Hospital Registration Waiting Time Reduction through Process Redesign

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Abstract

Registration process is the first process that patients interact with hospitals. The quality of experience in registration will form the perceptions for hospitals. Waiting time is an important performance metric for the registration process. In this paper, a rigorous Lean Six Sigma approach is used to analyze an existing registration process and the root causes for the long average waiting time are identified. Lean operation principles are used to redesign the registration process. After the implementation, a drastic reduction in average waiting time is achieved and sustained.

Key Words: Waiting time, Healthcare, Lean, Six Sigma, Registration

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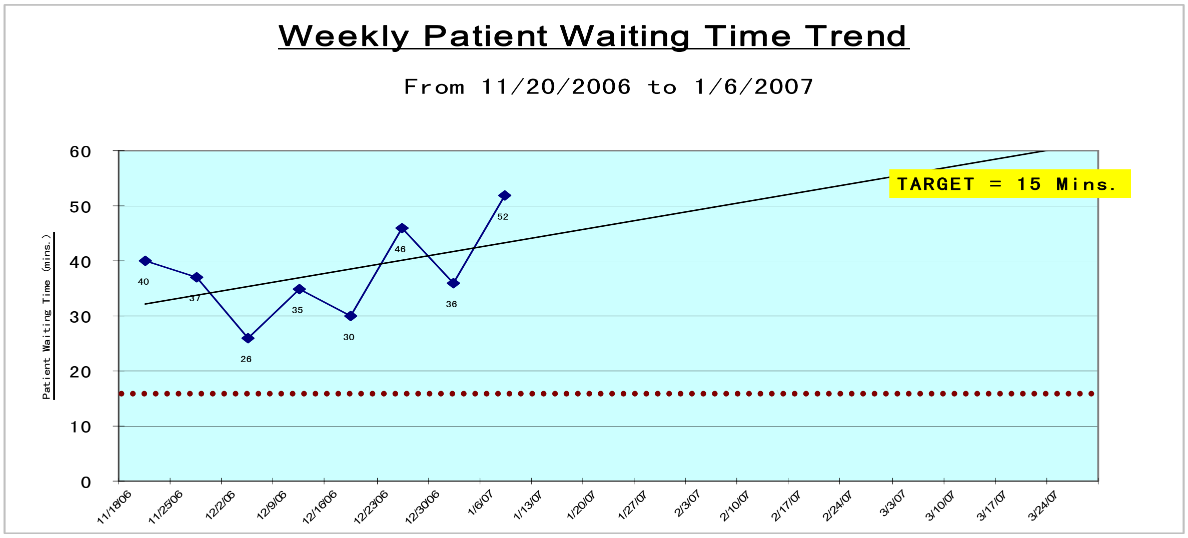
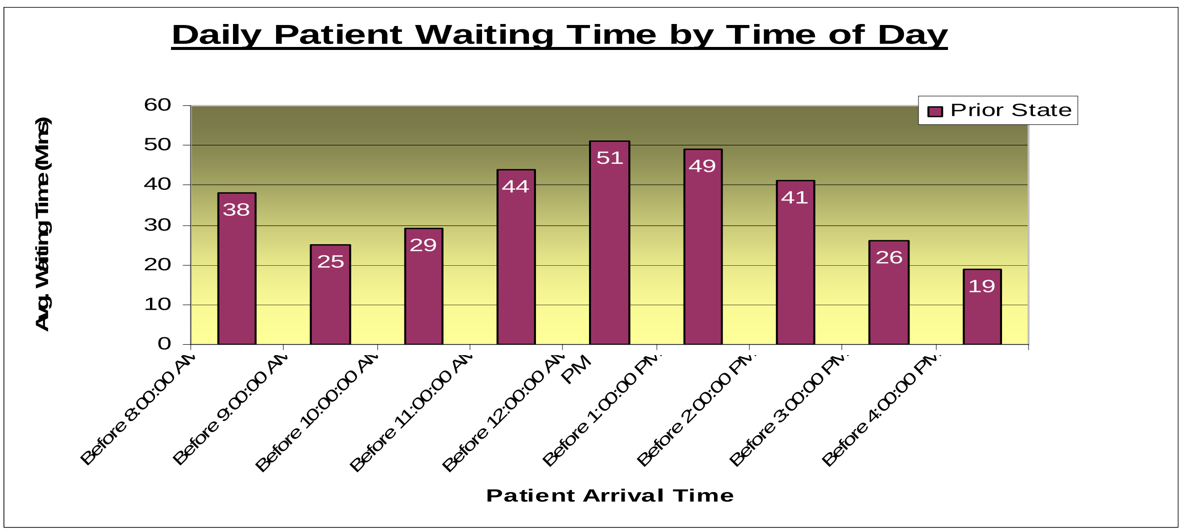
1. Introduction

Healthcare industry is taking a big chunk of economy in many developed countries. However, high healthcare cost and low efficiency are major concerns for consumers, business leaders, insurance industry and governments. In recent years, developing effective approaches to reduce healthcare cost and increase healthcare efficiency, without compromising the healthcare quality, is getting more and more attention.

This paper describes a healthcare efficiency improvement project that took place in the John D. Dingle Veteran Medical Center in Detroit, Michigan (Detroit VA Medical Center). The Detroit VA Medical Center is one of the VA medical centers that serve the medical needs of American veterans, and they are all under the supervision of the U.S. Department of Veteran Affairs. This project is related to the registration department of the Detroit VA Medical Center. The primary function of the registration department includes enrolling and updating the essential information of eligible veteran patients. It is the first department that the patients would visit, so the quality of experience in registration department will form the perceptions for the medical center. In this project, the average patients' waiting time in the registration department is the major concern. The waiting time is the time period between the moment that a patient arrives at the registration lobby and the moment this patient is being served by a registration clerk. Sometimes, a patient needs to fill some forms and paperwork before seeing the clerk. In this case, the time period to fill the paperwork is not considered as waiting time and is subtracted from the waiting time calculation. Clearly, long waiting time will cause patients dissatisfaction and tarnish the image of the VA medical center. Before this project was started, the average waiting time was about 42.3 minutes, and during some hours of the day, it could be as high as around 50 minutes. The average waiting time data is shown in Figure 1.



(a) Weekly Average Waiting Time Before Improvement



(b) Average Waiting Time by the Time of the Day

Figure 1 Average Waiting Time before the Improvement

The project team felt that the average waiting time of 42.3 minutes was too long; the target average waiting time was set to be 15 minutes or less for this improvement project. This 15 minutes target time is based on our industry wide benchmarking. Because Lean Six Sigma was successfully applied to many serve industries, (George 2003), Lean operation principles and Six Sigma approach were adopted in this improvement project.

2. Six Sigma

Six Sigma is a methodology that provides businesses with the tools to improve the capability of their business processes. (Pande et al 2000) For Six Sigma, a process is the basic unit for improvement. A process could be a product or a service process that a company provides to outside customers; it could also be an internal process within the company, such as a billing process, a production process and so on. In Six Sigma, the purpose of process improvement is to increase its performance and decrease its performance variation. This increase in performance and decrease in process variation will lead to defect reduction and improvement in profits, employee morale and quality of product, and eventually to business excellence.

Six Sigma is the fastest growing business management system in industry today. It has been credited with saving billions of dollars for companies over the past ten years. Developed by Motorola in the mid 1980's, the methodology only became well known after Jack Welch from GE made it a central focus of his business strategy in 1995.

The name ‘Six Sigma’ came from a statistical terminology, ‘Sigma’, or σ, means ‘standard deviation’. In a process, the ‘Six Sigma standard’ means that the process will produce defectives at a rate of 3.4 defects per million units. Clearly, Six Sigma indicates a degree of extremely high consistency and extremely low variability.

Six Sigma is a strategy that combines organizational support, professional training and a system of statistical based quality improvement methods. Six Sigma takes on problems on a project to project basis. The goal for any Six Sigma project is to enable the process to accomplish all key requirements with a high degree of consistency.

In a Six Sigma project, a five stage process is used to improve an existing process. These five stages are:

- Define the problem and customer requirements
- Measure the defects and process operation.
- Analyze the data and discover causes of the problem
- Improve the process to remove causes of defects
- Control the process to make sure defects don't reoccur

This five step strategy is also called DMAIC.

3. Lean Operation Principles

Lean operation principles are derived from the lean manufacturing practices. Lean manufacturing is a very effective manufacturing strategy first developed by Toyota. (Womack, Jones, and Roos, 1990) The key focus of lean manufacturing is to identify and eliminate wasteful actions that do not add value to customers in the manufacturing process. Because lean manufacturing deals with production system from a pure process point of view, and not a hardware point of view, it has been found that the principles of lean manufacturing can be readily adopted in other types of processes, such as office process, and transaction process. Therefore, lean operation principles can be used to greatly improve the efficiency and speed of all processes.

The key objective of lean operation is to eliminate all process wastes and maximize process efficiency. The key elements of lean operation include the following items:

- Waste identification and elimination in process
- Pull based production system
- One piece flow
- Value stream mapping
- Set up time reduction
- Work cells

In all above lean operation approaches, the waste identification and elimination is the key. In original Toyota production system, Tachii Ohno (Ohno1990, Liker 2004), an engineering genius of Toyota who is the pioneer of Toyota Production System, identified the following "seven wastes" in production system:

1. Overproduction: Producing too much, too early
2. Waiting: Workers waiting for machines or parts
3. Unnecessary transport: Unnecessary Transporting of moving parts
4. Over processing: Unnecessary processing steps
5. Excessive inventory: Semi-finished parts between operations and excessive inventory of finished products
6. Unnecessary movement: Unnecessary worker movements

7. Defects: Parts need rework or are scrap

These seven wastes are called “muda”. Muda is a Japanese term for missed opportunities or slack. These items are considered waste because in the eyes of customers, these activities do not add values to the products that they wanted.

Compared with most of the methodologies first introduced in Six Sigma movement, many of them being statistical in nature, lean operation principles can solve many operation efficiency problems effectively that cannot be solved by statistical methods. On the other hand, statistical based Six Sigma methods can solve quality and performance consistency problems effectively that cannot be addressed by lean operation principles, so statistical methods and lean operation principles are really complementary to each other. Six Sigma organizational infrastructures can also provide great help in leading projects efforts, training and implementation. Integration of lean operation principles and other Six Sigma methods have become a dominant trend in Six Sigma movement from early 2000s; this integration is often called Lean Six Sigma. (George 2003).

In this project, we took Lean Six Sigma approach that integrates the advantages of both Six Sigma and lean operation principles. Specifically, we adopted the Six Sigma DMAIC project roadmap because it is a well defined and disciplined approach to carry through an improvement project. We also adopted many Six Sigma data collection and analysis methods. Because we are primarily interested in reducing waiting time and improving the process efficiency for the registration department, lean operation principles will be used to improve our registration process in this project.

4. Define and Measure Phases

A Lean Six Sigma project would start with a Define phase. In Define phase, the goal and scope of the project should be defined. For this project, as we described in the section 1, the most important critical to quality characteristics (CTQ) is the waiting time in the registration department, a reduction of the average waiting time from 42.3 minutes to below 15 minutes is our goal. The scope of this project is within the registration department.

In Measure phase of a Lean Six Sigma project, all the necessary data needed for the CTQ and possible root cause analysis are to be collected. In this project, we can get some of the data from the computer system of the registration department, such as each patient's case service starting time with the clerk, the case type, and case finishing time. We also designed and implemented several data collection sheets in order to record and calculate the correct waiting time and other data.

The data we collected in this project includes:

1. Service date
2. Patient name
3. Patient arrival time
4. Service type (one of the following)

   a. new application
   b. means test
   c. Veteran ID
   d. Firm assignment

e. Copay
f. Regular update
g. Others

5. Service start time

6. Service end time

7. Clerk name who completes this service

During the project, we collected these data on 100% of cases and the collected data provided sufficient information to evaluate the process performance and analyze the root causes for excessive waiting time.

5. Analyze Phase

In this Analyze phase, our goal is to find out the root causes of the excessive waiting time. By braining storming, the team members came up with the following 5 hypotheses:

1. The arrival rate of patients exceeds the service time capability of the process;
2. Clerks do not attend promptly to the next patient after an appointment finishes, leaving gaps between service cases;
3. Patients with short service times are stuck in the queue behind long service time patients, which causes the average waiting time to increase;
4. Too few clerks are at working most of time;
5. How the window clerk works affect the waiting time significantly.

For each of the above hypothesis, we used collected process data and applied appropriate methodology to test each hypothesis. The results are the following:

Hypothesis 1: **The arrival rate of patients exceeds the service time capability of the process (Rejected).**

- Based on our collected data with 1528 case records (including the data collected from 11/20/06 to 1/5/07 in window roster), we calculated that the average inter-arrival time is 32.9 minutes; and the average service time for each case is 45.5 minutes. There are 7 clerks in the registration department. Based on our simulation model on ARENA, we get the following result as illustrated in Figure 2. ARENA is a popular process simulation software. In Figure 2, the top curve is the average each clerk utilization versus the number of working clerks, the bottom curve is the calculated waiting time versus the number of working clerks based on our ARENA simulation model. We can see as the number of clerk increases, both clerk utilization and patient waiting time will decrease. If there are 5 or more clerks working, the waiting time should be less than 1 minute. However the actual waiting time in this period is about 42 minutes. Clearly, the simulation model doesn't support this hypothesis.

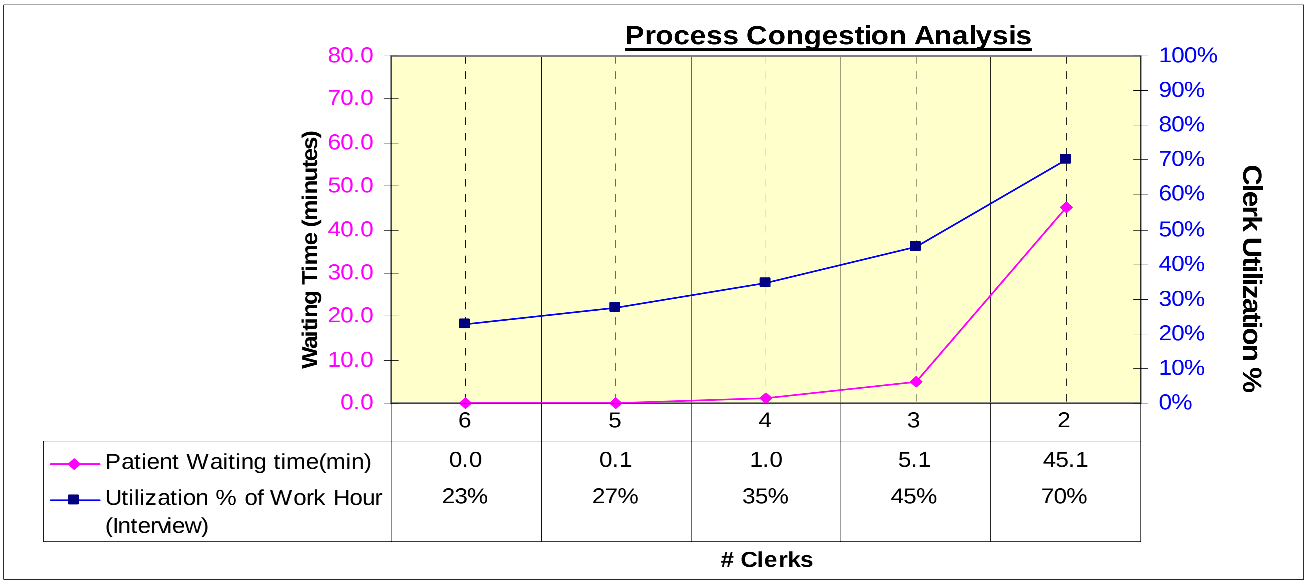


Figure 2 Simulation Results for Waiting Time Versus Number of Clerks.

Hypothesis 2: **Clerks do not attend promptly to the next patient after an appointment finishes, leaving gaps between service cases (Accepted)**

Based on our collected data with 1296 case records (These 1296 records were collected from 11/20/06 to 1/5/07 by booth clerks' activity sheets) , we calculated that the average gap time between two service cases is 13.2 minutes, and the standard deviation of the gap time is 14.8 minutes. There is strong evidence that the clerks do not attend promptly to the next patient after an appointment finishes. Based on the empirical distribution of the service gap data, we ran a simulation model that took the service gap into consideration. The ARENA simulation results showed that with the gap time, the average waiting time would be 16 +/- 6.1 minutes. If we let the gap time to be zero, then the patient waiting time will be 5.1+/- 4.9 minutes, based on our ARENA model. Figure 3 illustrates our simulation results. Our data analysis and simulation showed that there are clearly service gaps between each case and that the service gaps affect the waiting time significantly. We also found that the main reason for service gaps is the lack of discipline of clerks.

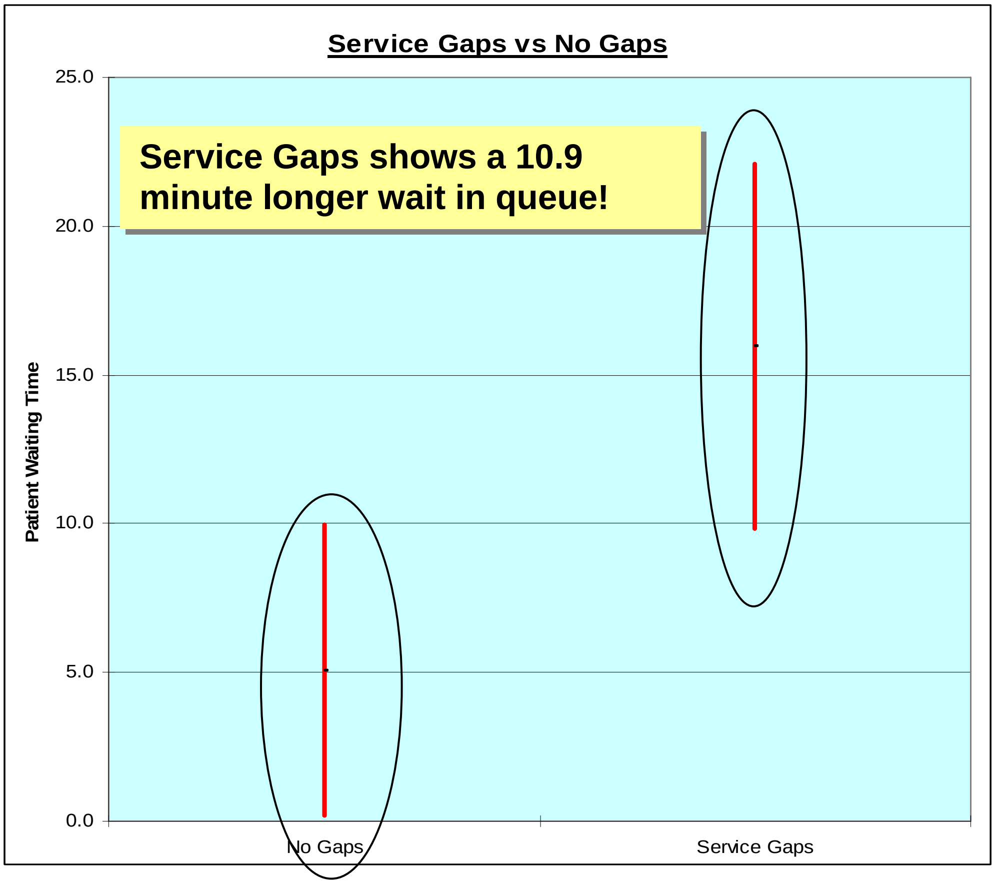


Figure 3 Expected Waiting Time Versus Service Gap

Hypothesis 3: **Patients with short service times are stuck in the queue behind long service time patients, which causes the average waiting time to increase; (Accepted)**

There are many different types of services delivered to the visiting patients in the registration department, as we described in the measure phase. Some service types would take a long service time to finish, such as new applications, and means test, we can call them long services; some service types would take very short time to finish, such as Veteran ID, we can call them short services. Based on the data we collected on 1528 cases (from 11/20/06 to 1/5/07) , the average service time for short services is 25.52 minutes; short services are accounted for 57.5% of all cases. The average service time for long services is 46.2 minutes; long services are accounted for 42.5% of all cases. It is suspicious that some of the patients with short service times are stuck in the queues behind long service time patients, which will cause the average waiting time to increase. Also, if a patient's service would only take 1 or 2 minutes to finish, but he/she will have to wait for an hour in the queue, his/her level of dissatisfaction will grow.

To test this hypothesis, we ran 2 separate simulation models in ARENA. The first one is a mixed queue (both long and short services are mixed in the same queue) with 2 clerks. The second one is a 'sorted queue' where short service patients have higher priority. The simulation result shows that for the mixed queue case, the average waiting time would be 42.48 +/- 16.57 minutes; for the sorted queue case, the average waiting time would be 1.97 +/- 0.55 minutes. This result is illustrated in Figure 4.

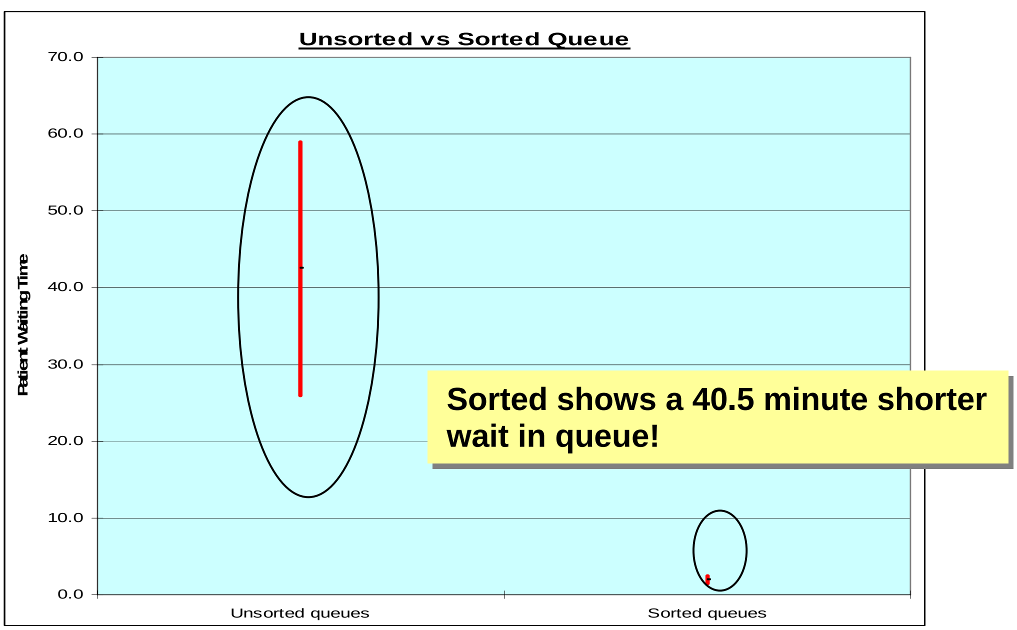


Figure 4 Mixed Queue vs Sorted Queue

Hypothesis 4: **Too few clerks are at working most of time (Rejected)**

Though there are 7 clerks in the registration department, the number of available clerks varies greatly from day to day. It is suspected that the long waiting time could be caused by low staffing level. To test this hypothesis, we did a linear regression analysis, where the x variable is the number of available clerks during the day, the y variable is the average waiting time of that day, and found that there is no statistically significant relationship between these two variables. Figure 5 shows the regression plot.

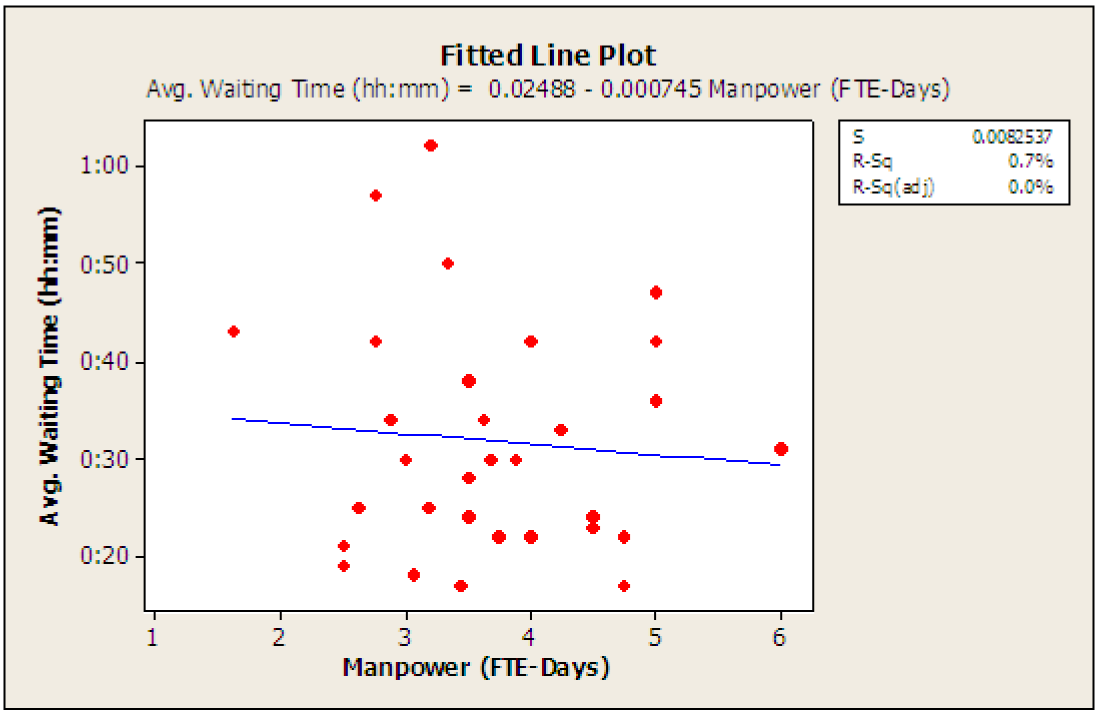


Figure 5 Man Power Level vs Waiting Time

We can see that for any given manpower level, the range of average waiting time varies greatly and there is no statistically significant relationship between the manpower level and average waiting time.

Hypothesis 5: H**ow the window clerk works affect the waiting time significantly (Accepted)**

In the registration process, there is a 'window clerk'. Every visiting patient will first talk to the window clerk, and then the window clerk will look into the patients' cases and distribute the cases to other clerks. From our observation, we suspected that how the window clerk works would affect the work flow and the waiting time. To test this hypothesis, we collected waiting time data with different window clerks and conducted the linear regression analysis on the data. From the linear regression analysis, we found that which window clerk is on duty will affect the average waiting time significantly.

The following is the MINITAB result of our regression analysis:

Regression Analysis: Minutes versus Window Clerk (AE, JA, LW, MJ, RK, SS)

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The regression equation is:
Minutes = 38.9 AE + 41.3 JA + 11.0 LW + 19.6 MJ +
24.4 RK + 24.4 SS
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Analysis of Variance

Source           DF        SS       MS      F      P
Regression        6   12579.3   2096.5  36.73  0.000
Residual Error    9     513.7     57.1
  Lack of Fit     2     142.7     71.4   1.35  0.320
  Pure Error      7     371.0     53.0
Total            15   13093.0
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The ANOVA table shows that this regression model fits data very well, based on the lack of fit test. In this model, AE, JA etc, represent different window clerks, and the following Table 1 illustrates the expected mean waiting times when different clerks are in window duty.

Name	Waiting time
AE	38.9 min
JA	41.3 min
LW	11.0 min
MJ	19.6 min
RK	24.4 min
SS	24.4 min

Table 1: Window Clerks vs Waiting Time

By further observing how different clerks distribute the workload, we found that some of the window clerks will distribute patients' cases to other clerks as soon as he/she receives the patient case. This practice will actually form separate 'multiple queues'. Some clerks will hold all patient cases, and he/she will distribute the case to the next available clerk. This practice will form a single queue and we found that this practice will lead to a shorter waiting time. This is consistent with a well known result in queuing theory that in a multiple server queue, with the same arrival rate and service rate, a single queue will always have shorter average waiting time.

In summary, in analyze phase, we found that the staffing level is not the cause for the excessive average waiting time, and we should be able to reduce the waiting time significantly by using the current staffing level. As we found that the practices of mixed queue and multiple queues would slow down the registration process significantly, we also found that there was too much gap time between consecutive cases for many clerks.

6. Improve Phase

Based on the results from the analyze phase, we implemented several new procedures for the registration process.

1. The Introduction of the Fast Lane

In many supermarkets, there are regular lanes and fast lanes. The customers with fewer items can go to fast lanes to get the quick service. Based on our analysis in the analyze phase, we found that if we use the sorted lanes, we can reduce the waiting time significantly. In this project, we implemented the separate fast lanes and regular lanes in the registration process. For any visiting patients with short services, the window clerk will assign them to the fast lane and these patients will get their services very quickly.

2. New Window Clerk Operating Procedure

Based on our analysis about the window clerk, we designed a new window clerk operating procedure. In this new procedure, the practice of single queue and other better practices become the standard practice for all window clerks.

These better practices include:

1. Using pull system instead of push system: Window clerk will assign patient to booth clerk only when booth clerk is available to serve the next patient or booth clerk will step up to the window to pick up the next patient when window clerk is busy.
2. Window clerks will do some quick service jobs if there is no patient standing in front of him or her for sorting service.

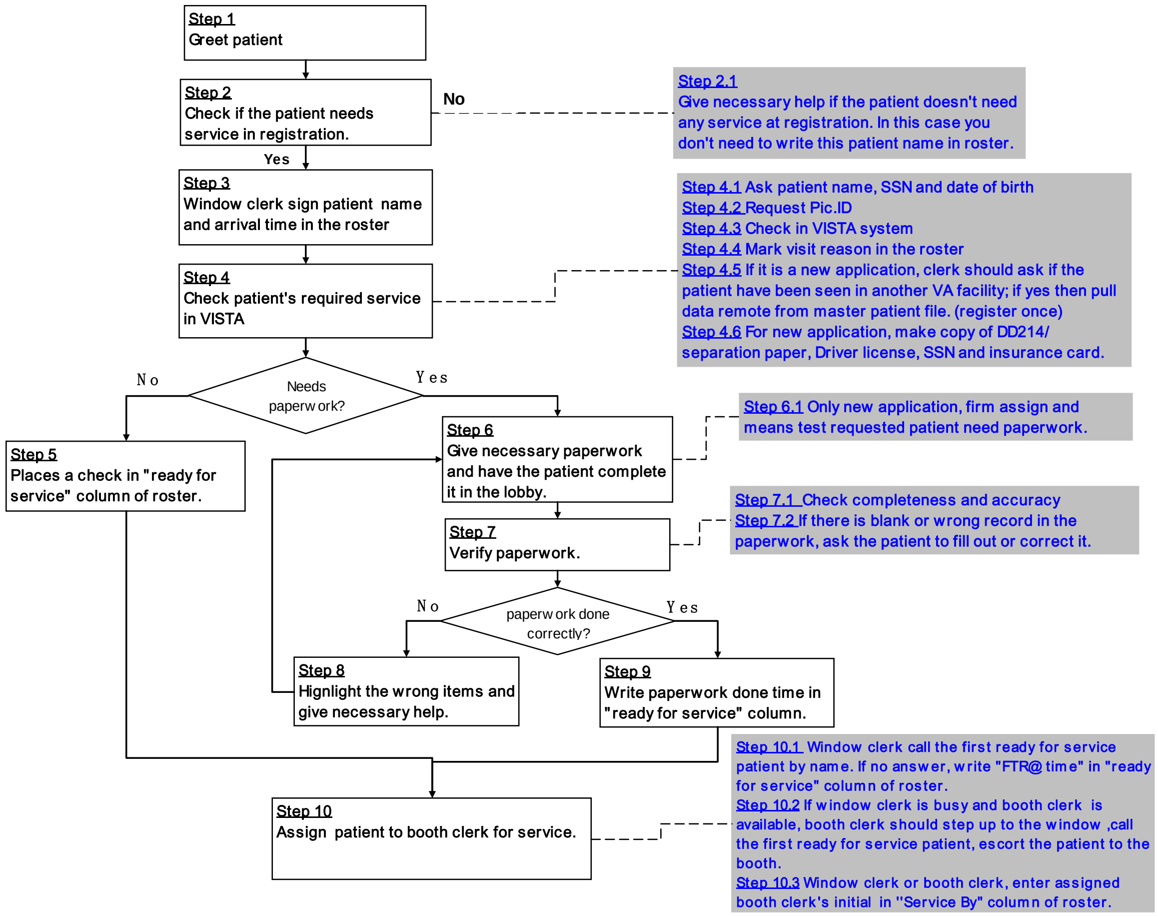

Figure 6 Window Clerk Standard Operating Procedure

The new window clerk standard operating procedure is illustrated in Figure 6.

3. Waste Reduction Based on Lean Operation Principles

By examining many current procedures for serving patients, especially for patients with long services, we found that there are a lot of wastes in the existing service procedures. For example, in existing precedure, all patients are required to fill forms no matter what the service types. We observed that patients who requested veteran ID filled one-page forms and the booth clerk subsequently shreded the form right after this service was done, because the information in the form would never be used. Actually, except in the case of new application, the patients' data are already available in the VA computer system. Clearly, asking all patients to fill forms will cause wastes. The only thing is that some portion of data might be inaccurate or obsolete. In this project, we proposed instead of asking all patients to fill out forms from the scratch, we will only provide forms to the patients who request new application, firm assignment and means test, other patients who request veteran ID, copay and phone or address update will not need to fill out forms. This change saved a lot of patient time and the clerk service time.

Besides the above 3 improvement procedure, we also conducted the basic lean operation training for all the clerks. After we implemented all these improvement procedures, we saw a drastic improvement in the average waiting time, as illustrated in Figure 7. After the improvement, the average waiting time is reduced to 6.55 minutes from the prior level of 42.3 minutes.

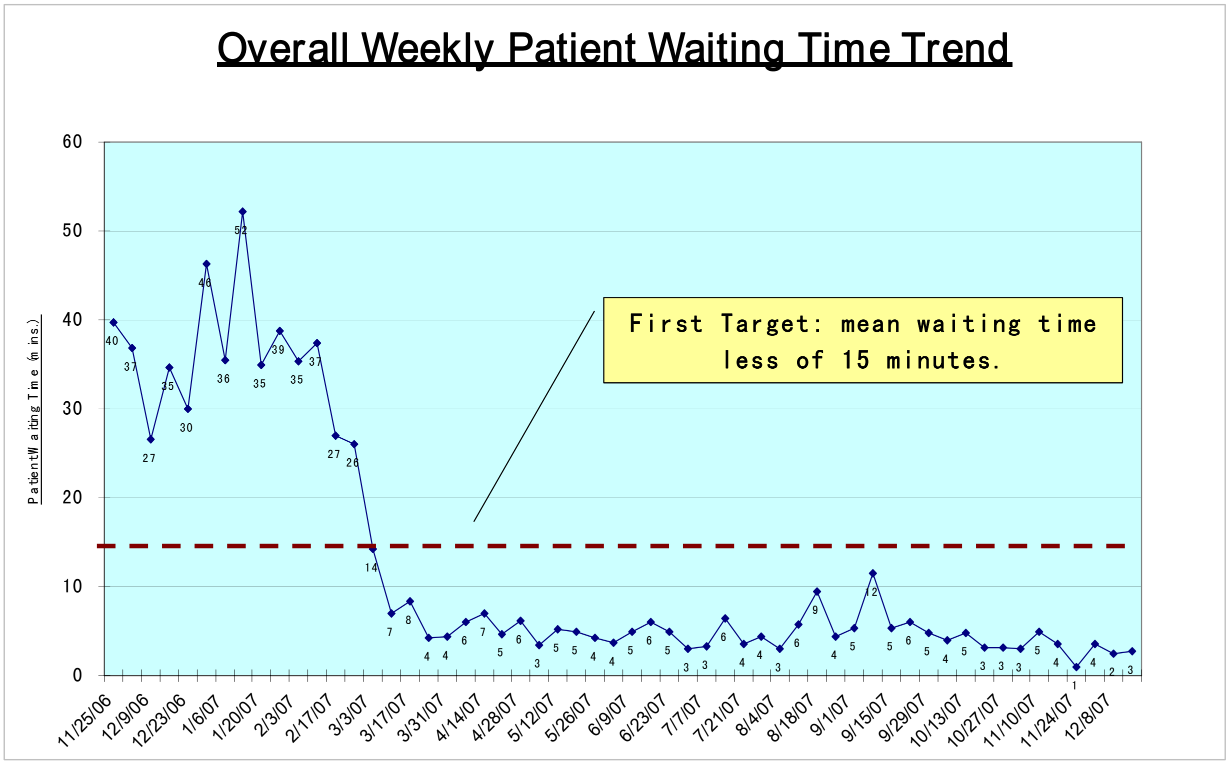

Figure 7 Waiting Time Reduction Results after the Improvement Phase.

7. Control Phase

In order to hold on to the drastic improvement of our registration waiting time reduction, we implemented two control procedures. The first procedure is the continuation of the data collection and establishment of the monitoring mechanism based on control chart. Figure 8 illustrates our control chart.

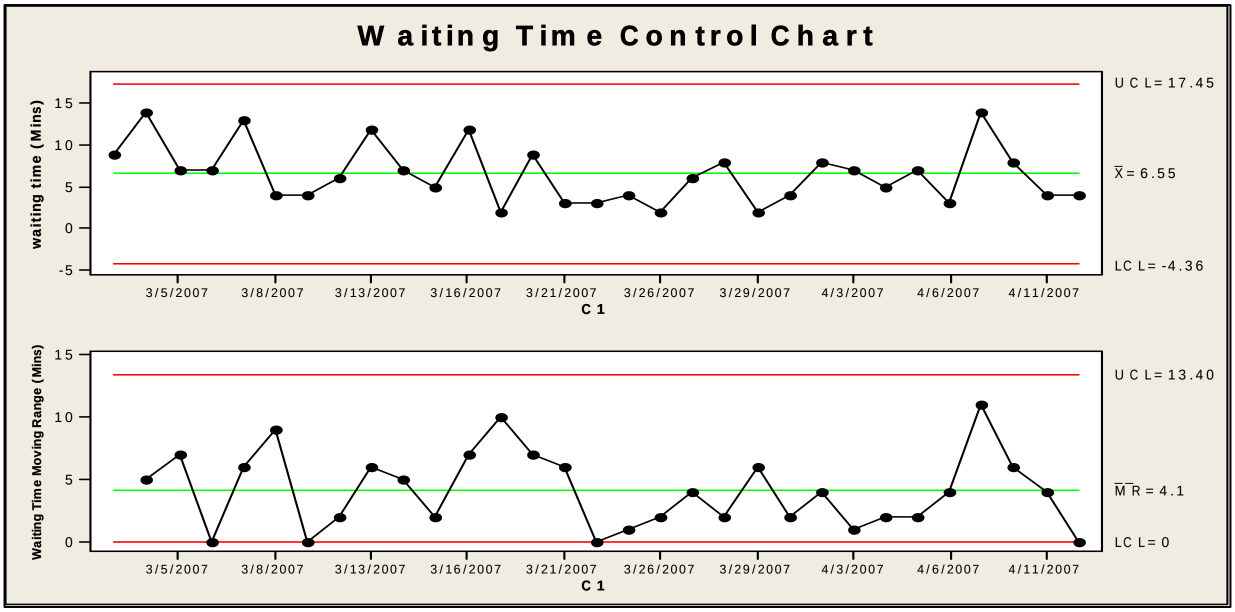

Figure 8 Waiting Time Control Chart

If we find an out of control situation, we will examine the data on that day in detail and conduct root cause analysis. By this way, we can find the root causes and bring the waiting time in control.

Another effective procedure to hold on to our improvement is the introduction of standard service time and employee lean scorecard. Based on our data, we calculated the key statistics of service times for all service tpes, such as mean service time, minimum time and maximum service time. These statistics and the standard service times are listed in Table 2. We designed the ‘standard service time’ for each service type by using a value slightly longer than the average service time. If a clerk completes a ‘new enroll’ task, we will count it as a 35 minutes of value added time in the current shift.

	from	17-Mar	to	24-Mar			
	New Enroll	Means Test	Copay	Firm Assign	Vic ID	Update	Verified
Total Patient Visit	45	89	9	17	174	21	7
Standard Service Time	0:35	0:10	0:10	0:10	0:05	0:10	0:10
Average Service Time	0:29	0:08	0:07	0:09	0:02	0:05	0:06
The Longest Service Time	1:04	0:45	0:22	0:20	0:25	0:17	0:07
The Shortest Service Time	0:17	0:03	0:03	0:05	0:01	0:02	0:03

Table 2 Standard Service Times

During the whole working day, the standard times of all the cases that a clerk completed will be added, this added standard service times will be the total value added time for that clerk. Because registration clerks not only serve the visiting patients but also serve paitents by phone averaging about one hour perday, so substracting 1 hour call service from 8 duty hours will result in each clerk having 7 hours of effective working time. The lean score card is calculated for each clerk for each working week. If a clerk has an average 5 hours or more value added time for a working day (7 hours), he or she will receive a lean score of A. This scoring scheme is based on the fact that there are always some non value added activities by necessary miscellaneous tasks such as training and meeting that will also use some time. If a clerk has less value added time, he/she will receive a lower grade. This lean score card serves as motivation mechanism for clerks to work effectively in the registration process.

Our procedures implemented in the control phase have been working very well and the low average waiting time is maintained succesfully.

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