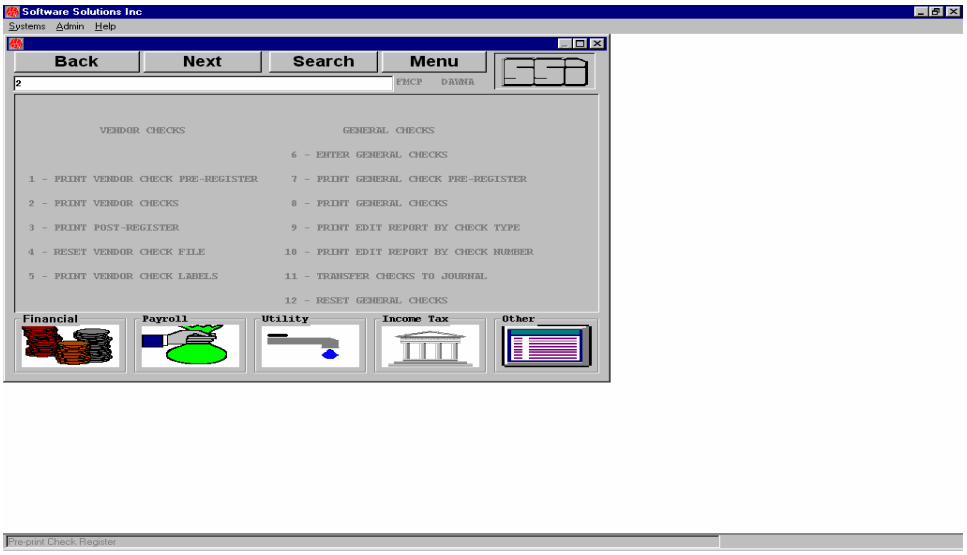


2) Type 1 (Print Vendor Check Pre-Register)<enter>.

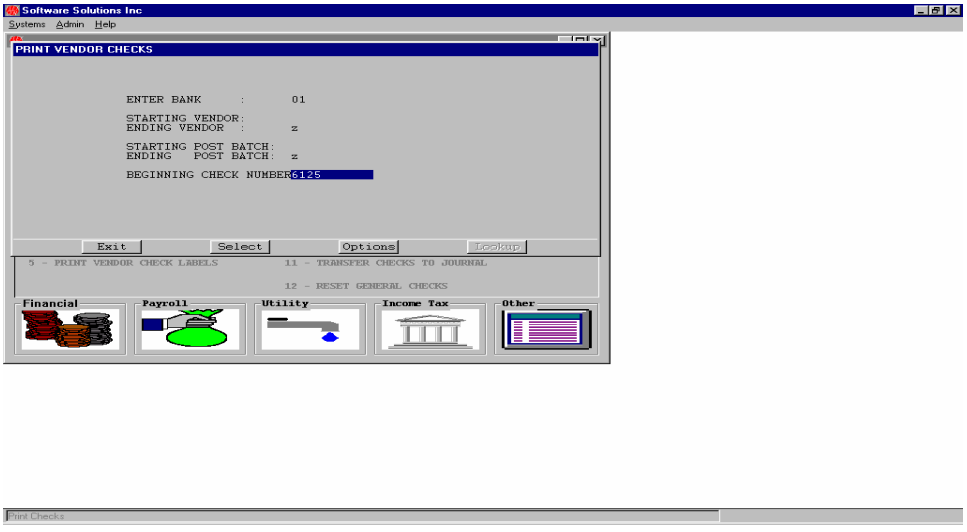


3) Select F4, then “Display” to display the Vendor Check Pre-Register to the screen (or Print to print to the printer). Verify totals.

4) Type 2 (Print Vendor Checks)<enter>.



5) Leave screen “as is” EXCEPT type in the Beginning Check Number and Press Select.



6) FSS will ask if you want to align checks. TYPE IN “N” - NEVER ALIGN CHECKS.

7) FSS will ask if you are finished printing checks. Type in "Y".

8) FSS will ask if "OK to update Audit Trail File", select "YES".

9) Selection 3 (Print Post-Register) will automatically print. Press <enter> to proceed.

10) Selection 4 (Reset Vendor Check File) will automatically come up. Press Update to proceed. FSS will ask, "About to reset check file, OK to continue", select "YES".

11) Separate the checks:
    a) Original is stapled to vendor remit to and mailed.
    b) Yellow copy is stapled to invoice and filed alphabetically.
    c) Pink copy is filed numerically.

END OF PROCEDURE

APPENDIX F
PROCESS MEASUREMENT CHECK SHEET

Financial Process: Purchasing/Accounts Payable

Metrics:

- Number of Problems per Invoice
- Time per Invoice
- Percent invoices without PO's (Purchase Orders)
- Percent invoices paid within discount period

Purpose: **To understand the number and types of problems identified during the accounts payable processing of invoices. To understand the time to process an invoice and the variation associated with the Accounts Payable process.**

Data Collection Mechanism: Accounts Payable Check Sheet

Procedure for Use of Accounts Payable Check Sheet:

Whenever an accounts payable process problem occurs, document the following on the Accounts Payable Check Sheet:

Table F. 1 Accounts Payable Process Check Sheet Field Definitions

Field	Description
Entered By	The person processing the accounts payable batch.
Date	The month, day and year when the person is processing the accounts payable batch.
Batch Number	The FSS system assigned batch number.
Total Time to Complete Batch	Record the total number of hours (or partial hours) spent processing the accounts payable batch.
Time per invoice	Divide the **Total Time to Complete Batch** by the **Number of invoices in batch**.
Number invoices in batch	The number of invoices processed in the batch.
Number of invoices without PO's	The number of invoices that are received where a purchase order does not exist in the system.
Number of invoices without discount terms	The number of invoices that do not have discount payment terms.
Percent invoices without PO's	Divide the **number of invoices without PO's** by the **number of invoices in batch.**
Number of invoices with discount terms	The number of invoices that have discount payment terms.
Number of invoices paid within discount period	The number of invoices that have discount payment terms that were paid within the discount period.

Field	Description
Percent invoices paid within discount period	Divide **the number of invoices paid within discount period** by **the number of invoices with discount terms**.
Number of Problems Per Invoice	Divide the "**TOTAL NUMBER**" of problems across the entire batch by the "**Number invoices in batch**" processed.
Problem Area	The type of problem encountered during the accounts payable batch processing. If the problem falls into one of the pre-defined problem areas, enter a tally mark in the "tally" column for the problem. If the problem does not fall into the pre-defined problem areas, document the problem area on a blank line, and record a tally mark in the "tally" field next to the problem area. NOTE: If the problem is a software related problem, also record the data required on the "FSS System Problem Report".
Tally	This field is where tally marks are recorded when a problem occurs that can be defined as the problem type in the corresponding row.
Number	When the batch is complete, total the number of problems in each problem area and write the number next to the tally marks.
Notes	Enter any "notes" that will further define the problem, such as software error message number, data involved, or steps performed when the problem occurred.
TOTAL NUMBER	Sum the total number of problems for the batch (across all of the problem areas).

Entered By: _____ **Date:** _____ **Batch Number:** _____
Total time to complete batch (hours): _____ **Time per invoice:** _____
No. invoices in batch: _____ **No. invoices without PO's:** _____
No. invoices without discount terms: _____ **Percent invoices without PO's:** _____
No. invoices with discount terms: _____ **No. invoices paid within discount period:** _____
Percent invoices paid within discount period: _____ **No. of problems per invoice:** _____

Problem Area	Tally	Number	Notes
Check Printing			
Posting			
Software			
TOTAL NUMBER			

Figure F. 1 Accounts Payable Check Sheet

LIST OF REFERENCES

Alukal, G. (2003). "Create a Lean, Mean Machine," **Quality Progress**. ASQ, Milwaukee, WI.

American Society for Quality website (2002). "American Customer Satisfaction Index: Satisfaction with Government Drops Slightly." American Society for Quality website http://www.asq.org/

American Society for Quality (2002). "Pilot Project Approved for Good Works Initiative." Milwaukee, WI.

ASQ's 56th Annual Quality Congress Proceedings (2002). **ASQ's 56th Annual Quality Congress Proceedings** 56

Benbow, D., Berger, R, Elshennawy, A., and Walker, F. (2002). "The Certified Quality Engineer Handbook." **ASQ Quality Press**.

Bolman, L., and Deal T., (1997). Reframing Organizations Artistry, Choice, and Leadership. Second Edition. **John Wiley & Sons,** San Francisco, CA.

Bossert, J., and Grayson, K. (2002). "Your Opinion", **Six Sigma Forum Magazine**, Vol. 2, Issue 1, November, ASQ, Milwaukee, WI.

Boyne, G., and Walker, R. (2002). "Total Quality Management and Performance, An evaluation of the Evidence and Lessons for Research on Public Organizations." **Public Performance & Management Review** 26 (2), pp. 111-131.

Bullington, K. (2003). "5S for Suppliers." **Quality Progress.** January 2003.

Caulcutt, R. (2001). "Why is Six Sigma so Successful?" **Journal of Applied Statistics.** 28 (3 and 4), pp. 301-306.

Chmielewski, T., and Phillips, J. (2002). "Measuring Return-on-Investment in Government: Issues and Procedures." **Public Personnel Management** 31 (2), pp. 225-237.

City of Coral Springs, Florida website (2003). "**Governor's Sterling Award Application."** City of Coral Springs, Florida website http://www.ci.coral-springs.fl.us/

City of Jacksonville, Florida website (2003). http://www.coj.net/default.htm

City of Fort Wayne website (2002). "Six Sigma and City Government." **City of Fort Wayne website** www.cityoffortwayne.org/6sigma.htm

Coronado, R. and Antony, J. (2002). "Critical Success Factors for the Successful Implementation of Six Sigma projects in Organisations." **The TQM Magazine** 14 (2), pp. 92-99.

Dale, B. (1994). "A Framework for Quality Improvement in Public Sector Organizations: A Study in Hong Kong." **Public Money & Management** 14 (2), 1994, pp. 31-36.

Dale, B. and Boaden, R. (1993). "Improvement framework." **TQM Magazine** 5 (1), pp. 23-26.

De Feo, J. (2001). "How the Future Will Impact Quality." **Quality** 40 (10), p. 40.

Drickhamer, D. (2002). "Best Practices – Where Lean Meets Six Sigma." **Industry Week**.

Dubai Quality Group (2003). "The Birth of Lean Sigma", The Manage Mentor, Dubai.

Erridge, A., Fee, R., McIlroy, J. (1990). "Public Sector Quality: Political project or Legitimate Goal." **International Journal of Public Sector Management** 11 (5), pp. 341-353.

Evans, J. and Lindsay, M. (2002). "The Management and Control of Quality." Fifth Edition. **South-Western Thomson Learning**.

Foster Jr., T., Howard, L., and Shannon, P. (2002). "The Role of Quality Tools In Improving Satisfaction with Government." **The Quality Management Journal.**

Furterer, S.L., and Elshennawy, A.K., **"**Applying Lean Six Sigma Tools to Local Government". **International Conference on Productivity and Quality Research**, February 2004.

George, M. (2002). "Lean Six Sigma Combining Six Sigma Quality with Lean Speed." **McGraw-Hill**.

Goldstein, M. (2001). "Six Sigma Program Success Factors." **Six Sigma Forum Magazine.** 1(1), November 2001.

Government Accounting Standard Board (GASB) (2002). "Performance Measurement for Government." www.seagov.org/perfmeasures/index.html

Goyal, N. (2002). "Applying Lean Manufacturing to Six Sigma – A Case Study." ISixSigma website, Six Sigma Article Spotlights www.isixsigma.com

Hahn, G., Doganaksoy, N., and Hoerl, R., (2000). "The Evolution of Six Sigma." **Quality Engineering.** 12, pp. 317-326.

Harry, M. and Schroeder, R. (2000). "Six Sigma The Breakthrough Management Strategy Revolutionizing the World's Top Corporations." **Doubleday**.

Hellein, R., and Bowman, J. (2002). "The Process of Quality Management Implementation State Government Agencies in Florida." **Public Performance & Management Review Journal,** 26 (1), pp. 75-93.

Hoffman, J. and Mehra, S. (1999). "Management Leadership and Productivity Improvement Programs." **International Journal of Applied Quality Management** 2 (2), pp. 221-232.

Hyde, A. (1997). "A Decade of Quality Management." **Government Executive,** Vol. 29, Issue 7, pp. 58-68.

Illing, J. (2001). "Seamless Integration of Lean Enterprises and Six Sigma." **Automotive Manufacturing and Production** 113 (2), p. 66.

Kandebo, S. (1999). "Lean, Six Sigma Yield Dividends for C-130J" **Aviation Week & Space Technology**, New York, July 12, 1999.

Kanji, Gopal. (2002) Measuring Business Excellence, Routledge, London, New York.

Kapadia, M., Mishra, A., Hemanth, S., and Limaye, V. (2003). From Project to Program: Key Lessons for Implementing Improvements. **Six Sigma Forum website** www.sixsigmaforum.com

Keller, P. (2001). "Recent Trends in Six Sigma." **ASQ's 55th Annual Quality Congress Proceedings.**

McAdam, R., and Mitchell, N. (1998) "Development of a Business Process Re-engineering Model Applicable to the Public Sector." **Total Quality Management** 9 (4-5), pp. 160-164.

McIlroy, J. and Silverstein, D. (2002). "Six Sigma Deployment in One Aerospace Company." **Six Sigma Forum website** www.sixsigmaforum.com

Mills, C., Wheat, B., and Carnell, M. (2001). "Leaning into Six Sigma." **Publishing Partners.**

Monden, Y. (1993). Toyota Production System, An Integrated Approach to Just-In-Time. Second Edition. **Industrial Engineering and Management Press Institute of Industrial Engineers**.

Montgomery, D., Runger, G., and Hubele, N. (2001). "Engineering Statistics." Second Edition, **John Wiley & Sons, Inc**.

Newman, J. (1994). "Beyond the Vision: Cultural Change in the Public Sector." **Public Money & Management** April-June 1994.

Northeast TQM Network (2002). "TQM Network." www.tqmnet.com

Poister, T. and Harris, R. Jr. (2000). "Building Quality Improvement Over the Long Run, Approaches, Results, and Lessons Learned From the PennDOT Experience." **Public Performance & Management Review Journal,** 24 (2).

Redman, T., Mathews, B., Wilkinson, A., and Snape, E. (1995). "Quality Management in Services: Is the Public Sector Keeping Pace" **International Journal of Public Sector Management,** 8 (7), pp. 21-34.

Roberts, J. (1997). Total Productive Maintenance. **The Technology Interface**.

Robertson, R., and Gill, P. (2000). "Linking Quality to Business Planning and Performance Goals in Local Government." Quality Congress, ASQ, Annual Quality Congress Proceeding, Milwaukee.

Rucker, R. (2000). "Citibank Increases Customer Loyalty With Defect-free Processes." **The Journal for Quality and Participation** Cincinnati, Fall 2000.

Schneider, B. and Bowen, D.E. (1995). "Winning the Service Game." **Harvard Business School Press**, Boston, MA.

Sensenbrenner, J. (1991). "Quality Comes to City Hall**."** **Harvard Business Review**, mar/April 91, Vol. 69 Issue 2, p64, 7p

Sharma, A. and Moody, P. (2001). "The Perfect Engine." **The Free Press**.

Sheridan, J. (2000). "Aircraft-Controls Firm Combines Strategies to Improve Speed, Flexibility and Quality." **Gale Group**, Penton Media, Inc.

Smith, B. (2002). "Integrating Six Sigma and Lean Manufacturing." Six Sigma Forum website www.sixsigmaforum.com

Smith, B. (2003). "Lean and Six Sigma A One-Two Punch." **Quality Progress** April 2003.

Smith, B. and Adams, A. (2001) "LeanSigma ^{SM}: Advanced Quality." **ASQ's 55th Annual Quality Congress Proceedings 55**

Stephens, K. (1997). "EVOP Revisited." **17th Southeastern Quality Conference.**

Sureshchandar, G., Chandrasekharan, R, and Anantharaman, R. (2001). A Holistic Model for Total Quality Service." **International Journal of Service Industry Management.**

Swindell, D. and Kelly, J. (2000). "Linking Citizen Satisfaction Data to Performance Measures A Preliminary Evaluation." **Public Performance & Management Review** 24 (1), pp. 30-52.

Trombly, R. (2002). "Running lean running strong: lean manufacturing processes lead to a stronger, more efficient business." **Reed Business Information, Gale Group**. .

Wadsworth, H., Stephens, K., and Godfrey, B. (2002). "Modern Methods for Quality Control and Improvement." Second Edition. **John Wiley & Sons, Inc.** New York, NY.

Wiklund, H., and Sandvik Wiklund, P., (2002). "Widening the Six Sigma Concept: An Approach to Improve Organizational Learning." **Total Quality Management** 13 (2), pp. 233-239.

Womack, J. and Jones, D. (1996). "Lean Thinking: Banish Waste and Create Wealth in Your Corporation." **Simon & Shuster,** New York, NY.