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References

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Implementation of TQM and lean Six Sigma tools in local government: a framework and a case study.

While TQM is an organization-wide approach, aimed at improving the quality of products and services and mainly focused on continuous improvement, 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 in a more synergistic manner has occurred in the literature over the last several years. The majority of TQM and Lean Six Sigma applications have been in private industry, focusing mostly on manufacturing applications. The literature has not provided cases of Lean Six Sigma programmes applied to local government. This paper presents some efforts of implementing TQM tools in local government and a case study of applying Lean and Six Sigma tools and principles to improving the quality and timeliness of providing local governmental services.

Keywords: Six Sigma; Lean Six Sigma; process improvement; quality management; Total Quality Management

Introduction

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 programmes, Six Sigma and 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 1980s at Motorola Corporation. Six Sigma was popularized in the late 1990s 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 & Jones, [16]). The term 'Lean Enterprise' is used to broaden the scope of a Lean programme from manufacturing to embrace the enterprise or entire organization (Alukal, [1]).

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.

Lean Six Sigma applications in private industry

The concept of combining Lean Manufacturing and Six Sigma principles began in the middle to late 1990s, and quickly took 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 (Sheridan, [15]).

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, [7]).

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 (McIlroy & Silverstein, [12]).

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, [10]).

Lean Six Sigma applications 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 centres, education, in administrative functions such as accounting and order processing, material procurement, and new product development (Bossert & Grayson, [3]).

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 (City of Fort Wayne, [6]).

The City of Coral Springs, Florida won the Florida Governor's Sterling Award in 1997 and again in 2003, being the first repeat winner of the award. 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 (City of Coral Springs, [5]).

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 (American Society for Quality, [2])

Although the literature does not provide cases of Lean Six Sigma programmes in local governments, there is evidence in the literature of applications of quality principles and tools in the public sector. Boyne & Walker [4] studied how TQM was used in private and public organizations and whether TQM helped to improve performance in these organizations.

A study by Hellein and Bowman investigated the impact of the implementation of quality management in four Florida state government agencies. 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 & Bowman, [8]).

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 (Redman *et al.*, [14]).

There are few long-term examples in the literature of mature quality programmes 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 programmes, 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 & Harris, [13]; Hyde, [9]).

Lean Six Sigma application in a local government: a case study

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 authors applied Lean Six Sigma tools and principles to the financial administration processes in a local governmental entity. These tools streamlined the processes and reduced the time to complete the financial processes.

The financial processes include payroll, purchasing and accounts payable, accounts receivable, and monthly reconciliation, in a 7000-citizen municipality. The Finance Clerk generates paycheques every two weeks for the city employees. 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. The customers of the payroll process are internal city employees and external agencies that receive withholding payments and reports. The initial or current processes 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 13 to 70 employee hours per pay period, depending on whether 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, and 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 cheques into the bank. In the current process there is a lag between when the revenue cheques 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 Six Sigma problem solving approach (DMAIC), along with quality and Lean tools were 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.

DMAIC in local government

The DMAIC (Define, Measure, Analyse, Improve, Control) problem solving methodology from the Six Sigma approach was used to improve the financial processes. Application of each phase in improving the financial processes will be presented in the following sections.

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 section will describe the activities performed within each phase of the DMAIC problem solving approach, and the Quality tools applied within each phase.

(1) Define process improvement need

The Finance Director identified the need to streamline the financial processes, and was the project champion.

(2) Identify department goals, project scope, objectives and project plan

The Team 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 team created a project plan with activities, a timeline, and resources. Table 1 identifies the team mission, and team members' roles and responsibilities.

Table 1. Team mission, roles and responsibilities

Team Mission

~~Team Mission~~ Document the current financial processes to create desktop procedures and to identify and implement financial process improvements.

Role

Document the current financial processes to create desktop procedures and to identify and implement financial process improvements.

Responsibility

Role

Finance Clerk as Process Owner

Responsibility

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.

(3) Form process improvement team

A process improvement team was formed, consisting of the Finance Director, the Finance Clerk, and a Team Quality Facilitator that performed the role of a Black Belt, a Process Analyst and a Consulting Manager. The Team Quality Facilitator, the Process Analyst and the Consulting Manager were hired from an external consulting firm.

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, and identify the process problems that are causing inefficiencies and errors and their root causes. The activities performed and tools applied during the measure phase are discussed below.

(1) Profile current state

We 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 the financial processes. We noted various system functions used to perform these processes within the process flows. We identified the written (of which few existed) and unwritten policies that governed the processes. We identified if any process measures existed, which they did not. 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 2.

Table 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

We 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.

We 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.

(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 5Ss) to identify process problems, such as, inefficient sorting and filing of purchase orders and invoices. We also used brainstorming to identify problems.

(3) Identify root causes of problems

We 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 1.

Graph: Figure 1. Cause and effect diagram

Analyse

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

(1) Analyse gaps from best practice

We identified gaps comparing the current state processes to best practice financial processes. We used Pareto Analysis to understand the vendor purchase patterns to potentially streamline the number of vendors across city departments. Figure 2 shows the number of vendors by the year-to-date dollar

volume. There are over 250 vendors with year-to-date (through August) dollar volume of activity less than \$500. We used our 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. We 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. We performed an analysis of reported financial information system problems using Pareto Analysis and Statistical Process Control Charts to identify employee training and knowledge gaps with respect to the financial and administrative information system. Figure 3 shows the reported information system problems organized by resolution category. This chart shows that training problems contributed to 54% of the reported problems. Figure 4 shows the moving range control chart of the time (in hours) that it took the software vendor to resolve reported information system problems. An individual chart was also used, but not shown here. The control charts showed that problems with the system contributed to process inefficiencies.

Graph: Figure 2. Vendors by year-to-date dollar volume

Graph: Figure 3. Pareto chart of information system problems

Graph: Figure 4. Moving range control chart for time to resolve problems

(2) Identify improvement opportunities and develop an improvement plan

We identified improvement opportunities that we grouped as Lean categories: standardized processes and procedures, good housekeeping, Kanban and visual control, waste identification and elimination, and one-piece flow.

Standardized processes and procedures:

- (1) We suggested that the finance department develop standardized desktop procedures. No written procedures existed in the current state.
- (2) Another improvement area was to use an Excel spreadsheet to standardize batch calculations for matching, and dividing invoice amounts across different account numbers.
- (3) We recommended that the employees who used the financial system get training from the software vendor tailored specifically to their streamlined financial processes.
- (4) We 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. We 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 a calculator.

Kanban and Visual Control:

- (5) We 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. The Kanban was organized in the order of the process steps. 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.

Waste Identification and Elimination:

- (6) We identified unnecessary steps in the processes, such as printing lengthy reports that were never used. We encouraged either not printing the reports at all, or printing them to an electronic file, which took seconds, instead of hours.
- (7) We encouraged the use of new accounts receivables technology that automatically transferred journal entries, instead of requiring redundant data entry.
- (8) We identified direct deposit as an improvement opportunity to eliminate printing of payroll cheques. We 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.
- (9) We recommended extensive information technology improvements that further streamlined the processes, and eliminated redundant data entry.

One Piece Flow:

- (10) Another improvement idea that we 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. We recommended that the accounts receivable (revenue) batches be processed daily, instead of holding them for one to two weeks.
- (11) We used the vendor Pareto Analysis to identify duplicate vendors and recommended that the number of vendors be reduced. 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.

(3) Perform a cost–benefit analysis

We identified potential costs and benefits of each proposed improvement to determine if the estimated benefits are greater than the costs to implement. Most of the costs were related to training, and the resources needed to implement and document the standardized procedures. The largest costs were related to obtaining laser printers that eliminated problems from dot-matrix printers and form-fed report printing that frequently jammed resulting in redoing complete cheque runs and processing.

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.

(1) Implement improvement solutions

We implemented the financial process improvements across a four-month period to the payroll and pension reporting, purchasing and accounts payable processes, accounts receivable, and monthly reconciliation. We first collected further information to validate the feasibility of the process improvement ideas presented in the analyse phase. We 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 analyse phase. We gained approval from the Finance Director to proceed with the implementation of the improvement opportunities. We implemented the improvements and redesigned the appropriate processes to incorporate the improvements. As part

of the project management of the implementation we provided weekly status reports to the team, which included the tasks that were completed and the status and estimated completion date. We also documented any outstanding unresolved issues on an Item for Resolution Form (IFR).

(2) Measure impact of the improvements

We 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 paycheque errors were found while migrating the Fire Department into the Finance Department's 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 cheques 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.

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 six per month.

Table 3 summarizes the estimated prior processing times, the estimated processing times after the improvements, and the percentage reduction of processing times.

Table 3. Percentage reduction in processing time

Process	Average estimated processing time prior to improvements	Average 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%

(3) Documenting procedures and training employees on the improved procedures

The process analyst documented the improved and standardized desktop procedures, which included detailed process steps and computer screen shots populated with representative process data. The desktop 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.

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.

Control

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

(1) Design and implement process performance measures

Several process performance measures were recommended to help assess the productivity and quality of the financial processes.

(2) Implement a continuous process improvement approach to always improve

We 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 staff turnover occurred, so that the culture would change to one that continually and always improved.

(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.

Results and concluding remarks

Through implementing a Lean Six Sigma programme, the city's Finance Department was able to reduce significantly 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 paycheque 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.

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 six per month.

Combining the principles and tools of Lean Enterprise and Six Sigma provides an excellent way to improve the productivity and quality of providing financial services at a local government level. 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 local government.

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