Improvement in the Utilization of the Utilities Operator's in a Pharmaceutical Industry in Puerto Rico

Karla B. Centeno-Morales
Master of Engineering in Manufacturing Engineering
Rafael A. Nieves, Pharm D
Industrial Engineering Department
Polytechnic University of Puerto Rico

Abstract *— Personnel's motivation, performance and accuracy to execute their duties are important part impacted by unbalanced workload and insufficient number of resources. The evaluation of resources and balance workloads are part of the goals as to achieve company's production expectations. The main objective of this project is to improve the operator's utilization by evaluating the number of operators and their work load. They were evaluated in order to identify whether those or other factors were the most significant contributors for not having enough time to prevent fails on systems. This project is focused in using Lean Six Sigma Methodology based on decrease the process variation, waste elimination, process improvement, and customer satisfaction in order to achieve the expected goal. The design project is composed of five phases using the Methodology of Lean Six Sigma; Define, Measure, Analyze, Improve and Control, in order to identify improvement opportunities and eliminating/reduction of wastes.*

Key Terms *— DMAIC, Kanban, Lean Six Sigma, Seven Wastes.*

INTRODUCTION

Pharmaceutical industries have different agencies which monitor all process related to their functions to provide excellent manufactured goods to the customer which don't put in risk their health. To achieve a company's production expectations and metrics the evaluation of resources and balance workload is a procedure that must be performed. Based on a study in the Utilities Process at a Pharmaceutical Plant, operators are utilized 100% having not additional time to prevent fails in equipment. In the occurrence of a Utility interruption, the manufacturing module can incur in a cost avoidance of $56,272. Because of the high cost of manufacturing biological products this is where this design project is develop in order to reduce 20% ± 10 of Utility Operators Utilization to give them available time to prevent fails and perform other tasks during their respective shifts. The design project is composed of five phases using the Methodology of Lean Six Sigma; Define, Measure, Analyze, Improve and Control, in order to identify improvement opportunities and eliminating or reduction of wastes.

RESEARCH DESCRIPTION

This design project is about development and implements the Lean Six Sigma Methodology to reduce non-value added activities performed in the Utilities Area of a Pharmaceutical Industry. The project will consist in improve long-term objectives of the company, to give additional time to operators to increase productivity, compliance of the area and avoid downtime in the manufacturing areas.

The importance to develop this design project and the related research is to implement Lean Six Sigma Methodology, not only to comply with the regulatory requirements, but also to improve Utilities Area performance, provide a controlled environment for manufacturing areas and eliminate wastes performed. In addition, the methodology will get cost avoidance in costs related with delays when equipment fails because of lack of time.

RESEARCH OBJECTIVES

The objectives to be achieved are:

- Reduce 20% ± 10 operator's tasks in the Utilities Areas by identifying non-value added activities.
- Identify all opportunities within the utilization of Lean Six Sigma Principles.

Research Contributions

The implementation of this project will help reducing redundant activities which are considered non-value added in order to reduce downtime in manufacturing areas, and improve Utilities metrics. Non-value added activities such as seven types of wastes will be eliminated or reduced by giving them additional time to react when a fail appears. By implementing Lean Six Sigma Methodology in Utilities Area is more than a challenge because of the nature of the work performed in the area. This will brings many benefits to the Pharmaceutical Industry, and prove that Lean Six Sigma Methodology is a very useful technique that can be applied in all environments.

Literature Review

This reviews the most relevant topics related to this design project with the aim of serve as a general introduction.

What is Lean Six Sigma?

"Lean thinking is sometimes called lean manufacturing, the Toyota production system or other names. Lean focuses on the removal of waste, which is defined as anything not necessary to produce the product or service" [3]. *"Six Sigma claims that focusing on reduction of variation will solve process and business problems".* [3]. By using a set of statistical tools to understand the fluctuation of a process, management can begin to predict the expected outcome of that process. *"If the outcome is not satisfactory, associated tools can be used to further understand the elements influencing that process"* [3].

DMAIC Method

Lean Six Sigma has numerous useful tools that can be used when a project/area needs to improve performance in their product, process and/or service. In this project the DMAIC Method combine with Lean were the one used to develop improvements in the Utilities Area. DMAIC is the abbreviation of five phases of the Six Sigma methodology: Define, Measure, Analyze, Improve, and Control. Six Sigma help people to understand their process analyze them; find way to improve it, and how to monitor the process to control it. This Methodology gets a "*deeper understanding of data, data analysis by graphical representations can provide new and different perspectives of the process behavior"* [3].

In this project the activities that will be performed in the different DMAIC phases are:

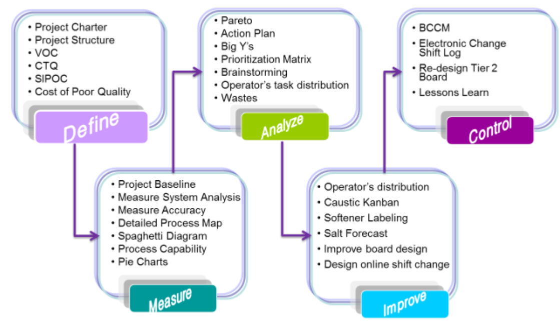

Figure 1
DMAIC Phases

As the methodology goes, there are different tools that could be used, in this project the tools that will be used are the ones described in Figure 1. The application of the tools will be based in the needs where they will be applied. Lean Six Sigma tools are applied through each phase of the DMAIC method to improve Operator's Time utilization, which were explained before. In this project a 30 days study was perform with six (6) operators. The areas of interest will be Monitoring, Tasks, Inspections and Improving actual documentation forms, in order to improve all processes into a lean process.

Methodology

As part of the developed project plan to achieve the objectives, Lean Six Sigma tools were used. As describe before on Chapter 2, the methodology used was DMAIC. Each phase has a structure to be developed as follow in Figure 2.

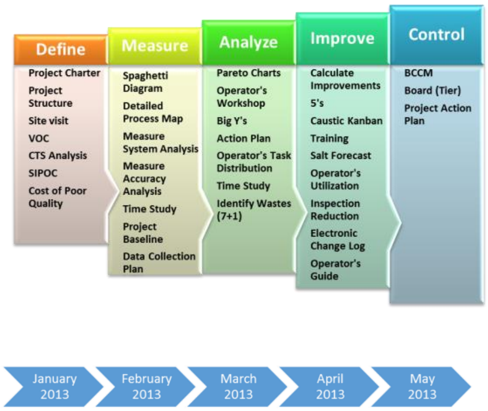

Figure 2
Project Structure

Define Phase

The define phase will add more definition about the project or problem to be solved. Project Charter - defines the team's mission, it includes the following elements:

- Problem/Opportunity Statement – What (Product/Service) is wrong or not working?, Where, When: from (date of earliest data) to (date of latest data), Extent (e.g., percent [%], average).
- Goal Statement - What are the improvement targets? That is, what does success look like? Extent (e.g., %, average match problem extent): reduce/increase (metric), When (date new performance is to be realized).
- Business Impact - Why should we do this? Business strategy scorecard metric, Financial Category, Consequence of current, performance/Benefit of goal performance.
- Project Scope - Process Start (1st activity included): Process Stop (last activity included): Out of scope (e.g., products, regions, etc.).
- Project Plan - Enter dates for completing major milestones (if possible, deliverables).
- Team Selection - for each resource, list: Who, Role, % of time dedicated to project.

A Project Charter does NOT solve the problem, is a repetitive process, and is often updated throughout the project.

Voice of the Customer/Business

Voice of the Business (VOB) is often best obtained from the Process Owner. Voice of the Customer (VOC) is obtained from the downstream customer, the direct recipient of the process/service.

- CTQ Analysis – Critical to Quality are parameters related to the wants and needs of the customer.
- SIPOC – is a high level map of the process you are focusing on in your project.
- Suppliers – Who provides Inputs?
- Inputs – What goes into the Process?
- Process – How the Process is performed?
- Outputs – What comes out of the Process?
- Customers/Clients – Who receives Outputs?

Measure Phase

The Measure phase involves more numerical studies and data analysis than the Define phase. This phase focuses on measurement system validation and gathering root causes [1].

- Spaghetti Diagram – is the visual creation of the actual process flow.
- Measure System Analysis – is an experimental and mathematical method of determining how much the variation within the measurement process contributes to overall process variability. [1].
- Time Study - time aspect of work, how long it takes to do a job. [1].

Analyze Phase

The **A**nalyze phase is the beginning of the statistical analysis of the problem. The practical problem was created in the earlier phases. This phase statistically reviews the families of variation and will determine which are significant contributors to the output [1].

- Pareto Charts – a statistical tool used to graphically summarize and display relative importance of the differences between groups of data. [1].
- Brainstorming – is a process for developing creative solutions to problems. [2].

- Big Y's or Y = f(X) - "Y is a function of X" equation; wherein Y is the outcome of the process; and the X's are the variables that impact, or causes of the problems, connected to the outcome.
- 7 Wastes – all activities that do not add valued to the process, in Japanese is known as MUDA. The seven (7) wastes consists of:
  a. Transportation – unnecessary movement of people or parts between processes.
  b. Inventory – raw material, work in progress or finished goods which are not having value added to it.
  c. Motion – unnecessary movement of people, parts or workers within a process.
  d. Waiting – people or parts that wait for a work cycle to be completed.
  e. Over Processing – process beyond the standard required by the customer.
  f. Over Production – to produce sooner, faster or in greater quantities than customer demand.
  g. Defects – non right first time, repetitive or correction of a process.

Improve Phase

- The Improve phase requires understanding the KPIV's that are causing the effect. This phase will help determine the relationships and amounts of these key variables to the project "Y" and lead to optimal improvement ideas. This is the phase of the project where all the team's work gets put into action, the rubber meets the road for hard driving. The solutions have been identified and the implementations to reduce variation in improve target performance [1]. 5's – a system used to reduce/eliminate wastes and optimize productivity through maintaining an organized workplace.
  a. Sort – the first step in making things cleaned up and organized.
  b. Set in order – organized, identify and arrange everything in the workplace.
  c. Shine – regular cleaning and maintenance.
  d. Standardize – make to everyone do it in the same way.
  e. Sustain – maintain what has been done.
- Kanban – is a simple tool used to visualize workflow, delivers a continuous flow of tasks and helps to improve inventory systems by follow visual signals.
- Forecast – a told used in process production to predict what is need, when its need, how much is need.

Control Phase

The Control phase is the conclusion of the team's journey. The final capability is determined and the closing performance and all related changes are documented on the closing contract [1].

Behavior Coaching and Consequences Management (BCCM) is a tool used to personal coaching helping functioning individuals set and achieve goals, overcome obstacles and maintain motivation. Leaders and managers must assume roles as coaches in organizations that aspire to become learning organizations as a way to improve employee's performance. Manager's commitment to coaching has the potential to impact performance at the individual employee, manager, and organization level.

RESULTS AND DISCUSSION

This chapter will consist in present and discuss the analysis and results obtained throughout this Design Project. The main purpose of this project was to improve the Utilization of the Utilities Operator's in a Pharmaceutical Industry in Puerto Rico by applying the Lean Six Sigma. The tool used in this project was the DMAIC (Define-Measure-Analyze-Improve-Control) methodology.

Define Phase

Lean Six Sigma tools are applied through each phase of the DMAIC method to improve Operator's Time utilization, which were explained before. In this project a 30 days study was perform with six (6) operators. The areas of interest will be Monitoring, Tasks, Inspections and Improving actual documentation forms, in order to improve all processes into a lean process. As a starting point during the Define Phase a Project Charter was developed in order to define the project team's mission and includes the following sections (see Table 1).

Table 1
Project Charter

Charter	
Problem Statement: Based on a study performed in March 2013 in the Utilities Process at a Pharmaceutical Industry, operators have been utilized 100% not having additional time to prevent fails in equipment.	**Goal Statement:** Reduce 20% ± 10 of Utility Operators Utilization to give them available time to prevent fails and perform other tasks by September 2011.
Business Impact: In the occurrence of a Utility interruption, the manufacturing module can incur in a cost avoidance of $56,272.	**Project Scope:** *In Scope:* Inside operation processes in the Utilities Areas at a Pharmaceutical Plant. *Out of Scope*: Equipment, Manufacture, Readings, other site plant.
Project Timeline: **Milestone** — **Date** **Define** — Mar 30, 2013 **Measure** — Apr 7, 2013 **Analyze** — May 20, 2013 **Improve** — Aug 30, 2013 **Control** — Sep 30, 2013	**Team Selection:** Primary Sponsor: Félix Matos Secondary Sponsor: Luis Brignoni Process Expert: Gilberto Candelaria Operators: Eric Rodríguez, Juan Hernández, Luis Soto, José Rivera, José de Jesús, Roberto Mercado, Israel González, Jorge Otero Team Member: Juan E. Crespo, Manuel A. Oliver Mentor: Mariselle González

As part of the Define Phase, the Voice of the Customer or better known as VOC was developed. The purpose of this tool is to understand and prioritize what the customer needs. The VOC was collected by interviews to the Manager, Group Leader, Process Owner, and Operators.

A SIPOC (Suppliers-Inputs-Process-Outputs-Customers) diagram was made. A SIPOC is a high level process map that helps to identify key inputs and outputs of the process and give a clear idea to the team to focus on customer and supplier relationships in the process. After observing the area and the manufacturing process the following SIPOC diagram (Figure 3) was made:

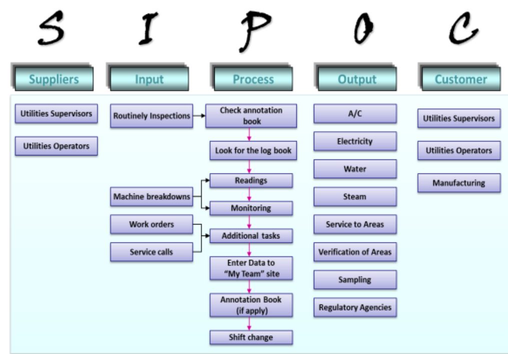

Figure 3
SIPOC

Measure Phase

This phase consists in collect the necessary data to see and understand the current state of the process which is the utilization of the utilities operators. This includes all tasks performed by operators. Different methods could be used to collect the necessary data, it is depending the problem and objective of the project. It is important to establish a data collection plan in order to determine where, how and when the data will be collected. Operator Utilization will be measured via direct observation of all shifts (1st, 2nd, 3rd, and 5th). The following will be extracted from the data for all them:

- Percentage (%) of time spent performing productive activities,
- Percentage (%) of time spent performing non-productive activities,
- Percentage (%) of time spent documenting.

Actually the Utilities Area does not have any measurement system established. The project is the first and principal data collection system. This system is very reliable but does not have all the details needed. A primary measurement system was developed after a brainstorming to have qualitative and quantitative data. A manual data collection system was developed. Those systems were:

- Checklist containing all the activities.
- A beeper that will emits a sound randomly.
- Go & See to determine the current state of the process.

- Stopwatch to measure the operators' time per activity, and motion from one place to another.

The beeper unit was set to sound aleatory 8 times per hour. Data will be collected in the designed checklist. The checklist consists in a pre-determine activity list. The study frame was: 30 days of study, 6 operators by the time data collection of the project begins. The Figure 4 shows data collection plan to be follow.

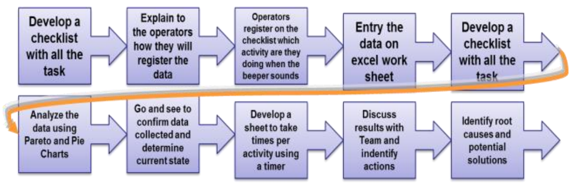

Figure 4
Data Collection Plan

The operator's activities were divided by several categories:

- Desk Documentation – All related documentation that the operators' uses in their daily work. Includes preparing, writing in hardcopy or in computer. Example: Shift Change Documentation, Correction documentation, etc.
- Inspections – All that requires the operator to go physically to the equipment or area and perform task. Example: Forklift Inspection Trench Inspection
- Field Readings – Everything that includes daily readings that needs to be taken by the operator. Example: Boilers, Air Compressors, Demins Area, etc.
- Monitoring – All related with the operator being present in a specific place for a specific time to assure that process is within equipment parameters. Example: Water System, USP Monitoring.
- Field Tasks – Actions that the operator needs to do because of repair or told to do. Example: Caution or anion Regeneration or Softener, Boilers Blowdown.
- Shift Change- Example: Shift Change, Reading Shift Change, Receiving Shift Change.
- Other – Activities related with telephone calls, or additional tasks not enlisted.
- Trainings
- Meetings
- Lunch

In order to demonstrate the Measurements System Analysis, data entry accuracy, all the baseline data entries were verified. The data collected manually was verified with the checklist sheets versus percent (%) of errors found in the data entries challenge. Sample size: 651 entries, Errors found: 16 entries (see Table 2).

Table 2
Measurement System Analysis

Shift	Beep	MSA	Errors
1st shift	153	153	0
2nd shift	195	185	10
3rd shift	186	181	5
5th shift	54	54	0
GL 1st shift	63	62	1
sample size	**651**	**635**	16
Difference	16		
Accuracy MS	97.54%		

The Table 3 and Table 4 represent a comparison between the activities and the percent of the time that they spent.

Table 3
Percentage of Tasks per Shift

Percentage

Activity	Overall	Shift 1 GL	Shift 1	Shift 2	Shift 3	Shift 5
Documentation	6%	11%	5%	3%	9%	2%
Inspection	5%	3%	5%	9%	2%	2%
Readings	33%	11%	44%	36%	37%	0%
Monitoring	14%	2%	11%	18%	17%	11%
Other	6%	10%	5%	5%	4%	19%
Preparations	2%	0%	3%	2%	1%	7%
Tasks	30%	55%	26%	25%	24%	53%
Verifying	4%	8%	1%	2%	6%	6%
Total	100%	100%	100%	100%	100%	100%

Table 4
Time of Tasks per Shift

hour:minutes

Activity	Overall	Shift 1 GL	Shift 1	Shift 2	Shift 3	Shift 5
Documentation	00:28.8	00:52.8	00:24.0	00:14.4	00:43.2	00:09.6
Inspection	00:24.0	00:14.4	00:24.0	00:43.2	00:09.6	00:09.6
Readings	02:38.4	00:52.8	03:31.0	02:52.0	02:57.6	00:00.0
Monitoring	01:07.0	00:09.6	00:52.8	01:26.0	01:21.0	00:52.8
Other	00:28.8	00:48.0	00:24.0	00:24.0	00:19.2	01:31.0
Preparations	00:09.6	00:00.0	00:14.4	00:09.6	00:05.0	00:33.6
Tasks	02:24.0	04:24.0	02:04.8	02:00.0	01:55.2	04:14.0
Verifying	00:19.2	00:38.4	00:04.8	00:09.6	00:28.8	00:28.8

The 1st shift shows that 44% of the time the Operator was taking readings, 26% on tasks, and 11% monitoring the areas. The 2nd shift shows that 36% of the time the Operator is taking readings, 25% on tasks, and 18% monitoring the areas. The 3rd shift shows that 38% of the time the Operator is taking readings, 24% on tasks, and 17% monitoring the areas. The 5th shift shows that 54% of the time the Operator is doing Tasks, 19% other type of activities, and 17% monitoring the areas.

The Table 5 shows approximately the Cost of Poor Quality for every interruption in systems due to lack of operator's availability. The cost was performed using labor cost of $31,346, a Cost of idle time of $6,184, and a cost of investigation process of $7,200. The total cost avoidance of poor quality is $67,541/year.

Table 5
Cost of Poor Quality

Improve Operator's Utilization - Arecibo				
Cost of Poor Quality				
A) Labor				
Utilities:	(w/y)*(d/w)*(h/w)=Operator's work (h/y)			
Weeks/year	days/week	hours/week	hours/year	
52	5	8	2080	
(operator's work)*(% desired)=hours to be better utilized				
hours/year	% of desired improvement	hrs to be better utilized		
2,080	20%	416		
(hrs to be better utilized)*(operator's rate/hour)*(operator's qty)=cost avoidance				
hours	operator's rate per hour ($)	operator's qty	cost avoidance	
416	15.07	5	$ 31,346	
*Cost avoidance is divided by 4 shifts				
B) Avoidance Operator Idle time (downtime)				
Note: Data colleted from January 2010 to July 2010				
One (1) Area (FB1236) and One (1) Operator were considered to perform this analysis				
Manufacture:	(hours of downtime)*(operator's rate/hour)=idle time			
hrs of downtime	operator's rate per hour ($)	idle time (downtime)		
375	16.49	$ 6,184		
C) Investigation Process				
Note: Data colleted from January 2010 to July				
Exent:	(Atypical events)*(rate/hr)*(people involved)(µ hours utilized)=cost of			
Atypical events	rate per hour ($)	people quantity	hours utilized	cost
12	30.00	4	5	$ 7,200.00
Benefit 1.51				
Cost of Poor Quality = [cost avoidance + idle time(downtime) + Cost of investigation process]*%benefits				
Cost of Poor Quality = $ 67,541 (cost avoidance)				

Analyze Phase

In this phase is where the results from the data collected and the root causes (x's) of documentation errors are obtained, and evaluated statistically. First, opportunities are identified, classified during the measure phase. This is by using statistical tools like Pareto Chart, to visually denote the frequency of each defect or opportunity for improvement This chart was helpful to prioritize and arrange the types of errors from major contributors to minor contributors to the problem. Readings and Tasks represents 80% of the time that the operator is busy.

A Big Y Analysis (Figure 5) was made to display the relationship among the customer's vision of the problem (Big Y), the stratification of the problem (little y's) and the causal factors affecting the problem (x's). The Big Y of this project was Operator's Utilization not having additional time to prevent fails. The little y's are arranged from general to specific, which are the activities performed by operators. Then a Prioritization Matrix (Figure 10) was developed in order to identify and prioritized in order to focus on solutions above with the High Impact and Easy to Do.

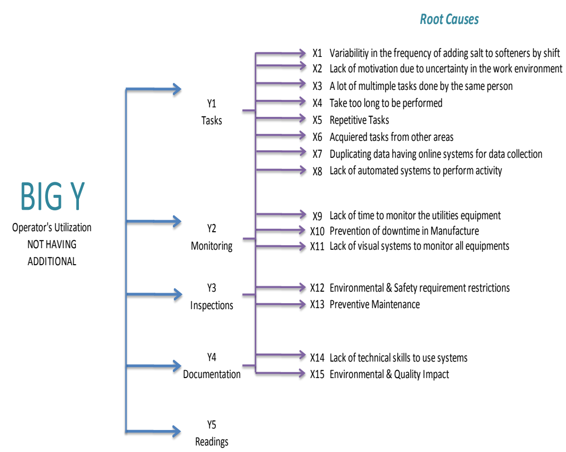

Figure 5
Big Y Analysis

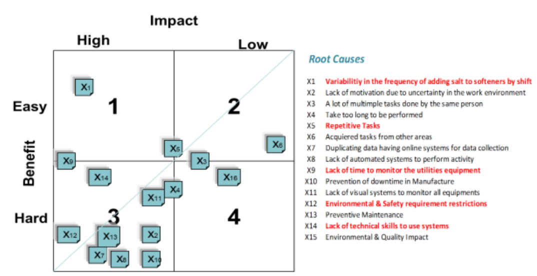

Figure 6
Prioritization Matrix

An Action Plan was developed to improve the Operators Utilization caused by excess of readings, tasks, monitoring, inspections during each shift in order to give them additional time to prevent fail on systems. These changes were made based on brainstorming, interviews and suggestions of operators, supervisors and process owner. 26 Actions were identified to impact Tasks (T), Documentation (D), Inspections (I) in order to reach the Project Goal of reducing 20% ± 10 Utilities Operator's Utilization.

The Table 6 shows the actual distribution of tasks per shift. A 30 days study was performed with 6 operators. The actual distribution per shift shows the time that the operator spent occupied the 1st shift spent 6.54 hours, 2nd shift 7 hours, 3rd shift 7.35 hours, and 5th shift 7 hours, respectively.

Table 6
Actual Operator's Distribution

Shift	Busy Time (HR)	Available Time (HR)
1st Shift	6.54	1.46
2nd Shift	7	1
3rd Shift	7.35	0.65
5th Shift	7	1

This analysis was performed using a task's list and a chronometer, taking times per operator and shifts. A sheet was used to count the time spent during the study, and every task performed during the shift. The purpose of this study is to determine how many times they spend on every task; also to identify non-value added activities.

As part of this project non-value added activities were discovered. Some of the wastes found were: Prasa & Waste Water Treatment Plant System (Over Processing) - Operators are taking readings every 2 hours, having a system which saves this data online. Equipment standardization (chlorine) (Waiting & Over Processing) - Operator utilize this equipment every time that they perform chlorine test. They spent around 5 minutes while standardization is complete. Chlorine & Hardness Test (Over Processing) - Operator perform this test 4 times on USP every 2 hours during a shift and 1 time in Potable Water. Chlorine Test on Potable Water (Over Processing) - Operators are taking this sample once during every shift, but exist a system which is sampling every 5 minutes and saves this data online.

Lack of discipline to integrate Tier (Re-work) - This tool can be used to avoid re-work performing troubleshooting, and let them know what was happening and or needed during the shift. Also, it can avoid duplicity of Preventive Maintenance activities. IP Tablet Computer (Re-work) - the use of this computer will help to avoid documentation errors, also to update the information that actually the operator is taking on handwrite and then pass the data to a spreadsheet on excel, and he can monitor the areas while he is out of the Energy Center. Lack of motivation due to uncertainty in the work environment (PEOPLE) - Waste of personal skills, Operators must be train using different tools (computer programs, corporation systems).

Waiting for security to open laboratory to take readings (Waiting) - Operators are taking laboratory readings during weekends and holidays, while there are personal of the laboratory present. The operator most of the time has to wait for a Security person to open the laboratory and sometimes this person is at other Plant. Salt' Replenishment (Transportation) - Operators must replenish salt in the Energy Center (EC), but they need a forklift truck, most of the time is not available and they have to wait until it's free to use. Distances between every point of readings (Motion) - Operators are most of the time on the field, when they are taking readings/inspections the distances between every point are far.

Improve Phase

An action plan was developed in order to achieve all the improvements needed to reduce operator's utilization (Table 8). This project was identifying opportunities by reducing waste and creating other tools to have a better visualization of the problems in the area. For each improvement training was given to Operators, Supervisors, Process Owner and Process Leader. These changes were made based on brainstorming, interviews and suggestions of operators, supervisors and process owner. Lack of visual aids as one of the opportunities identified. Figure 7 shows a before and after picture of the lack of standardization of adding salt to the tanks. A label showing the appropriate level of salt and the quantity needed by shift was added.

Figure 7
Visual Aids – Softeners Tanks

Figure 8 shows a Kanban for Caustic Solution in order to have it available all the time for all shifts. Every 6 empty gallons the Kanban must be activities and prepare solution. This implementation was needed because not all the operators prepared enough solution for all shifts; most of the time they prepared what was needed. Also this is useful in order to avoid accidents during the 3rd shift because of lack of light.

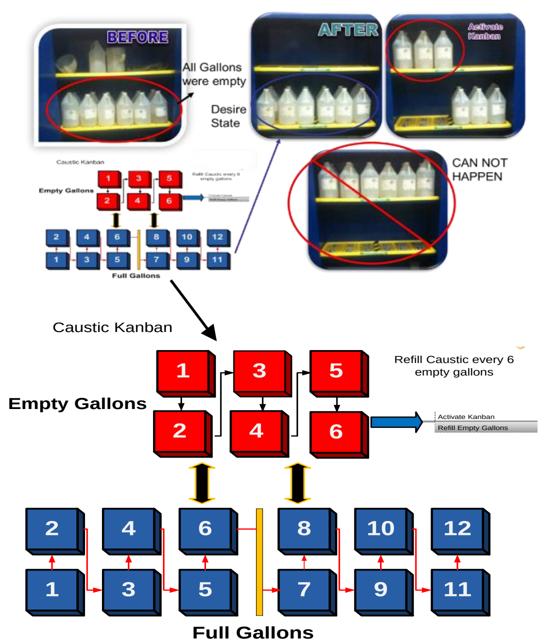

Figure 8
Caustic Solution Kanban

Equipment's inspection, which was performed twice (2) per shift, three (3) sheets. In those forms the operator must verify the compressors, dryers, generators, battery bank, chillers, and parshall plume. The frequency of the inspection was reduced to once (1) per shift, one (1) sheet.

Electronic Change Log was created, before they used a hardcopy book which consists in a excel spread sheet in which they can write all success during every shift. The benefit of changing to this method was that it is now a permanent document, its user friendly to access and use, user friendly to find past information, it is also helpful to everyone and it will make visible the operator's performance, equipment performance, utilities performance, improvement opportunities, problems will be visible, and equipment downtime. It also will show the monthly performance of the area.

Figure 9 shows an improvement to the actual Tier Board. It will have all the performance of the area visible, like Operator's schedule in order to know who's on duty, Utilities Metrics, to let them know how is the actual performance vs. goals, Operator's licenses, to keep a track of the renovations needed and do not incur in violations, Daily Shift/Operator Performance, the purpose is that the area can see how is their performance going on, Electronic Shift Change Log, Monthly Performance, the purpose is that the area can see their performance in overall by month, a list of the Recurrent Tasks by shift and with specific days in order to avoid violations, all notifications in way to avoid duplicity of Work Order, Preventive Maintenance, Special Tasks, and Opportunities Area.

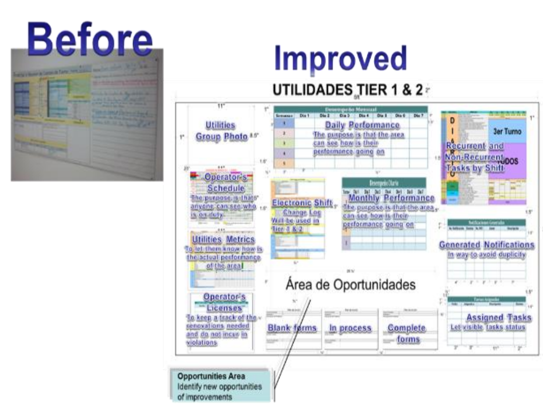

Figure 9
Tier Board Design

Table 7 represents reduction of Inspections before and after project.

Table 7
Reduction on Inspections

Before		After
Inspections	**Frequency**	**Frequency**
Equipment	Twice per shift	Once per shift
Fuel Tanks	Weekly	Monthly
Transformers Dykes	Weekly	Monthly
Chlorine & Hardness Sample Test on USP Water System	Every 2 hours (4 times per shift)	Every 4 hours (2 times per shift)
Thermal Oxidizer Log	Every 2 hours (4 times per shift) (even if it is not in use)	Will take readings only when it is in use

After implementations there every shift has time available. First shift will have 1.88 hours available, Second Shift 2.31 hours available, and Third shift 1.14 hours, time that will be used to monitoring and preventive fails on equipment. Implemented tasks improve a 15.2% of the operator's utilization for a total of $56,272 yearly. In the Transition Plan a 5.3% will be achieve for a 20.5% of improvements. Some of the identified opportunities were in Readings, which are Out of Scope.

Control Phase

As part of the control phase, a control plan was made to monitor and sustain the improvements made. A control plan was established to sustain the changes made on process batch records, to monitor the different operator's available time, performance, and equipment performance.

As part of the Control Plan, a Behavior Coaching and Consequences Management (BCCM) was created for the following reasons:

- Personal coaching is helping functioning individuals set and achieve goals, overcome obstacles and maintain motivation.
- Leaders and managers must assume roles as coaches in organizations that aspire to become learning organizations as a way to improve employees' performance.
- Manager's commitment to coaching has the potential to impact performance at the individual employee, manager, and organization level.

As part of the Control Phase an Electronic Change Shift Log and Board for Tier 1 & 2 was created. The main objective of the project was to Improve Operator's Utilization in way to give them additional time to prevent fails on equipment. The Board and the Electronic Shift Change Log will helps the Area to see a(n):

- Permanent Document on the system,
- User friendly to access and use,
- User friendly to find past logs,
- Useful for every Tier 1 & 2,
- Tendencies of fails on equipment,
- Equipment's downtime,
- Which equipment is failing and why,
- Operator's Performance,
- Equipment Performance,
- Utilities Performance,
- Opportunities for improvements,
- Problems will be visible,
- Can be used as part of the Utilities Metrics
- If the problems are visible we can prevent fails.

Conclusion and Recommendations

DMAIC provides structured tools that help to perform improvements in any environment that are applied. Lean Six Sigma methodology helps all industries to identify, evaluate and categorize opportunities of improvement taking in consideration the different impact and difficulties during the process. After implemented tasks the Operator's Utilization improved a 15.2% for a total of $56,272 yearly (cost avoidance). This implementation achieves the elimination of waste, and standardized work. These results, demonstrate that the design project used was successful, since goal, expectations and customer's needs were reached. Several tools were created in order to maintain standard and balanced shifts, as Electronic Change Log, Tiers, in order to compromise not only operators, managers as well.

The implementation of this tools allows the continuously flow of information in a simplified way to recognize equipment needs, opportunities, and also give visibility problems. After implementation and accomplishing project goals recommendations made to sustain improvements are to give twice per year, training to personnel of the expected behavior and goals to be achieved. The used of the DMAIC methodology to improve the operator's utilization were able to reach project goals. The tools used throughout each phase helped to learned and understand the process, the procedures and the people involved in it to achieve process outputs. The Tier 1 & 2 Board utilization will help to monitor and evaluate the areas and operator's performance made during each shift and month, discuss them with the operators and supervisors to obtain possible causes for them and suggestions on how to improve. Taking into consideration the opinion of the experts or the people who is affected by changes, many problems could be solved.

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