Case Study

Application of Lean Six Sigma to Improve Service in Healthcare Facilities Management: A Case Study

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ABSTRACT

The purpose of this paper is to present a case study on the application of the Lean Six Sigma (LSS) quality improvement methodology to facilities management (FM) services at a healthcare organization. Research literature was reviewed concerning whether or not LSS has been applied in healthcare-based FM, but no such studies have been published. This paper aims to address the lack of an applicable methodology for LSS intervention within the context of healthcare-based FM. The Define, Measure, Analyze, Improve, and Control (DMAIC) framework was followed to test the hypothesis that LSS can improve the service provided by an FM department responsible for the maintenance and repair of furniture and finishes at a large healthcare organization in the southwest United States of America. Quality improvement curricula and resources offered by the case study organization equipped the FM department to apply LSS over the course of a five-month period. Qualitative data were gathered from pre- and post-intervention surveys while quantitative data were gathered with the Organization's computerized maintenance management system (CMMS) software. Overall, LSS application proved to be useful for the intended purpose. The authors proposes that application of LSS by other FM departments to improve their services could also be successful, which is noteworthy and deserving of continued research.

INTRODUCTION

Healthcare organizations operate numerous facilities serving various purposes relating to inpatient care, outpatient care, specialty care, surgery, administrative services, education, research, laboratories, central utilities and engineering. Facilities management (FM) departments at healthcare organizations provide services ranging from facility planning and design to construction, renovation, operations and maintenance. FM is vital to maintaining aesthetically attractive, functionally efficient, safe, comfortable and recuperative healthcare facilities, but examining the quality of the services provided and taking steps to improve those services is easily overlooked.

Application of Lean Six Sigma (LSS) for deploying quality improvement (QI) has proliferated in the 21st century, and is becoming the de facto approach for business and industry (Timans, Antony, Ahaus, & van Solingen, 2012). LSS is a hybridized solution that integrates the philosophies and associated tools and techniques of Lean manufacturing and Six Sigma (Douglas, Douglas, & Ochieng, 2015; Timans, Antony, Ahaus, & van Solingen, 2012). Numerous research publications are available documenting the successful application of LSS in industries other than healthcare FM—predominantly in the service and manufacturing sectors (Gijo & Antony, 2014; Mohsen F. Mohamed Isa & Mumtaz Usmen, 2015; Roth & Franchetti, 2010; Saja Ahmed Albliwi, Jiju Antony, & Sarina Abdul halim Lim, 2015; Svensson, Antony, Ba-Essa, Bakhsh, & Albliwi, 2015). Generally speaking, LSS researchers tout the methodology's adaptability and encourage trial applications in new fields, inferring that success can likely to be found if LSS is applied carefully (Antony, 2014; Gijo & Antony, 2014).

This article begins with a literature review of research of Lean Six Sigma application in Healthcare and other related FM industries. Next, the authors developed a quality improvement project (QIP) to improve customer satisfaction and FM response time in a large healthcare organization. The eight-person team used the Define, Measure, Analyze, Improve, and Control (DMAIC) framework. Results are then presented for each phase of the DMAIC framework. Qualitative data was obtained through interviews and a comprehensive survey, while quantitative data was extracted from the Organization's computerized maintenance management system (CMMS) software

LITERATURE REVIEW

Lean and Six Sigma are perhaps the two most popular strategies for deploying continuous improvement in the industrial world (Saja Ahmed Albliwi et al., 2015). The term "Lean" is derived from the phrase "lean manufacturing" which was coined by Womack et al. (1990), who defined Lean as a "dynamic process of change, driven by a set of principles and best practices aimed at continuous improvement." Lean's roots are traceable back to the industrial revolution, Henry Ford, and Taiichi Ohno's Toyota Production System (TPS) (Assarlind et al., 2013; DeCarlo & Breakthrough Management Group, 2007; Womack, Jones, & Roos, 1990). Lean is a time-centric process improvement methodology that focuses on improving overall efficiency by eliminating non-value added activities and different types of waste (DeCarlo & Breakthrough Management Group, 2007; Saja Ahmed Albliwi et al., 2015).The eight wastes are generally considered to be: waiting, overproduction, rework, motion, transportation, processing, inventory, and intellect.

Psychogios et al (2012) describe Six Sigma as a collection of analytical and statistical tools and techniques. "While Lean is all about speed and efficiency, Six Sigma is about precision and accuracy: Lean ensures that the resources are working on the right activities, while Six Sigma ensures things are done right the first time" (Bhat, Gijo, & Jnanesh, 2016). In other words, Six Sigma aims to reduce variation and defects to bring about consistency in a process (Psychogios, Atanasovski, & Tsironis, 2012). In the 1922, Walter Shewhart introduced the term "sigma" in relation to quality "when he proposed a concept of three standard deviations along both sides of the mean, suggesting that outputs falling outside the three sigma range on both sides of middle of the normal curve, indicate a defect, requiring some process intervention" (Mohsen F. Mohamed Isa & Mumtaz Usmen, 2015). True Six Sigma-level performance means achieving less than 3.4 defects per million opportunities, however it is not always rational or cost-effective to target Six Sigma in certain processes. Regardless, the Six Sigma methodology has become a proven methodology for improving process performance.

The first integration of Lean and Six Sigma was in the USA by the George group in 1986 (Svensson et al., 2015). Since then, LSS has increased in popularity and deployment, especially in large organizations such as Motorola, Honeywell, and General Electric (Psychogios, Atanasovski, & Tsironis, 2012; Saja Ahmed Albliwi et al., 2015). Neil DeCarlo describes LSS as a "hybridized solution...meaning it is applied in companies that formerly would have applied each of its core elements (Lean and Six Sigma) separately" (DeCarlo & Breakthrough Management Group, 2007). The combination of Lean's concepts and principles with Six Sigma's DMAIC framework to bring about process improvements is the essence of LSS (Mohsen F. Mohamed Isa & Mumtaz Usmen, 2015). Bhat et al (2016) stated that LSS uses tools from both the Lean and Six Sigma toolboxes, in order to get the better of the two methodologies, increasing speed, while also increasing accuracy. Assarlind et al (2013) argued that "the benefits of Lean and Six Sigma can be achieved without a single, clear-cut, standardized approach towards an integrated Lean Six Sigma concept" (Assarlind et al., 2013). Both concepts can be used concurrently and integrated at the same time, but the level to which each is deployed, can vary.

CASE STUDY

Details of the Organization

This case study focused on application of LSS in a FM department specializing in the maintenance and repair of furniture and finishes at a large healthcare organization in the southwest United States of America, herein referred to as "the Organization." The Organization is a nonprofit, worldwide leader in medical care, research and education with two other major campuses in the Midwest and Southeast regions of the US.

The Organization's Southwest enterprise is comprised of two main campuses in the greater Phoenix (Arizona) metropolitan area. Total square footage of the Organization's infrastructure exceeds 2,200,000 square feet according to the Organization's department of planning & design. The Organization's facilities are maintained by staff within the Organization's FM division named Facilities & Campus Management.

Departments of the FM division at the Organization include Environmental Services, Facilities Engineering & Operations, Healthcare Technology Management, Landscaping, Project Management, Project Planning and Design, Security, Systems Engineering, and Building Services. In-house staff performs much of the work throughout in the FM division, while some activities, such as engineering and construction work, are subcontracted to outside vendors.

Building Services—herein referred to as "the FM team"—is the department of the Organization's FM division that specializes in the maintenance and repair of furniture and finishes within the Organization's facilities. The FM team is comprised of 13 staff members—two supervisors (one for each main campus), one coordinator, and 10 technicians divvied up across two main campuses. Daily operations primarily consist of activities in response to corrective maintenance-type facilities service requests (FSRs) submitted by employees of the Organization through a web portal on the Organization's intranet. FSRs are received and stored by the Organization's Computerized Maintenance Management System software, herein referred to as "CMMS"—a computer database of information about the Organization's maintenance operations. The FM team manages 115 active FSRs on a given day. Common FSRs entail the following tasks: wall repair, flooring repair, hanging of items such as art/dispensers/brackets, replacement of ceiling tiles, furniture installation and repair, signage installation and repair.

Preparation for LSS Application

Prior to the case study, the FM team had established a reputation for satisfactory customer service, but their reputation was loosely based on hearsay and occasional compliments from satisfied customers. Despite the lack of any major sense of customer displeasure with the FM team's services, the FM team itself was curious to more closely analyze and improve their service. The situation was viewed as an opportunity to study the applicability of LSS methodology to improve FM-based service.

A formal QI intervention at the Organization, such as LSS, was referred to as a Quality Improvement Project (QIP). The results of completed QIPs were submitted for review by the Organization's Quality Review Board. The workshop coached leaders from the participating teams (2-4 participants) on how to navigate through a QIP and was closely aligned with a Project Scoring Template that was used in assessing the Organization's projects. The workshop was divided over three half-day sessions with approximately 6–8 weeks between each session. Participating teams were expected to work on their QIPs between class dates and after the last class in order to complete their QIP and submit it to the Organization's Quality Academy for review.

Tthe FM team assigned roles to individual team members in preparation for the first workshop session and kicking off the formal QIP at the Organization. The FM team was comprised of four technicians, one coordinator, two supervisors, and one interior designer. The team was designed to include all of the FM team that was responsible for the sites that would be within scope of the QIP, plus the other campus' supervisor and coordinator were included to participate as fellow process owners who could offer insight during the QIP. An interior designer that frequently supports the FM team in daily operations was also invited to participate as a key stakeholder who could offer their own insights from a planning and design perspective. The FM team was granted permission to participate in the workshop after submitting an abstract proposal to improve a gap in quality relating to overall duration of the FM's teams' activities per FSR. The abstract proposal differs from the definitive aim statement of the QIP though that was developed by the whole FM team in the Define phase, which is described in the following section.

DMAIC is a proven quality improvement framework whose roots are in Six Sigma, but is an applicable framework to follow in LSS interventions ("Making it better," 2014; Roth & Franchetti, 2010; Saja Ahmed Albliwi et al., 2015; Svensson et al., 2015). There are five phases to DMAIC: 1) Define, 2) Measure, 3) Analyze, 4) Improve, and 5) Control. The Organization regularly promotes DMAIC for QIPs such as the case study LSS intervention.

Define Phase

DMAIC begins with the "Define" phase which aims to identify what the gap in process quality is. The FM team's QIP was initiated to explore whether the FM team was focusing on the needs of their customers and to identify any gaps that might be present in that pursuit. The first workshop session helped the FM team's leaders learn more about how to develop a S.M.A.R.T. (specific, measureable, agreed to, realistic, and time constrained) aim statement, conduct a Supplier Input Process Output Customer Requirement (SIPOC+R) exercise, and seek stakeholder input with various Voice of the Customer (VOC) tools.

Following the first workshop session, the FM team held weekly meetings and spent approximately six weeks exploring opportunities for improvement through brainstorming, FSR data analysis, and Voice of the Customer (VOC) exercises. A Critical-to (CT) Flow Down exercise (Appendix C) was conducted to brainstorm key factors and project ideas pertaining to the timeliness, price, and quality of their services.

A SIPOC+R diagram (Fig. 1) was prepared by the FM team to identify and document all relevant elements of the FM team's FSR process. The SIPOC+R diagram created an ability to manage expectations and quickly identify and communicate:

- Who the FSR process serves (Customers)
- Required inputs to make the process successful (Inputs)
- Who provides the required inputs (Suppliers)
- Steps involved to complete the task (Process)
- The results that the process delivers (Outputs)
- What the customers expect (Requirements)

After creating the SIPOC+R, the FM team concentrated on the steps between "FSR Created" and "FSR Assigned" under "Process" as the focus of their LSS QIP intervention. A Swim Lane Process Map was developed to show how the FSR process flowed and who was responsible for each step. After mapping the current state of the FSR process in the Measure phase, the FM would eventually circle back during the subsequent Improve phase to create a future state map to help identify process changes that would need to be implemented in order to improve the team's timeliness.

The FM team was also eager to hear the Voice of the Customer (VOC). Past and present leaders of the FM team were interviewed; seeking comment the FM team should be designed to serve the core mission and strategies of the Organization. A 10-question customer service satisfaction survey was prepared by the FM team with a web-based application promoted for use by the Organization. The survey was distributed electronically to 379 customers of the FM team from the previous six months along with an open invitation for sharing the survey link with anyone else willing to contribute feedback. The first four questions in the survey asked customers to rate their satisfaction with the FM team's responsiveness to specific types of FSRs (i.e. repair/replace, install/uninstall, ergonomic furniture adjustments, and staff moves), based on a Likert-type rating scale of 1–5 , with 1 representing "Very Dissatisfied" and 5 representing "Very Satisfied". Four additional questions asked customers to rate, in general, how satisfied they were with initial response time, communication, overall speed, and overall quality of service provided. An additional question asked if the customer agreed that the speed of response to and completion of FSRs should be the FM team's top priority. If customers answered "no," additional questions were asked to elicit suggested priorities (i.e. Cost, Quality, or other). The last question of the survey allowed for written comments, questions, or concerns.

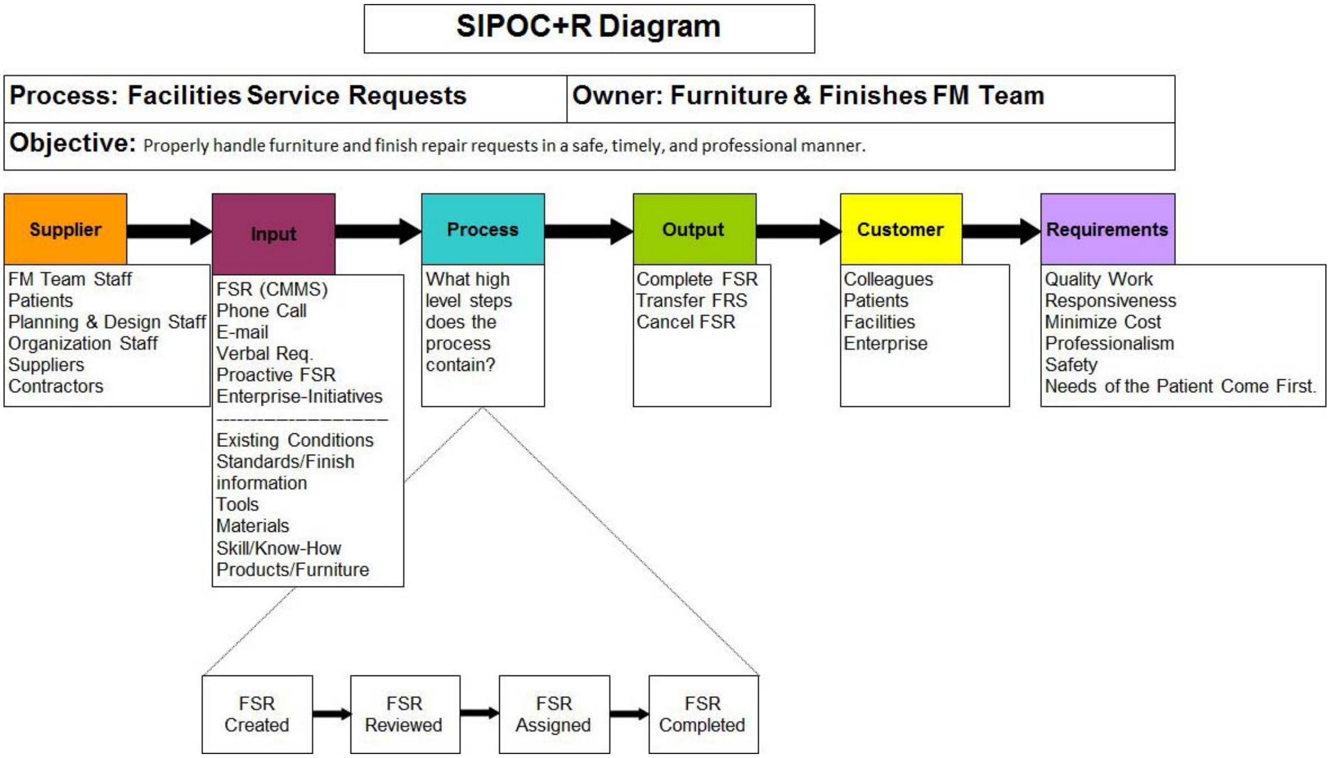


FIGURE 1.—SIPOC+R Diagram for the FM Team

In total, 177 responses to the survey (47% response rate) were received. The survey confirmed that customers were generally very satisfied with the FM team's service, where average customer satisfaction measured 4.77 out of 5.0. It was also confirmed that timeliness was most important to the FM team's customers and validated the team's intent to focus on improving the timeliness of their service.

Measure Phase

Entering the Measure phase of DMAIC, the FM team sought to assess their current performance. Before initial wait time became the focus of the QIP, the FM team analyzed completion info logged in the CMMS for FSRs completed the month prior to the QIP's kickoff.

Utilizing FSR data logged by the CMMS software, the FM team devised a way to calculate initial wait time through the reference of a sub-status field on FSRs in the CMMS software. A data collection plan was drafted to document the data sourcing procedure. Staff agreed to change the sub status of an FSR from the default value (i.e. "Web Request") to "Issued to Worker" in the moments after an FSR was being addressed to indicate that the customer had been made aware that their FSR was being addressed and by whom. A timestamp was automatically recorded in a Sub Status Log (Fig. 2) within each FSR in the CMMS software and could be referenced as a data point when calculating initial wait time.

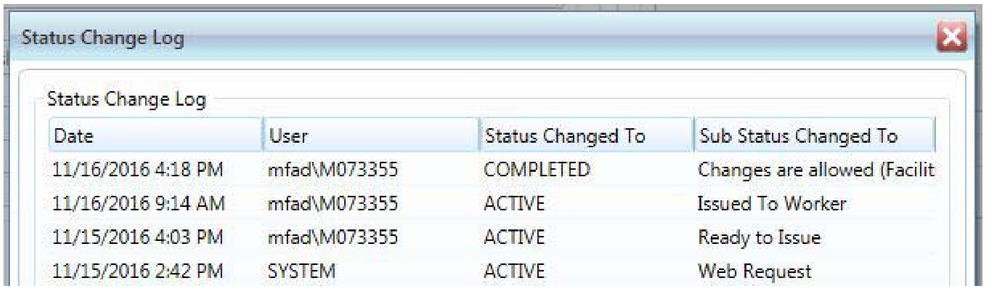
A baseline measure based on two full work weeks of FSR data was created. Each week of data—for the baseline period and for the duration of the QIP—began on a Tuesday and ended on the following Monday so that weekends would be included in the data.

A control chart helped draw attention to both special cause and common cause variation. Upon closer review it was determined that 14 FSRs were created on Fridays and were not addressed until the following work week resulting in longer than average wait times. At the advice of the QIP advisor, 48 hours (representing time elapsed Saturday through Sunday) were credited to those 14 FSRs whose initial wait time measurement included weekend hours when the FM team staff are normally off duty.

The status change logs for each of 94 FSRs were reviewed from a two-week span in September 2016 and typed the corresponding date values into an excel spreadsheet to calculate the initial wait time for each FSR.

The Minitab software was utilized to calculate and display descriptive statistics, a histogram, a box plot, and normality test information based on the baseline wait time data. The mean wait time was then inserted into the aim statement and used as the pre-LSS intervention baseline to measure against.

The 14-day average wait time was calculated to be 37.8 continuous hours—from the time of FSR submittal to the time that a BS staff member first addressed the FSR according to the status change log date value. Total FSRs analyzed in the baseline was 84 (Fig. 3) and constituted most of the population. Ten (10) FSRs did not include the appropriate sub status changes to be able to confidently calculate initial wait time and were not included in the baseline.


Status Change Log

Status Change Log

Date	User	Status Changed To	Sub Status Changed To
11/16/2016 4:18 PM	mfad\M073355	COMPLETED	Changes are allowed (Facilit
11/16/2016 9:14 AM	mfad\M073355	ACTIVE	Issued To Worker
11/15/2016 4:03 PM	mfad\M073355	ACTIVE	Ready to Issue
11/15/2016 2:42 PM	SYSTEM	ACTIVE	Web Request

FIGURE 2.—Sample Status Change Log Data from a Single FSR at the Organization

Figure 3 displays a summary report of the baseline data including descriptive statistics calculated by the MiniTab software. The mean of 37.75 hours is the average time customers waited for the FM team staff to address their new FSRs including overnight hours (4:30 PM–4:00 AM) when staff is not on duty, and accounting for the FM team's lack of weekend coverage as described earlier. The histogram portion of the summary report shows that a high percentage of FSRs were already being addressed promptly, with a median value of 10.55 hours. However, 25 out of the 84 FSRs (30percent) measured in the baseline were more than 24 hours and skewed the data. A control chart helped the FM team identify which specific FSRs represented special cause variation, and studied those particular requests and discussed the reasons it took longer for the FM team to address them. Said discussions were crucial to understanding how the team could improve their timeliness. The high standard deviation value indicated extreme variability in wait time for BS customers, which was also validation that utilizing LSS methodology was appropriate since it could address both the timeliness and variability/efficiency issues that were of concern to the FM team.

A run chart was used to monitor the behavior of the average initial wait time (per week) once the baseline was

FIGURE 3.—Summary Report for Pre LSS Application (MiniTab)

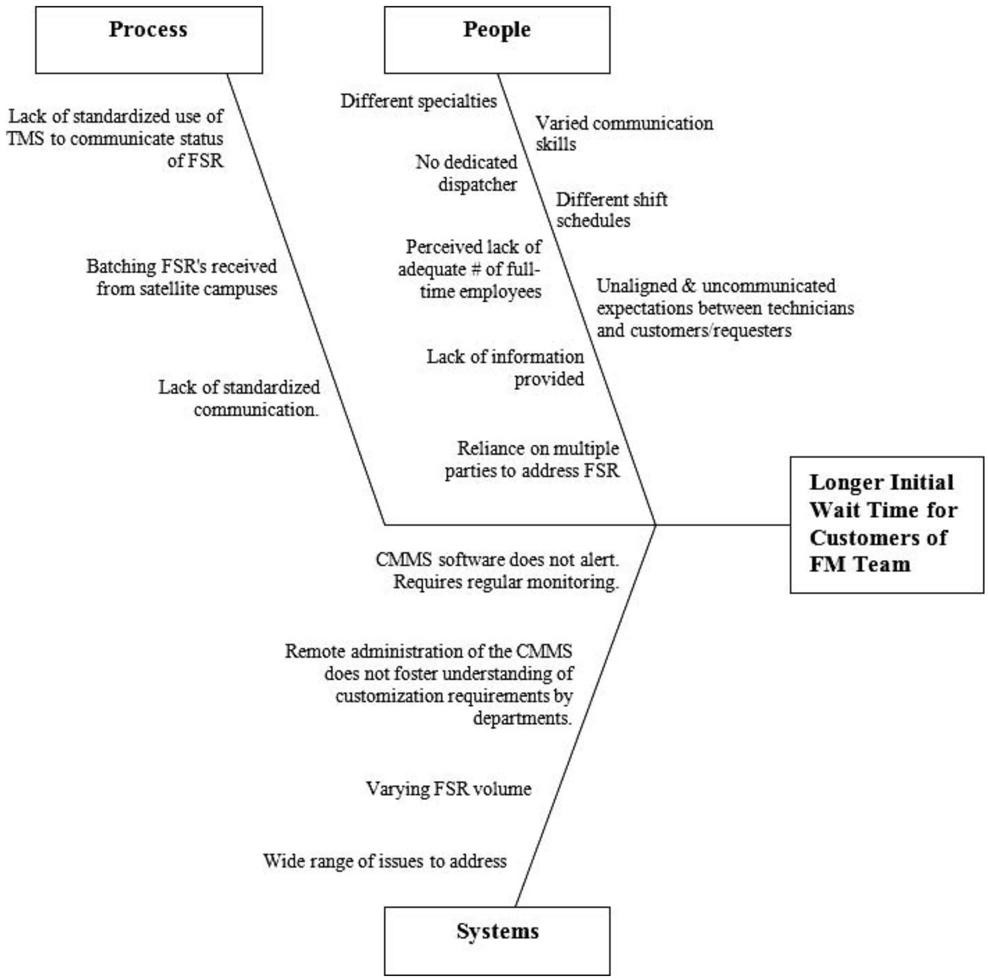


FIGURE 4.—Cause and effect diagram for longer initial wait time for customers of the FM team.

established (Fig. 5). The run chart became the most clear visual representation of the progress being made as the QIP progressed.

Analyze Phase

The Analyze phase of DMAIC focused on identifying the key factors that were causing longer initial wait time on the FM team's FSRs. While the FM team was exploring various opportunities for improvement in the define phase, the opportunity to improve overall duration of FSRs was reviewed. The team analyzed duration data from 193 FSRs in the CMMS that were completed within the month prior to starting the QIP. A Pareto chart and histograms were deployed using Minitab 17 to illustrate the underlying distribution of FSRs according to category. These analysis tools aided the FM team in identifying the more prominent types of FSRs from the month before. The FM continued exploring other opportunities for improvement though after deciding that the Pareto chart and histograms only illustrated that almost every category of FSR accounted for 80% of the FSRs received in a month's time.

The FM team brainstormed root causes for longer initial wait times by preparing a Cause and Effect Diagram (Fig. 4). Once the key factors causing longer initial wait time were identified in the Analyze phase, the FM team entered the Improve phase of DMAIC.

Improve Phase

In the Improve phase, the FM team brainstormed potential solutions for the gap in quality (i.e. longer initial wait time) based on the key factors identified in the Analyze phase. An Affinity Diagram was created by the FM team to organize their proposed solutions into natural groupings based on relationships between the ideas. Solutions were then numbered and plotted on an Impact/Effort, four-quadrant grid to determine which solutions were feasible given the effort required to implement each one and the expected benefits.

The FM team implemented the following interventions to decrease average customer wait time for initial address by staff:

- Address FSRs—All staff check the CMMS software for new and/or unaddressed FSRs at least twice daily with the intent to address those FSRs with 24 hours of their creation, by communicating an anticipated response plan

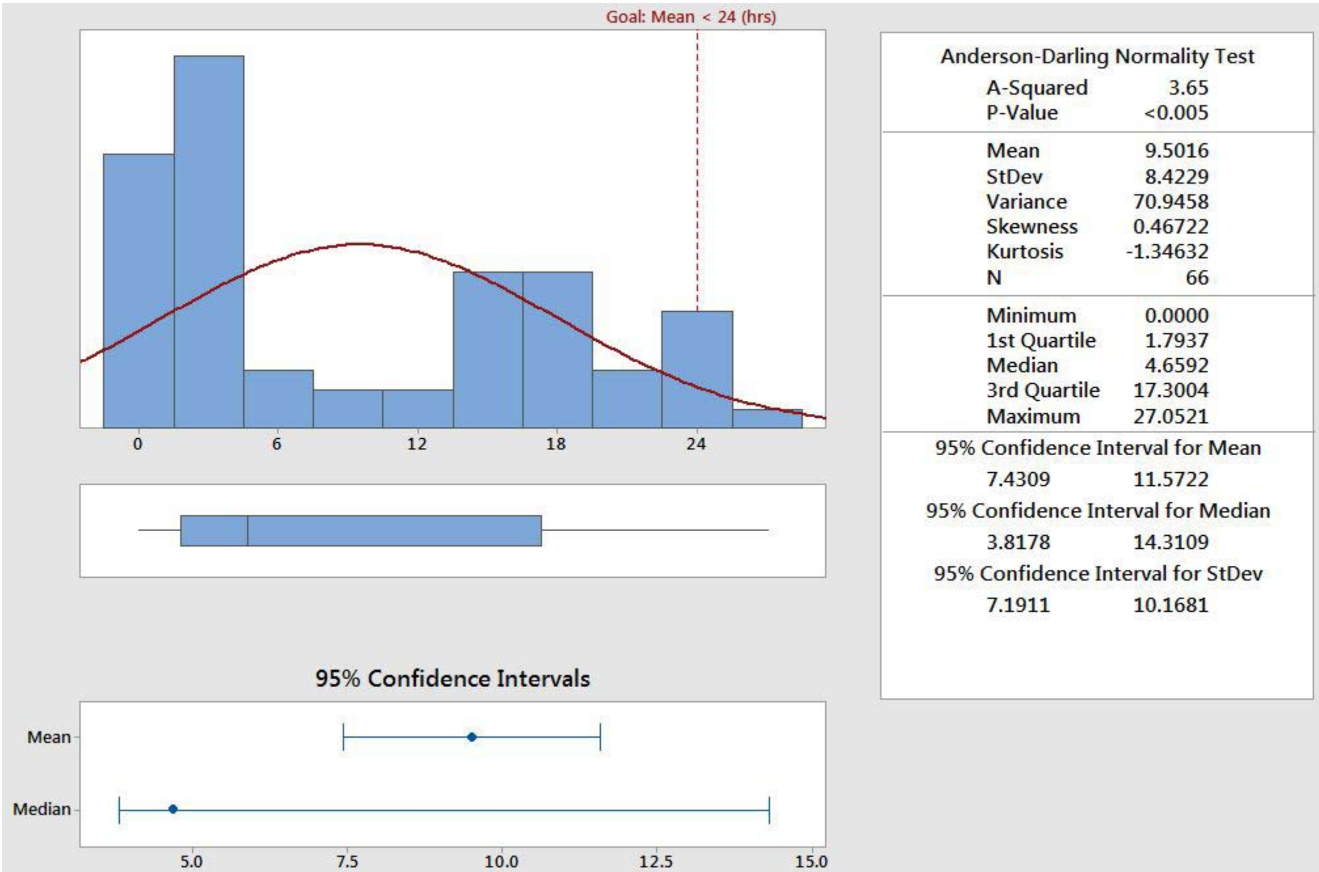


FIGURE 5.—Summary Report for Post-LSS Application

and schedule (i.e. establishing expectations for the customer) with the customer.

- Standardize use of CMMS fields—Staff standardized the use of and defined the meaning of the sub-status and assignment field values on FSRs to better communicate current status and responsibility of FSRs to each other, thereby also reducing redundant efforts in communication and physical activity (i.e. investigating an FSR that another team member has already begun to address).
- Use technology to expedite communication—Pertinent, reusable messages, also known as "canned responses," are deployed via features in both CMMS and Microsoft Outlook (i.e. Quick Parts) to aid staff in addressing FSRs promptly.

The above solutions were implemented by the FM team over the course of several weeks after the baseline was measured and the solutions were developed. A run chart shows the effect of the solutions over the span of the QIP. A graphical representation of the post-improvement results is shown in Figure 5.

Control Phase

In order to control and sustain the improvements implemented during the QIP, the FM team agreed to measure their average response time based on a sampling of the population of FSR data, on a quarterly basis after the conclusion of the formal QIP, following the same procedure that was documented in the data collection plan during the Measure phase. If the mean response time of the sampled FSRs is calculated to be greater than 24 hours, further review and analysis of the sampled data will take place. Individual FSRs with response times measuring longer than 24 hours will be considered process failures and will be subject to a follow-up DMAIC process where the each letter of the acronym stands for:

- Determine—the specific failure(s)
- Measure—the impact of the failure
- Analyze—the cause of the failure
- Improve—the process to address the failure
- Control—Continue to control the "new and improved "process

RESULTS

Summary

Re-measurement of average customer wait time for initial address was based on a 14-day, post-improvement study of 66 FSRs received between Nov. 8–21, 2016—a time span identical to the baseline period. The average wait time during the post-LSS application period measured 9.50 hours, which was a 75% improvement from the baseline

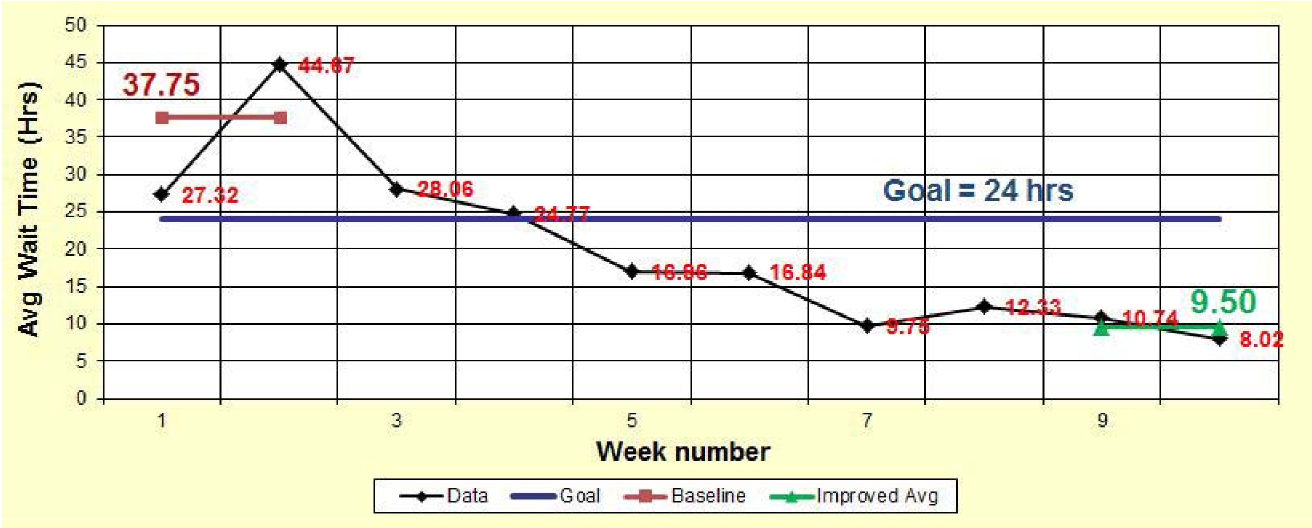


FIGURE 6.—Run Chart of Average Wait Time per FSR per Week During FM Team's QIP

mean. The standard deviation improved by 88% dropping from 70.03 hours down to just 8.42 hours. Figure 5 provides a graphical display of the results along with descriptive statistics calculated with the Minitab software. Appendix K provides a side-by-side comparison of the results, pre- and post-LSS Application.

A run chart (Fig. 6) was updated weekly throughout the QIP. The first two weeks (14 calendar days) correspond with the baseline period whose mean wait time was measured to be 37.75 hours. Over the following eight weeks, the run chart was updated with weekly averages and shows how the mean wait time trended well beyond the improvement goal of less than 24 hours as the FM team developed and deployed solutions. The last two weeks on the run chart represent the comparison period where the mean wait time was calculated to be 9.50 hours, which is a 75% improvement from the pre-LSS Application/baseline measure.

Minitab was used to calculate the statistical significance in the improvement. A two-sample T-test resulted in a P-Value = .001, meaning that the QIP interventions had a significant impact on the measured improvement.

Lastly, it is important to note that the FM team also included counterbalance measures, identifying two unintended consequences or external factors impacted by the LSS intervention as part of the Organization's requirements for attaining a gold-rated QIP. The improvements implemented by the FM team forced the technicians, coordinator, and supervisors to adopt new practices and procedures in their daily activities. In doing so, the FM team did not want their improvement interventions to negatively impact team cooperation or trust. The pre-measure for the counterbalance came from the results to two relevant questions cited from an all-staff survey that had been distributed by the Organization several months prior to the FM team's QIP. The two questions were:

1. "There is a high level of trust among employees within my work unit."
2. "There is a spirit of cooperation and teamwork within my work unit."

The post-measure was a survey asking the same two questions of the FM team members to ensure that their improvement interventions did not negatively impact team cooperation and trust.

The premeasure for the first question—regarding level of trust amongst the team—was originally measured at 2.8 on a scale of 1-to-5, with 5 being "very favorable." The post-measure for the same question after the QIP concluded was measured to be 3.3 on the same scale. The sense of team trust improved by 29% according to the counterbalance measurements.

The premeasure for the second question—regarding spirit of cooperation and teamwork—was measured to be 3.3 on a scale of 1-to-5, with 5 being "very favorable." The post-measure for the same question was 3.7 on the same scale. The spirit of team cooperation and teamwork improved by 22% according to the counterbalance measurements.

Success Factors

The host organization's robust QI curriculum, quality academy, and QI experts were all key factors contributing to the success of this LSS application. It is notable that the Organization's culture and leadership encourages all staff to take time to learn how to lead quality improvement efforts regardless of their rank or role. It was also quite helpful to have an advisor available to coach the FM team throughout the QIP.

The CMMS software was also great resource for tracking and exporting quantitative data from both previously completed and presently active FSRs. The host Organization has long utilized CMMS software to track FSRs and hence provided a comprehensive archive of FSR information that the FM team could review and analyze. The CMMS was a key tool for measuring the response time of the FM team as well as for deploying canned responses to customers based on pre-defined criteria such as sub-status value.

Limitations

During the literature review, no journal articles were found focused on application of LSS in healthcare FM. The lack of precedent made this case study an important contribution to guide future practitioners. Another limitation was that the case study applied within a specialized, FM department at one campus of a healthcare organization; hence there is limitation in generalizing the results from the study.

This was the FM team's first-ever QIP. Only one of the FM team's members had ever previously participated in a QIP at the Organization. Given the lack of experience amongst the FM team members, the team often wished for better access to expertise (i.e. the Advisor) whose availability was limited at the organization due to a number of concurrent QIP team activities. The team would often wait days for advice or reassurance before feeling comfortable with a decision and making progress during the QIP.

Another barrier to improvement was the lack of administrative rights necessary to make changes to the CMMS software that the FM team discussed as potential solutions to improve their ability to address FSRs and communicate with customers in a timelier manner. The Organization administers changes to the CMMS through a select group of individuals in another state that do not have a good understanding of how the FM team utilizes the CMMS software. Inviting a CMMS administrator to participate in the QIP with the FM team would have been helpful and may have resulted in additional improvements.

Future Research

There is a shortage of publications on LSS in healthcare FM. Additional case studies of other applications of LSS within healthcare FM should be conducted to develop additional knowledge and lessons learned. Future research is also recommended to assess how best to measure return on investment (ROI) when improving service in cost centers such as an FM department or division. Identification of key performance metrics for healthcare FM and how to measure them would also be important to research. Furthermore, there is a gap in literature relating to understanding of how to initiate LSS application in FM and healthcare FM (Albliwi, Antony, Abdul Halim Lim, & van der Wiele, 2014; Saja Ahmed Albliwi et al., 2015). Future research is recommended to address the current gaps in literature.

Conclusion

The goal of this study was to assess whether and how LSS methodology could be applied to FM services in a healthcare organization. It has been shown that careful application and implementation of LSS principles and tools can be used to reduce response time and thus improve services by an FM department at a healthcare organization. Be defining the problem, the FM team could measure their performance and analyze the data retrieved to develop an improvement and control plan. While only one process of a single FM department was studied in this paper, the LSS methodology deployed is applicable to other FM groups as well, with appropriate modifications and selection of relevant LSS tools.

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