

Implementing Lean Methodologies in Healthcare Systems - A Case Study

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Abstract

The Toyota Production System (TPS) is mainly based on industrial principles and uses to eliminate the wastes in a production system to increase the products' efficiency. Several lean tools and principles like Value Stream Map, which represents not only the flow between people, materials, and information but also value added and non value added steps. In this project, a team implemented lean principles to improve the sterilization department in hospital. The project was done in a step by step suggesting manner. Two Kaizen events were identified for which a pokayoke system was developed and some changes were made in the current working patterns. In one of the kaizen events, the cycle time of the process was reduced by implementing lean principles in the healthcare system.

Keywords

Toyota Production System, Kaizen events, Lean manufacturing, Mudasa, Value stream map, Takt time, Cycle time, Pokayoke design, Kanban.

1. Introduction

In the last decade, Lean manufacturing principles have been adapted by many US industries to produce superior quality products with less cost. Recently, since the healthcare system in U.S. exists serious waste problems, people are trying to implement lean manufacturing principles in it. Individuals visit hospitals in the extreme situation because insurance companies just cover a small amount of money comparing to the large amount that people spend on healthcare. In order to control this problem, the government has made two bills: (a) Patient Protection and Affordable Care Act, which became law on March 23, 2010; and (b) Health Care and Education Reconciliation Act of 2010. Sooner the implementations of these laws lot of changes are going to take place in the medical sector. These changes are going to continue till 2018. [1][2]

Benefit from these two laws, there may be more amounts of patients visiting hospitals. Hospitals need to explore new methodologies and techniques to deal with large amount of patients. In this situation there will be a great amount of inflow of patients to the hospitals. Hospitals are required to give the same quality of service at a lower price based on the laws. Tools like Continuous improvement, QRM, Six Sigma, Lean Manufacturing etc. are some of the techniques which can satisfy these requirements. Since lean principles are implemented in industrials widely and receive significant improvements, this paper focuses on lean principles to help hospitals meet these requirements.

Before the study, many people stress that hospitals can offer better quality of service at a lower cost after adapting lean manufacturing principles. A group of students from University of Iowa Hospitals and Clinics used a case study "Lean Sigma - will it works for healthcare" [3] to figure out this under the guidance of their professor. The group of students worked as a team and specified their work in a five-day schedule. As a result, the team succeeded obtaining the desired results, however, it failed to show a standard pattern or procedure to get started the process and keep it going. This paper proposed a method of starting from the basic idea to finish final improvement stage. A new framework was developed in this process. Finally, the proposed method was tested by using a case study.

The rest of the paper is arranged as follows. Section 2 presents the proposed frame work; Section 3 proposes a case study where the proposed frame work is implemented. Conclusions are shown in Section 4.

2. The Proposed Lean Implementation Framework in Health Care

This section outlines a systematic approach to adapt lean manufacturing in healthcare. After training the team, it developed a process flow map. The detail of each process is shown in a flow chart in Figure 1. The entire process is divided into three stages. They are Strategy, Planning, and Execution stage. Strategy stage mainly involves in identifying current system, understanding it, finding the scope for improvement and developing a future map. Planning and Execution Stages are based on the factors in Strategy stage [4][5] and they focus on developing an initial Future value map. Kaizen events should be identified in Planning stage, and they should be improved to eliminate muda in Execution stage.

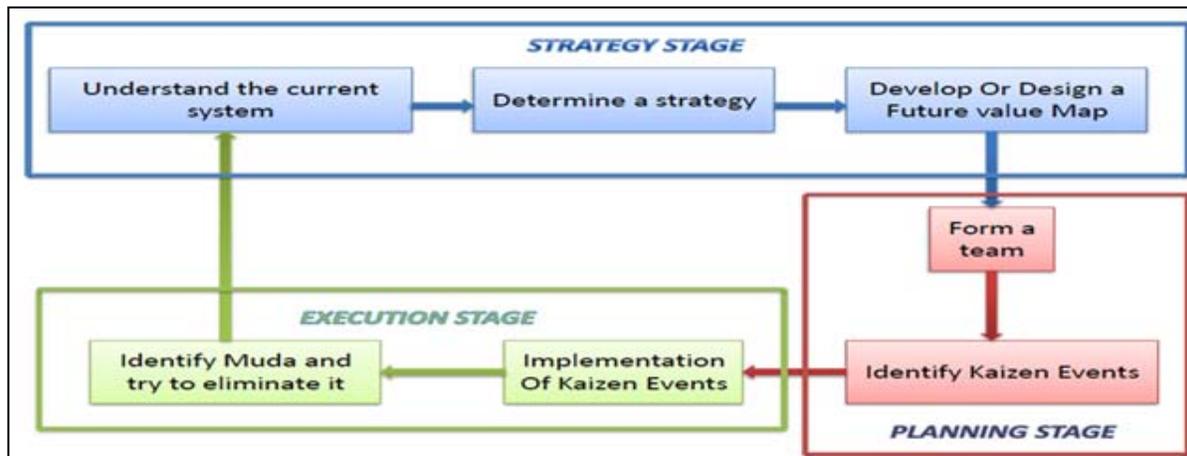


Figure 1: Various stages in process of Lean implementation

After analyzing the process map, the team selected a specific area and get to the process. The first step of the process is to draw a current value stream map [6][7][8].

2.1 Draw Current value Stream Map

A team who are familiar with the entire process was formed. Now a specific area is identified from where the process of implementation of lean principles is started. Current State map gives the team present flow process. The following are some of the tips for getting started with current state map. First tip is that drawing by hand instead of using software. Second tip is to collect the required data walking through the process completely. This helps to get details required very accurately. Third tip is that members should start from end process and move upstream. This is because the process should be a pull system. Fourth tip is to use certain standard icon which helps to draw VSM easily. Current State map provides major information of existing problems and helps team in consecutive steps [9][10][11].

2.2 Develop a Future Value Stream Map

The relations between each and every department in the process are shown in the future state map even the quantity to be produced. There are a set of question the team has to go through. Based on the answers to the questions the team should map them on current map. The following are the questions that are to be considered in table 1 [12].

Before the future value stream map could be drawn, the team needed to finish the brainstorming and find the answers of questions above. Furthermore, it had to identify various kaizen events that can be implemented by eliminating various mudas [13][14]. Muda is a Japanese term which means waste. Each organization defines its muda categories. Most common muda's used are: Over production, waiting, transportation, over processing, inventory, motion, and defects [15][16]. Kaizen event is a continuous process of improvements which involves in

identifying the mudas, eliminating them and standardizes the work at that level. Table 2 summarizes the steps that are to be followed to get started in Kaizen events. Some kaizen tools, such as target progress report, standardized work sheet, time observation sheet, takt time/cycle time calculations and kaizen proposal sheet-try are used to eliminate mudas.

Table 1: Requirements for developing Future Value Stream Map

What does the customer need and when?
How often is the performance checked?
Which steps create value and which waste?
How often to maintain flow with least possible interruptions?
How to control work between interruptions?
Is there an opportunity to balance the work load?
What are the improvements necessary?

Table 2: Steps involved in Kaizen Process

Step No.	Information
Step 1	Form a team <ul style="list-style-type: none"> Identifying the leader and the team members.
Step 2	Identify the problems in the area of concentration. <ul style="list-style-type: none"> What's planned and what's happening? Data that is available in that section.
Step 3	Develop a theme and set some targets to be achieved <ul style="list-style-type: none"> Developing the counter measures for the identified problems. Setting some targets in that process of implementation.
Step 4	Establish a timeline for the process <ul style="list-style-type: none"> Key tasks to be achieved? When is it scheduled? Who is doing what?
Step 5	Identifying the current operation <ul style="list-style-type: none"> Data collection of the process
Step 6	Analyzing the underlying problems <ul style="list-style-type: none"> Identifying the need Determining the root cause with help of fishbone and 5 why's principles
Step 7	Developing the counter measures <ul style="list-style-type: none"> Activities to be worked to achieve the set targets Planning the implementations Comparing the work before and after the implementations
Step 8	Standardizing <ul style="list-style-type: none"> Updating the standard operating procedures as needed in daily work.

Up to now, the framework of lean manufacturing to be used in a health care related facility was proposed. The framework has four steps.

Step 1: Specify an area from the developed process map.

Step 2: Draw a current stream map.

Step 3: Based on the current stream map and some specific questions, develop a future stream map.

Step 4: In order to transform current stream map to future stream map, Kaizen events of the system have to be figured out to eliminate muda.

To support the above stated procedure a case study is followed in the next section.

3. Lean Implementation in a local Medical Center

A case study that lean procedures are implemented in a hospital is shown in this section. This case study gives specific procedures to identify and eliminate the non-value added steps.

3.1 Hospital introduction

The hospital is located in Peoria, Illinois. It consists of various departments, such as Registration-Check In, Pre Op area, Surgery area, Phase 1 recovery, Phase 2 recovery, general ward, and Checkout section. It provides emergency, surgery, general services. Figure 2 shows the flow chart between each department of the hospital.

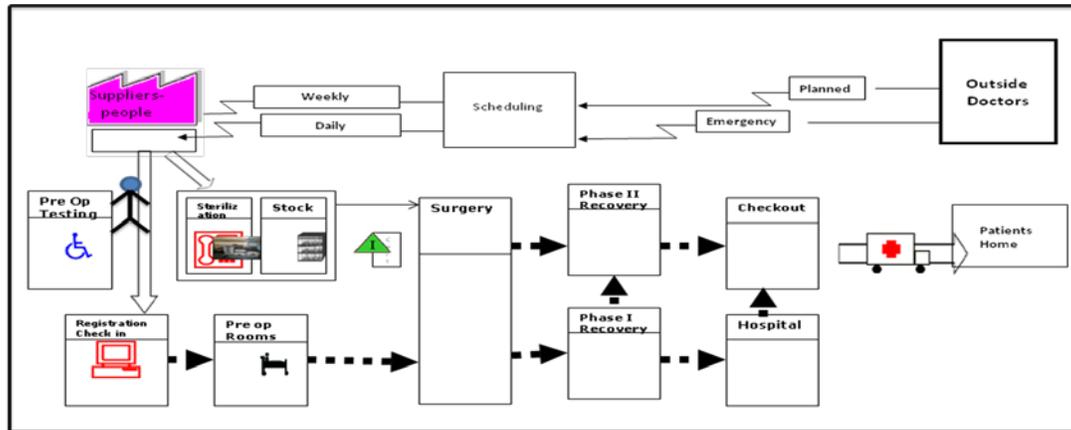


Figure 2: Patient Flow Diagram

Inventories are required in order to have a smooth flow between every department in hospital. In order to provide enough inventories, there is a separate department called sterilization and stocking which manages the inventory. This department mainly focuses on using surgery trays in surgeries. Before getting surgery trays into use, they need to be sterilized. Cleaning department is responsible for cleaning and sterilizing the surgery trays. Currently, cleaning department is facing the problems that the cycle time of various processes do not coordinate with each other, and the same problem for inventory and transportation, etc. Hence, the main concentration of this project is to provide them recommendations to coordinate different cycle time.

3.2 Draw Current Value Stream Map

This project aimed at improving the sterilization department in the hospital. In the six-person team, one member is a staff of the hospital who is in charge of the sterilization section and the rest are students. The team had to receive lean principles training and understand the entire sterilizing process before optimizing it. For example, sterilizing a used tray has to go through different processes, including hand washing, machine washing, inspection, wrapping, sterilization and scheduling.

Initially, the staff member provided basic information about the sterilizing process, working method, and demand to the team. After understanding the process, the team understood the entire sterilizing process and collected information for two purposes:

- By consulting various process operators, the team gets familiar with the entire process and sequence of getting a tray cleaned.
- To obtain information such as process time, number of workers, work in process, stock on hand of each workstation.

The team started current state map after the information collection. During developing current state map, the team needed to know how various departments communicate information. This data was given by operators. It helped to draw the linkage between various departments in current state map. Second the team had to know the time factor, which was helpful for the calculating of lead time and process time. The time are represented a time line at bottom. Current state map is shown in Figure 3.

The main objective of drawing the value stream map is to find ways or means for improvement. The team identified the area where some improvements can be made.

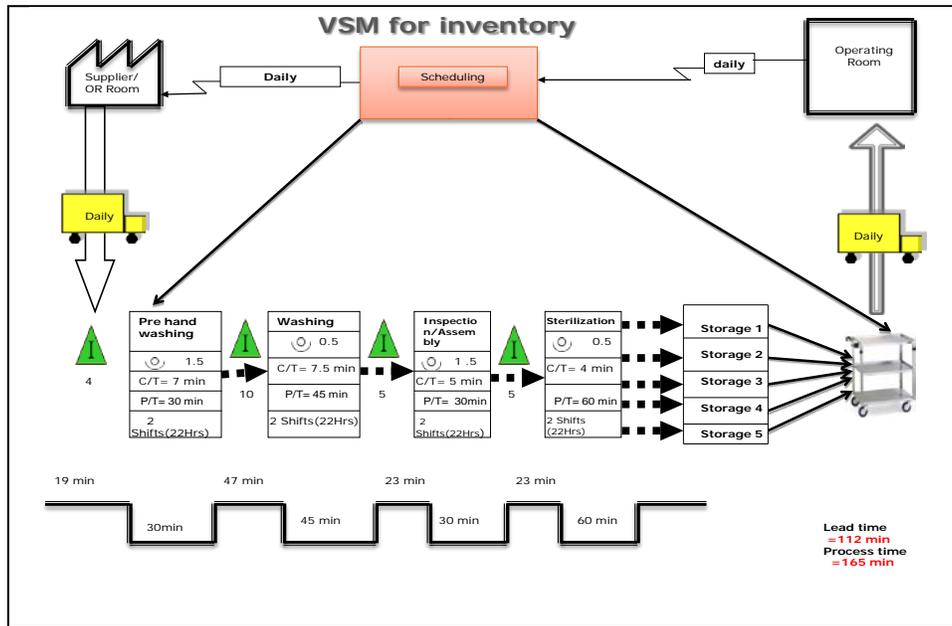


Figure 3: Current Value Stream Map

3.3 Develop a Future value Stream Map

After going through these processes, some needed improvements were determined in current state situation. Based on the current state map and available information, future state map was started. The future value stream map forms the stated procedure in a framework. The following questions were answered.

- What does the customers need and when?
In this study, Operation Room is considered as customer who requires the trays with shortest time. From the past available demand data, takt time is calculated.
Takt time= Available working time/Demand= $(22 \times 60) / 277 = 4.76$ min/tray
From the calculation, it is observed that after every 4.76 min a tray is required.
- How often is our performance checked?
Unless a major change is made in the process, performance checks are never done.
- Which steps create value and which waste?
According to the current value stream map, only the processes add value to the tray. So, the rest of them performed on the tray are considered non value added or Muda.
The following are common mudas observed: Transportation, Defects, Inventory, Waiting, Overproduction, Over processing, and Motion
- How often to maintain flow with least possible interruptions?
Right now there is no time limitation and control mechanism for each process which may cause some delays or irregularities in process. For this, specifying time limits for various processes and having someone to visualize the entire process makes a big change.
- How to control work between interruptions?
According to the observation, every process is done using a push mechanism which might increase the working pressure of the successive department. Thus, the team members came with a suggestion of implementing a pull mechanism which flows in reverse direction and can be controlled by kanban system.
- Is there an opportunity to balance the work load?
The team suggests that leader should always be part of keeping a continuous check on the time factors in the entire process. This results in improving the lead time of the process and meets their demand with much ease.
- What are the improvements necessary?
The team observed that there is no proper flow of information from scheduling department to any of the departments in the sterilization area. To make things look better the team has suggested to implementing a

Kanban system in which the information flows from scheduling and carting area. In this way, flow of information is not direct but from the preceding department.

Now with the answers to the above questions, the team members had an idea of how to get started on future state map. After a brainstorming session the team came up with the following Future state map shown in Figure 4.

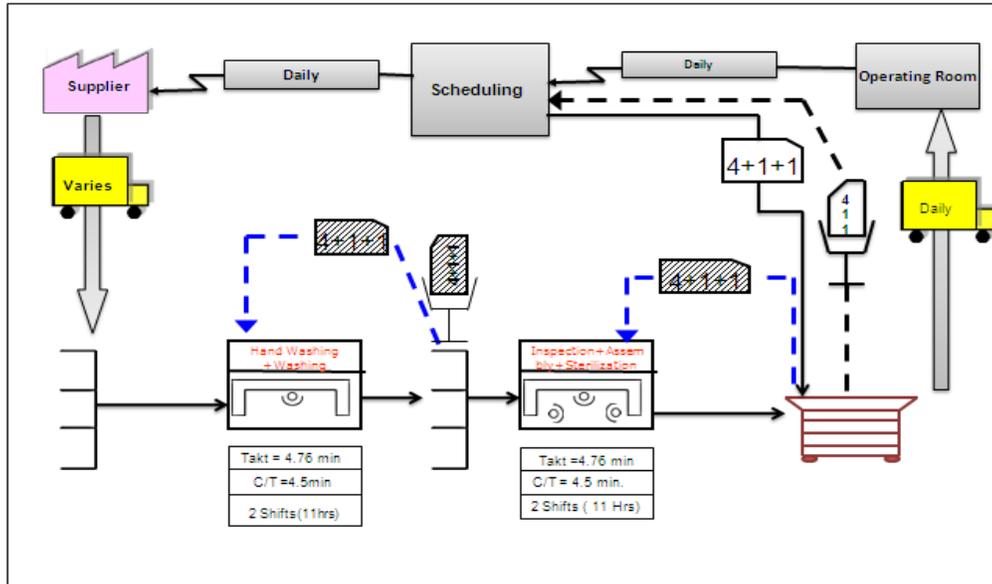


Figure 4: Proposed Future Value Stream Map

Once the future value map was developed, the team had an idea of what to be done to achieve this state. Since the current and future maps are different, there will be a transition. In order to make this transition smooth, the team implemented loop mechanism where the future value stream map was categorized into loops. It simplified the process of kaizen implementation.

3.4 Kaizen Events

To transform the current state map to the desired future state, the team implemented various kaizen events. The outcomes of each kaizen event were summarized as following sections.

3.4.1 Kaizen event 1- Eliminating Defects Mudas

Team identified defects mudas which has a major scope for any modifications. Defects generally results in rework. In the current process, defects were observed in the inspection/assembly section where the trays were packed for sterilization. There may be some equipment missing in the trays occasionally (120 times yearly). It resulted in the technician to get a new surgery trays between surgery, which may delay in the surgery (current and the successive), increase cost of the OR room, change the schedule of the surgeon. Or it would cause the death of patient in some rare cases. The defects obviously would cause an increasing of cost.

To get into the root cause for this mudas, this paper used one of the lean tools called 5 why's principle. The following are the 5 why's for defects mudas

- Why defects muda's?
Because trays are missing tools even after inspection.
- Why are trays missing tools after inspection?
Due to error in counting parts.
- Why there is an error in counting?
Because of human error.

So, the root cause for this was identified as human error. In order to eliminate this, team suggested a pokayoke (Japanese term as defect prevention) system which helps to minimize human error. After a brainstorming session, the team came up with a shadow board layout idea and to integrate it with the current process. As soon as the workers in the inspection/assembly section scan the tray along with the checklist in the computer screen, there will be a shadow board which projects on the table. Figure 5 denotes the sample of the shadow board, as a pokayoke system, that suggested by the team.



Figure 5: Template of the suggested Shadow board

The images of the necessary tools required that tray are projected from top into the tray. In this way it's much easier for the operator to pack the trays with the correct tools or instruments without defects. Figure 6 shows the procedure of Pokayoke System.

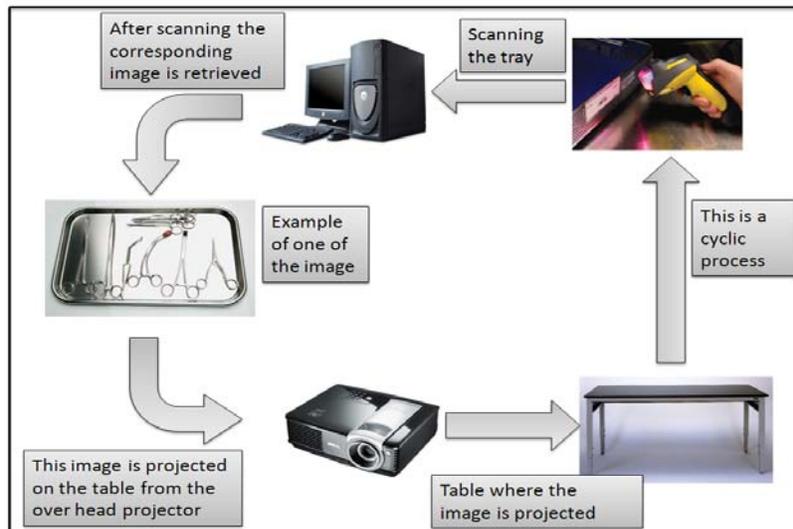


Figure 6: Pokayoke System – projection template

The cost associated with this implementation is as follows:

- **Yearly Defect Cost** = (Per minute cost of operating room)*(Estimated time for technician to retrieve another tray)*(Estimated number of instances a year)

$$= (\$61) * (5 \text{ min}) * (120)$$

$$= \$36,600 \text{ per year}$$

- **Proposal cost** = (Projector)+(IT and implementation)
 = (\$2000) + (\$3000)
 = \$5000 as one time investment.

Total savings = \$36,600-\$5,000= **\$31,600** in the first year due to the investment made
 = **\$36,600** yearly from the coming years

From the analysis above, the suggested pokayoke system can prevent defects efficiently and at least save \$36,600 every year, sometimes even patients' life.

3.4.2 Kaizen event 2- Over Processing Muda

For the second kaizen event, team identified over processing muda where improvements can be made without much modifications to the process. Over processing is to do extra work on the product which does not add any value. Currently, worker in the hand washing section wasted time for sorting the used and unused trays which came from operating room.

It took 4.5 minutes before the worker actually started to work on the trays. If observed clearly there were a lot of over processing involved which does not add any value to the tray. To get into the root cause, the 5 whys principle is used.

The following are the 5 why's for over processing muda.

- Why is there over processing at hand wash?
 Hand washer needs to sort the unused and used trays and then wash.

Root cause for this is identified as the sorting process. After a successful brainstorming session this team came up with a suggestion that the technician who brings the cart from the operating room should do the sorting work. Then, worker in the hand washing section could save time in sorting work. The proposed process at glance is shown in Table 3.

Table 3: Proposes Process at Glance of the new system

Process	1	2	3	4	5	6
Operation	Moving Carts	Sorting	Scanning	Moving Trays- Hand Wash Section	Moving Trays- Washing Section	Moving Carts
Picture						
Description	Bringing the carts from hallway to hand wash section	Sorting the used and unused trays	Scanning the trays in the cart	Moving the trays to hand wash section	Moving the trays to washing section	Moving the carts out of hand wash section
Average process time	1 min	1 min	0.75 min	0.5 min	0.75 min	0.5 min
Inspection Tool	Technician	Technician/ Self	Scanner	Self	Technician	Technician

With the proposed process, operator in hand washing section saved 3 minutes for each cart. So, the estimated savings that can be obtained with changes are calculated below.

The following is the data obtained from the hospital records:

- A- No. of carts coming to hand washing area every day= $277/6 = 46$ carts
- B- Salary of the operator in hand washing area= \$20 (regular salary + overhead)
- C- Yearly working days= 260

Total savings with 3 min reduction each cart= $A*B*C*3 = 46*20*260*3 = 717600/60 = \mathbf{\$11960/Year}$

The second suggestion from this kaizen event saved 3 minutes for each cart. There are 46 carts come to hand washing area every day. It saves \$11,960 every year just by organizing the working process. There are more improvements could be made by using this systematic lean principle framework.

4. Conclusion

In recent years, lean principles are stressed by industrial people. However, it has never been used in health care system. This paper proposed a framework for implementing lean principles that provided guidelines for the healthcare system. This framework consist four steps, including process map, current VSM, future VSM, and kaizen events to transition the state of current VSM and future VSM. A case study was shown to establish an improvement in the sterilization section in the hospital, which standard and specific framework for implementing lean principles. A team trained to eliminate defects and get desired output in the hospital. In team members had gone through several walk-through processes to build the current VSM, brainstormed for the future VSM, and set the implementation plan to achieve it. In this process, the team developed a future VSM by eliminating various non-value activities. This improvement would create a saving of around \$43,000 per year by eliminating the non-value added processes. This case study shows there are more potential improvements could be done by using the proposed lean principles framework.

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