Adapting Lean Six Sigma for a Non-Profit Organization

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Abstract

Lean Six Sigma is a process improvement practice most commonly used in large scale manufacturing and health care industries to improve performance and efficiency. The goal of Lean Six Sigma is to improve efficiency, consistency, and focus on value added elements. Over the years, Lean Six Sigma has evolved from being primarily a manufacturing practice to serving more service based industries such as healthcare and government. However, Lean Six Sigma has yet to be implemented in the non-profit sector. This technical report outlines the importance of identifying the unique characteristics of the organization you wish to improve and then adapting lean six sigma techniques accordingly. This report will specifically look at the challenges faced by a non-profit organization, GRID Alternatives, and evaluate how Lean Six Sigma techniques can be adapted to improve their warehouse procedures and conditions.

What is Lean Six Sigma?

Lean Six Sigma is a methodology that focuses on continuous process improvement. Lean Six Sigma is a combination of Lean Manufacturing and Six Sigma. Lean Manufacturing focuses on people involvement, the business philosophy, doing the right thing, creating a more predictable process, and most importantly reducing waste. The eight types of waste in Lean are defects, overproduction, waiting, neglecting resources, transportation, inventory, motion, and extra processing. The goal is to develop "eyes for waste" so that you can recognize and eliminate the unnecessary or non-value added steps in a process. Six Sigma focuses on applied statistics, tools to improve business processes, creating a more capable process, and reducing process variation. Six Sigma really focuses on the numbers, the statistical definition of Six Sigma is striving for a process to be 99.9 percent capable and producing only 3.4 defects per million opportunities (DPMO). Six Sigma is about reducing the number of defects and errors while simultaneously lowering costs, saving time, and improving customer satisfaction.

Lean Manufacturing and Six Sigma together are much more powerful. Lean Six Sigma is defined as a "well-structured theory based methodology that improves performance, develops effective leadership, customer satisfaction and bottom line results" (Zhang). Lean Six Sigma is very project based and strives for continuous improvement.

Lean Six Sigma originally came from manufacturing industries and has now found its way to services. "Lean Six Sigma: A Literature Review" mentions that in addition to manufacturing Lean Six Sigma has also become very common in healthcare, since defects and

errors are even less tolerable in this industry. Lean Six Sigma is not only in healthcare and manufacturing but is also seen in government, the military, and financial services. Literature reveals that Lean Six Sigma is beneficial for different industries with little modifications per industry requirement. In addition, it has been stated that Lean Six Sigma is "equally beneficial for manufacturing or services concerns in large or small scale organizations" (Zhang). These finding come to show how applicable Lean Six Sigma can be in different organizations whether it's based on type of industry or size of the organization.

However, it is still suggested to continue research for implementing Lean Six Sigma where financial capability is a hurdle (Zhang), which brings our attention to a specific industry that needs more Lean Six Sigma implementation research: the nonprofit sector.

Nonprofit Case Studies

Currently, there are very few literary works that examine the implementation of Lean Six Sigma in the nonprofit sector. There is a case study by Chen-Yang Cheng and Pu-Yuan Chang from Tunghai University in Taichung, Taiwan that examined how to implement Lean Six Sigma in a non-profit organization that provided wheelchairs, walkers, and various assistive devices for people with disabilities. Their work is titled "Implementation of the Lean Six Sigma Framework in Non-profit Organisations: A Case Study." Cheng and Chang mention that prior to their case study, which took place in 2012, the Lean Six Sigma process had not yet been applied to non-profit organizations. Their case study demonstrates that they were able to improve efficiency by reducing transfer and delay times, and raising process cycle efficiency by 27% and 28% (Cheng, Chang). However, at the end of their case study, they emphasizes the importance of recognizing the unique characteristics of the non-profit organization you wish to improve stating that it can "provide a reference to improve the

efficiency of non-profit organizations' services." This case study reveals the importance of recognizing the culture and structure of the organization you plan to work with because it can reveal certain queues that may help improve different processes' within the organization.

Another relevant literary source is "The Role of Process Improvement in the Non-profit Organization" by Vikki C. Lassiter, a master student from the University of Pennsylvania. This thesis case study is different from Cheng and Chang's because it focuses on the application of the process improvement concepts in general and then applies those specific principles to nonprofit organizations. Process improvement in general is different from Lean Six Sigma because as Lassiter states Lean Six Sigma methods and tools are "somewhat limiting, since they tend to examine only individual processes rather than integrating these processes into an examination of the complete system at work within an organization." Lassiter looks at process improvement in non-profit organizations as a whole and assesses the understanding of process improvement culture in an organization as well as overall organizational growth.

These literary works support the purpose of this technical report demonstrating that there is a need for more Lean Six Sigma case studies in the nonprofit sector. This report also recognizes the importance of paying close attention to the unique characteristics of the non-profit organization services' and processes because they provide queues and references for not only improving process performance and efficiency but also help in creating a culture of understanding process improvement in the organization.

This report is a documentation of the implementation of Lean Six Sigma process improvement tools at GRID Alternatives' Warehouse, and the results and recommendations for adapting Lean Six Sigma for their specific needs. However, first it is important to

understand the type of organization that GRID Alternatives, what makes it unique and some challenges this organization faces.

What is a Nonprofit?

A non-profit is an organization that has no owner, stockholder or trustee that shares in the profits or losses of the organization. Nonprofits exist not to make revenue but to promote a mission that generally enhances community welfare (Lassiter). GRID Alternatives is a non-profit solar organization that provide solar electric systems for low income families. The GRID Alternatives' mission is to "make renewable energy technology and training available to underserved communities" (GRID Alternatives). The GRID Alternatives goal is not to make money but to provide a service for low income families. By installing solar, GRID Alternatives is not only reducing our carbon footprint, but is also providing families with energy savings and up to 10 volunteers per install with free solar job training (Non-profit group).

Common Nonprofit Challenges

Nonprofit organizations are faced with a variety of challenges on a day to day basis. Some of these challenges include a rapidly growing demand for their services, pressures to incorporate a fee for the services being provided, competition from for-profit organizations, and many more that require a consistent evaluation of ongoing organization effectiveness (Lassiter). GRID Alternatives for instance constantly faces all of these challenges. With the changing economy more and more homeowners are meeting the low income requirements and people are seeking job training opportunities. Therefore there is an increasing in demand for GRID Alternatives services.

In addition, to the growing demand for their services, GRID Alternatives also faces the pressure of charging a service fee. According to Energy Informative, solar electric systems are not cheap and states that "a residential electric systems cost upwards of thirty thousand dollars" (Non-profit group). In order to help finance the expenses of these solar electric systems GRID Alternatives has made an effort to partner with Third Party Owners (TPOs) to help cover the expenses. GRID Alternatives has also recently incorporated a homeowner contribution fee to help the program continue its efforts. Homeowners are asked to contribute two cents per kilowatt of energy their electric system generates every month. On average a homeowners pay about eight dollars a month to help the program continue its mission to providing energy savings and job training for underserved communities (Non-profit group).

Lastly, GRID Alternatives is also facing more and more competition from for-profit solar providers. Today, there are numerous solar company providers that sell and rent residential solar electric systems to homeowners, some of these companies include Solar City, Sun Run, Vivent Solar, and REC Solar. These companies are competitors to GRID Alternatives because they are selling or renting solar to homeowners who may have qualified for their services. To make matters worse, because they are for-profit companies they have more money to spend on marketing and advertising. Therefore, GRID Alternatives struggles to compete with these large for-profit organizations. Every low income home that receives solar from a for-profit company means that that is one less family that GRID Alternatives can provide a service too and one less install that could have been an opportunity to provide job training to the community. A growing demand for services, financial pressures, and competition from for-profit companies are just a few organizational challenges GRID

Alternatives faces. These challenges come to show that there is a need to consistently reevaluate the effectiveness of this organization's operations.

So how does Lean Six Sigma come into the mix? Well you see as Lassiter states "every organization, whether it is large, medium, or small, profit-driven or not-for-profit, has one thing in common: their operations requires processes. Processes are the fundamental way of thinking about operations and managing an organization." It is really important to plan a systematic way to measure, analyze, and improve organizational performance and Lean Six Sigma is a very applicable and methodological approach to do so.

However, it is important to clarify that the purpose of this report is to not to evaluate the operations of the GRID Alternatives organization as a whole but instead to look at a specific process and evaluate how effective that process performance is. Lean Six Sigma is about refining and continuously improving processes within an organization. Certainly the goal is improve the overall organization as a whole, but realistically speaking the best way to tackle such an enormous task is to look into the components of the organization and tweak, modify, and improve those smaller components. Therefore, for this particular case study we are going to focus on a GRID Alternatives Warehouse and implement Lean Six Sigma Tools to evaluate the performance of the warehouse procedures and conditions.

GRID Alternatives Warehouse

GRID Alternatives is a relatively large organization and has numerous offices in California alone, and also has offices in Colorado and New York. However, for this particular project we are going to focus on the Central Coast Office in Atascadero, California. Within this particular office we are going to take a look at the warehouse space and the procedures by which this warehouse operates.

This warehouse space is primarily used by the construction staff at GRID Alternatives. The warehouse is the area in which all the solar modules, conduit, hardware, supplies, and equipment are stored and kept. The construction staff not only uses this space to store all the supplies and equipment but also uses the space to prepare and load for a build as well as unload after a build. This case study will apply the DMAIC method to evaluate the performance of this warehouse space and use Lean Six Sigma tools to make suggestions on how to improve efficiency.

DMAIC Methodology

The DMAIC method stands for Define, Measure, Analyze, Improve, and Control. DMAIC is the main method for Lean Six Sigma implementation. It is used to identify problem areas, define root causes and constraints to an issue, measures current state processes, analyze the data and observations collected, make recommendations to improve the current state process, and then propose ways to control and monitor improvement changes. The DMAIC process was used to improve warehouse conditions and procedures at GRID Alternatives. The process was implemented over a period of 2 months and consisted of a phase for each DMAIC step. Each DMAIC step utilized at least 2 Lean tools to complete each phase. Some of the Lean tools used were: Fishbone Diagram, Five S, Five Whys, Standardized Work, Pareto Charts, and Time Studies.

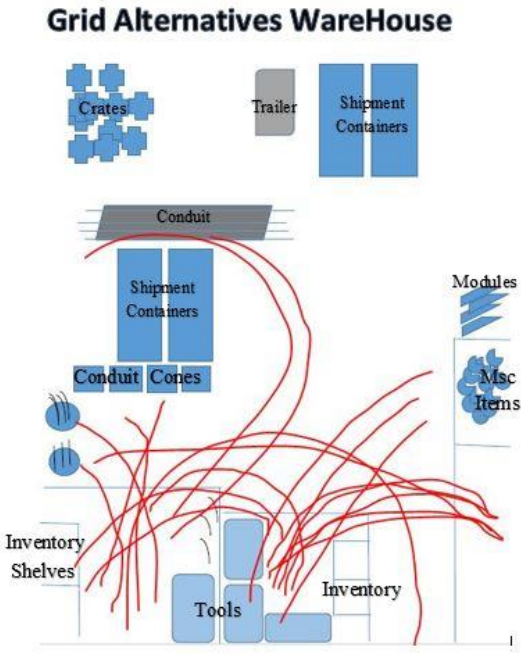
The Define phase of the GRID Alternatives Warehouse Improvement project consisted of staff interviews, a project charter, and a spaghetti diagram. The staff members that were interviewed for the define phase were Carlos Chairez, the Warehouse Manager, and Xavier Villazana, the Construction Manager. The reason these two staff members were selected to be interviewed in this phase of the project was because they were the most knowledgeable in how

the warehouse space was currently being used and they were the most familiar with procedures and issues being faced. Some of the questions that asked were: What is the most common bottleneck or constraint? What is the general process or procedure for how things get done? Who is responsible? What issues are most commonly neglected? The interview questions were particular designed to gather information about the reoccurring problems or issues. After interviews the next step was establishing a project charter.

A project charter was created to help define the scope, parameters, and mission of this warehouse improvement project. The project charter outlined deliverables, expectations, milestones, completion dates, and resources needed. This tool helped to clearly communicate the purpose, expectations, and deliverables of this project to the supervising sponsor, Carlos Chairez. The project charter stated that the problem was that it was taking the construction staff a really long time to load and unload the equipment before and after an installation build. The goal was to improve the current warehouse procedures and conditions and to make loading and unloading processes easier and quicker. In addition, the project scope also included making recommendations on how to improve warehouse processes and how to control the changes that were going to be implemented. In addition, to making suggestions on how to improve the warehouse this project was actually going to implementation the proposed plans. The project scope did not include monitoring long term warehouse progress.

A spaghetti diagram was also used in the define phase of this project to narrow the scope even further. The spaghetti diagram helped identify where in the warehouse space the process improvement project would take place. The spaghetti diagram outlined the layout of the warehouse work space and illustrated the physical flow of materials/equipment relative to their physical location. Especially, when construction staff loaded and unloaded equipment before and

after an installation build. ***Figure 1*** below shows the material and equipment flow in red and reveals that the majority of the material flow is in the inventory shelves and tools area and very



little to no flow occurs in the shipment container and crates area.

Figure 1 Spaghetti Diagram used in Define phase illustrates the work flow and material flow at the GRID Alternatives Warehouse space.

The interviews revealed the problem, the project charter outlined the project goals and plans and the spaghetti diagram showed the specific problem area. The following step in the DMAIC process is measure.

The Measure phase for this project consisted of a Pareto chart and a Time study. A Pareto chart was used to measure the frequency of reoccurring issues and was then used to rank the priority of each issue in descending order. The ***Figure 2*** below is the Pareto chart that was created and to help determine which issues to address first. The Pareto chart show that the most reoccurring issues were: old and outdated inventory taking up space, the need to trash or recycle miscellaneous items, and the need sort and organize unloaded equipment. These 3 issues alone

accounted for 79% of the warehouse procedures and conditions problems. Therefore, the Pareto chart suggests that these issues had the greatest priority.

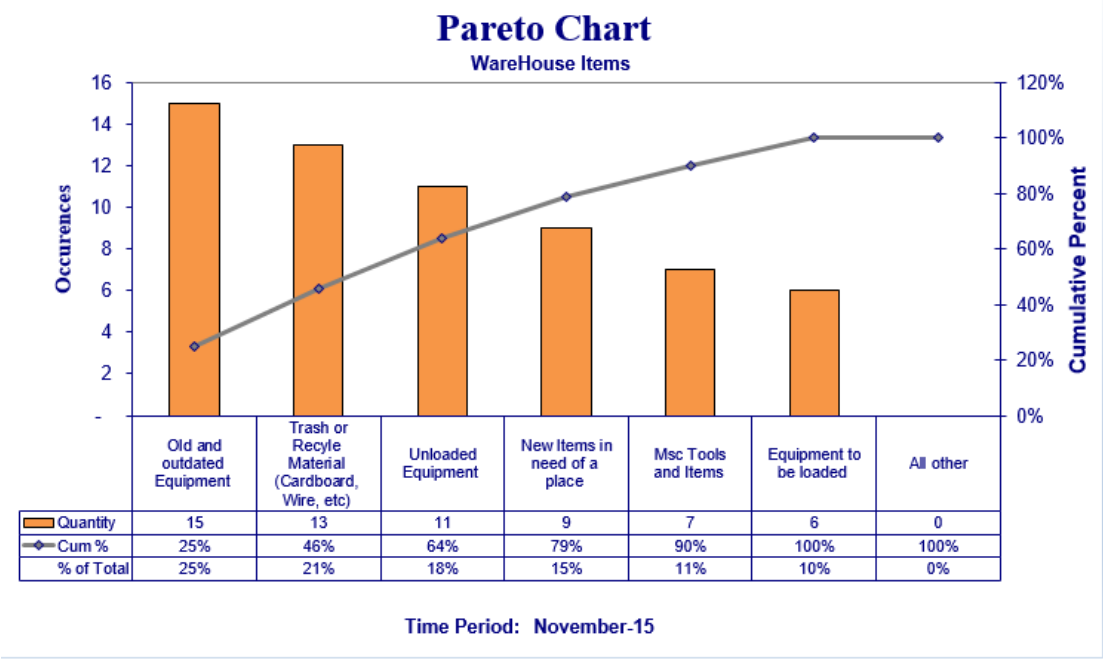


Figure 2 A Parto Chart was created in the measure phase to identify the most reoccurring issues in the loading and unloading process.

Next, a Direct Time Motion study was conducted to determine how long it was really taking the construction staff to load and unload equipment and supplies after a build. The Direct Time Motion study measured cycle time, including a performance and allowance rating and calculated normal and standard time. The Direct Time Motion study was useful because it helped determine the approximate amount of time it took to complete specific task (cycle time). Normal time is the basic time it takes to complete a specified task and is calculated by multiplying the performance rating (difficulty of task) and the cycle time of each process step and then adding all those times. Standard time is the time it takes to complete a specified task while taking allowances or break time into consideration. The standard time is calculated by adding basic time and allowances. The figure below show the data that was collected for this time study.

Date Collected:	11/4/2015	**WareHouse Manager**
Time:	9:00:00 AM-11:00AM	
Data Taken By:	Jocelyn DeLeon	
Subject Performing Task:	Carlos Chiarez	

Working Conditons: Cold weather conditions, outside, of walk space, and low volume music
Tools/Equipment: Pocket Knife, Tape, Sharpie, Screw Driver
Irregular Elements: Walking up to the office to pick up items

(sec)	Element Description	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6	Cycle 7	Cycle 8	Cycle 9	Element Average	Performance Rating
Element 1	Return and Store Equipment	60.0	120.0	30.0	50.0	180.0	150.0	125.0	90.0	100.0	100.6	1
Element 2	Restock Inventory	45.0	60.0	120.0	180.0	30.0	65.0	190.0	88.0	90.0	96.4	1
Element 3	Sorting through Items	180.0	240.0	120.0	300.0	360.0	200.0	400.0	100.0	210.0	233.3	1
Total:		285.0	420.0	270.0	530.0	570.0	415.0	715.0	278.0	400.0	430.3	1

Allowance:	22%	Personal Allowance for standing, cold weather, walking up, down,back, and forth, and lifting items and boxes.
Normal Time:	7.17	min
Standard Time:	8.75	min

Figure 3 This is the Time Study data collection table which shows that the standard time was 8.75 min and normal times was 7.17 min.

This Direct Time Motion study indicates that the normal time to sort through items, return and store an item to its designated location, and position or restock accordingly, took approximately seven minutes. When considering an allowance of 22% due to the weather conditions, standing for long periods of time, lifting, and bending the standard time to complete these tasks was about nine minutes. The performance rating or difficulty of each element/ task in the process was one meaning that they had relatively low complexity ratings. The average cycle time to return and store equipment was about 2 minutes, to sort through items was about 4 minutes, and to position or restock accordingly was about 1 minute. Therefore, on average the most time consuming element was to sort through miscellaneous items. The measure phase identified which issues were occurring the most: old and outdated inventory were taking up space, miscellaneous items needed to be trashed or recycled, and unloaded items needed to be sorted and organized, and which task took the longest to do: sorting through items. The next phase was to analyze these issues and tasks in attempt to discover the root causes.

The Analyze phase consisted of a fishbone diagram and 5 Why 1 How analysis. These Lean Six Sigma Tools were used in the analyze phase because they helped investigate the root causes, issues, and determining factors for why the construction staff was taking so long to load and unload equipment before and after an installation build.

This Fishbone diagram showed that the key factors that were affecting the warehouse conditions were the people, material, equipment, and procedures. The people that had the greatest impact on the warehouse environment was the warehouse manager and construction staff. The most common issues with regards to material, machines, and equipment was that items were misplaced, old, or outdated. In addition, the most complex and time consuming process was sorting through inventory and finding a place to store items. The figure below shows the Fishbone diagram that was created to assess the different factors and issues in the warehouse.

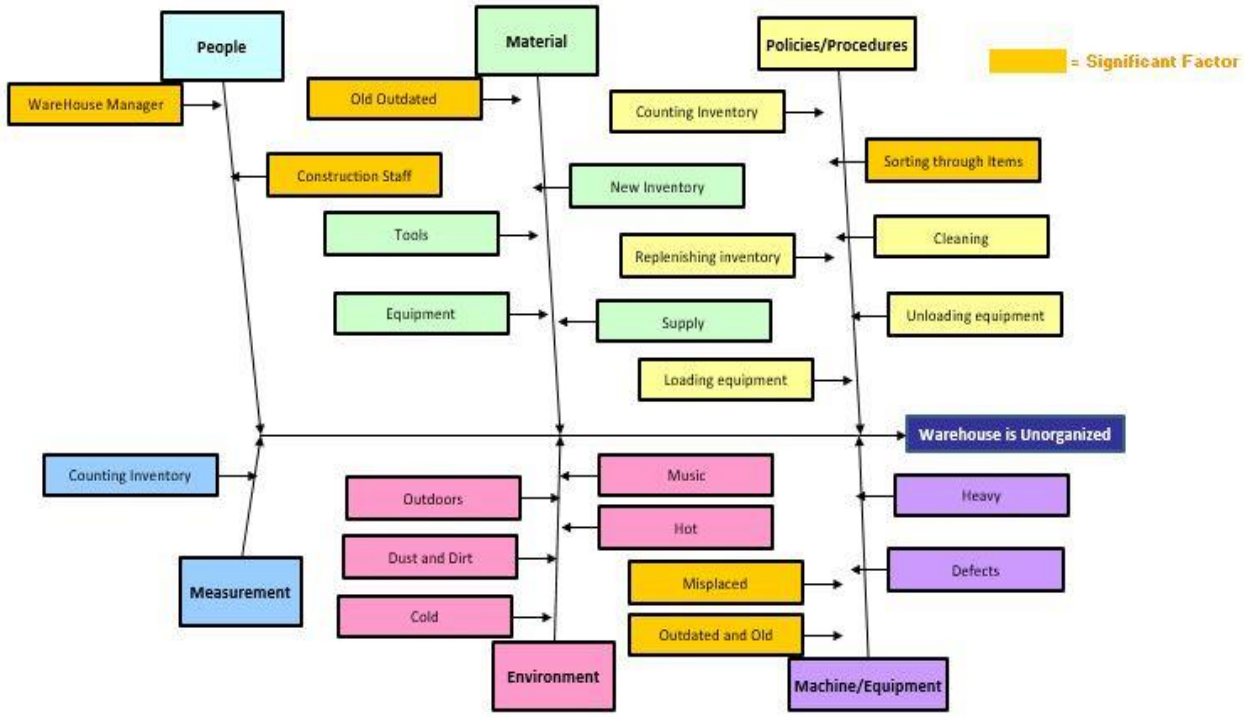


Figure 4 This Fishbone Diagram was used in the analyze phase and highlights the significant factors: the warehouse manager, construction staff, old outdated material and equipment, misplaced equipment, and the sorting through items process when loading and unloading after a construction build.

The 5 Why-1 How analysis tool was then used to delve deeper in the issues highlighted in the Fishbone Diagram. The 5 Why analysis tool helps gain a better understanding of how the warehouse issues are related in terms of cause and effect. ***Figure 5*** below shows the 5 Why –1 How analysis and shows that the root cause for why the warehouse conditions are not as organized as they could be, is because the warehouse space is understaffed and the person currently maintaining the warehouse is overworked. Therefore, regular warehouse procedures were being neglected and items were accumulating fast, making the sorting and storing of items time consuming to do. Now that the root causes had been identified the next step was to determine what actions to take to improve the warehouse space.

5 Why-1 How Analysis

Symptom:	The current inventory system is not as organized as it could be.
	Why?
Symptom:	There are inventory items that have no designated location.
	Why?
Symptom:	There is no room or space available in warehouse for new items.
	Why?
Symptom:	There are old inventory items that haven't been thrown out or recycled.
	Why?
Symptom:	Difficult to find the time to sort through all the inventory items.
	Why?
Root Cause:	Warehouse manager is overworked and has numerous responsibilities.
Counter Measure:	**How?**
Work with supervisor to schedule a time devoted to specifically working in the Warehouse and communicate that the warehouse is understaffed to get assistance.	

Figure 5 A 5 Why and 1 How Analysis tool was used in the analyze phase to identify the possible root cause for why the current inventory system was not as organized as it could be.

The Improve Phase was about identifying which lean tools could be used to improve the warehouse conditions and procedures. The team leader and sponsor determined that a 5S and Kanban projects would be best improvement project to do because it would help standardize the warehouse space.

5S is an organizational tool that is used to improve visual controls in a workspace, reinforce safety practices, and support worker performance. 5 S stands for Sort, Straighten, Standardize, Scrub, and Sustain. This tool was selected because it would help organize warehouse inventory and procedures. In addition, 5S could help decrease time spent searching for tools or supplies.

The 5S plan was to sort inventory items according to use: in use vs non-opened (new). All items were also to be straightened by grouping items of similar function and use, returning items to original storage location, and positioning all the items according to inventory levels. For standardization, items were to be designated a permanent area and labeled or tagged for visual controls. The warehouse was to be kept clean by wiping down surfaces, keeping walkways and work areas clear, and keeping inventory off the floor and in boxes or packaging. Lastly, for sustaining organization a Kanban replenishment system, a check process, and visual controls were to be implemented. The 5S plan is shown below in ***Figure 6.***

5S	
Sort	Sort between new and old Items to identify disposalable, reusable, recyable items. Separate open/in use packages from closed/back up inventory items.
Straighten	Sort by similar function (Tools, Modules, Conduit, Bits, etc), use based on position, restock and return items to designated area.
Standardize	Create designated areas for different types of inventory items (Loading, Unloading, Supplies, Tools,etc.) Use labels and red tags
Scrub	Keep Inventory off Floor, Store in Tool Boxes or Orginal Packaging Dust, Wipe Down Surfaces, Keep Workstations Clean and Organized
Sustain	Implement 2 Bin Kanban Replishment System, Check Process, Visual Controls

Figure 6 A 5S plan was created to help improve the current warehouse space conditions.

A Kanban Replenishment system was also planned to organize the equipment, tools, and supplies because Kanban's specify how many parts or items need to be restocked. Kanban systems also eliminate waste by preventing the accumulation of excess inventory and visual obstructions, preserving storage space, reducing long cycle times, and avoiding unnecessary inventory transactions. A two bin Kanban replenishment system was specifically recommended to aid inventory replenishment. The two bins system is meant to communicate when there is and isn't a need to replenish. The bins are to be placed in front of one another and ideally in two different colors (ex. red and blue). For example, when the red bin is in front then that indicates to replenish the inventory stock (alert) and if the blue bin is in front then do not replenish. In addition, to the different colored bins it was also proposed to attach tags and barcodes on the bins. The tags were to be labeled "restock" and "stock card." These tags are to be visual controls that clearly communicate and reinforce inventory status this is in addition to the color coded bins. Another proposed idea was to incorporate a barcode system that corresponded vendor and inventory status which could help simplify the replenishment process. The ***Figures 7 and 8*** below show examples of what a two bin Kanban system could look like. Now that the plan on how to improve the warehouse was decided on it was time to brainstorm how the improvement changes would be maintained.

Figure 7 Example of Kanban bins with visual control stock cards.

Figure 8 Example of color coded Kanban bins.

For the Control phase of the DMAIC process the team leader and sponsor brainstormed methods and tools that could be used to sustain the improvement changes in the warehouse. They proposed that a Check Process and a Control Plan would to be implemented.

A Check Process is a quick and effective verification tool that can be used to evaluate process conformance. This tool was proposed because it could be used as a guideline to make sure that the basics were consistently met. The Check Process stands for Correct, Housekeeping, Equipment, Contain, and Keep Doing it and these are the metrics the Check Process accounts for.

For each Check Process measure it is important to include questions that truly reflect the current state. For instance, for the Correct measure the question to be asked is "Are tools, equipment, and materials in their designated location? Or are items labeled and stored correctly?" For Housekeeping, it was proposed to ask questions about workspace cleanliness, organization, safety hazards, and whether or not there was an ample and comfortable amount of space to work in. For the Equipment measure, questions tried to verify if equipment was in proper working condition, was well calibrated, and accounted for in the inventory. For Containment the measures ensured that defects or mishaps had not passed on to the following steps in the process. And lastly, the Check Process asks and makes sure that process is

consistently being done and is part of the daily routine. ***Figure 9*** below shows the Check Process in greater detail.

CHECK PROCESS	
Correct	Verify that Staff is following correct Warehouse practices.
☐	Are Warehouse staff trained and aware of procedures?
☐	Are Visual Instructions & Maps available?
☐	Do staff know acceptance standards of tools, equipment, & supplies?
☐	Are the specified Procedures, Methods, and Guidelines being used?
Housekeeping	Verify clean and orderly stations
☐	Is the workspace clean and organized?
☐	Is the workspace ample and comfortable to work in?
☐	Confirm that there are no safety hazards or awkward ergonomics.
Equipment	Verify Equipment and Tooling is in proper working order and calibrated.
☐	Is there documentation or record of equipment conditions and operations?
☐	Are tools, equipment, and supplies in inventory database?
☐	Are tools, equipment, and supplies up code standards?
Contain	Confirm process to ensure that defects are not passed on to next step in process.
☐	Is there a means to identify defects?
☐	Is there a means to repare or correct defects?
Keep Doing It	Make the CHECK process part of the **daily** rountine.
☐	Continually verify the conditions every shift using the CHECK process. **CONSISTENT ATTENTION IS THE KEY TO SUCCESS**

Figure 9 Check Process plan to help maintain the improved conditions of Warehouse space.

The other control tool was to implement a Control Plan, which is a centralized document that keeps track of the status of all significant process characteristics. This tools was recommended to help control warehouse conditions because it would provide a visual record of project status and aid as a reminder to get certain tasks done that may affect process flow. The proposed processes to keep track of in the Control Plan were inspections for inventory standards, trash, reuse, and recycle items, and safety inspections. These are useful processes to keep track of because they could alert the warehouse manager of the urgency or need to follow up with a certain action and how often. The control plan is very useful because it really helps reinforce the

Lean principle of continuous improvement. The figure below shows the Control Plan in greater detail.

Grid Alternatives Warehouse and Inventory Database

Revision Number

Key Contact: Carlos Chiarez
Phone: (805)769-0629

Control Plan

Date 11/1/2015

Process	Process Step	Critical to Quality Characteristic	Sig Char #	Significant Characteristic Description	Measurement Technique	Chart Champion	Chart Location	Measurement Study	Process Stability	Reaction Plan
Inventory Standard Inspection	Inspect Equipment for outdated/ uncompliant parts	Up to Code Standards, Compatiable with Current Electric Module kits and systems	2	Code Standards, System Compliance	In the Excel or Inventory Database keep track of up to date and outdated items	C.C.	SOP	Y/N	-	Every 30 days
Trash, Reuse, or Recyle Items	Sort through the msc material and items to determine whether to recyle, reuse, or trash	determine whether or not items add value if not discard appriopratel y	2	Keep Workspace clean and organized	Create a designated location for trash, reuse, and recyle items (loading area) then based on amounts or overflow address	C.C.	SOP	Y/N	-	Once a week
Safety Inspection	Inspect Equipment for defects or safety concerns	Up to Code Standards, Durable, Reliable, and Safe to use	1	Up to Safety Code Standards and Regulations	Determine a CTQC to determine whether an item is safe to use, meet certain requirement, make note on label or item for reference	C.C.	SOP	Y/N	-	Biweekly

Figure 10 The control plan to help keep track of the status of improvement tasks.

The discoveries and proposed project plans that resulted from the DMAIC process steps were to implement 5S, a Kanban Replenishment system, a Check Process, and a Control Plan. The goal was to standardize inventory items and procedures by eliminating tedious tasks such has having to continuously sort and organize items and creating a designated spot and location for all items so that they could easily be put back in their spot and found. Even though these proposed plans for improving the warehouse procedures and conditions were valid and logical using the DMAIC method, the actual implementation of these project didn't exactly go as planned.

Implementation of Improvement Plan

Carlos Chairez, the warehouse manager and I spent about 3 weeks cleaning, sorting, organizing, and standardizing the warehouse tools and shelves area. We sorted through miscellaneous items such as trash, recyclable items, outdated inventory items, current

inventory items, and new delivered items. We then got rid of outdated and recyclable items to create space for the current and new inventory items. We then created permanent designated areas for the different items, tools, and equipment and created stations for the different activities/ tasks that took place in the warehouse space. For instance, we made a loading table area in the shed, an unloading table in the open space shed, and a drop off table for new inventory items that are delivered. The warehouse manager and I decided to created different work station areas so that the different types of inventory items would be kept separate from one another. At each work or task station we also included different accommodations to simplify the processes at each station. At the unloading table we added bins where employees could easily leave or pull loose bits, nails, and screws after each build. Then the loading table inside the shed was designed so that inventory stock items could be pulled and loaded into the large storage bins that get loaded into the construction trailer and the new inventory items table has plenty of open space to separate items by type. Lastly, we labeled each shelf according to the type or group of item that was stored there and we also labeled each container according to its contents. ***Figures 11 and 12*** below show the before and after conditions of the warehouse shelves and tool area.

What made this particular implementation project unique was that the warehouse manager and I had to be creative and resourceful when implementing our warehouse improvement plan keeping in mind that there was little to no funds to support our project. First, space was limited and not all items had a designated storage location so rather than investing in more storage space such as expanding the warehouse tools and shelves area we decided to make better use of the space we had. So that was why we trashed, repurposed, and recycled items we didn't need or use. Second, we didn't have the funds to buy new shelves/

cabinet space or buy bins to sort and store all the inventory items. So what Chairez and I did was make our own new shelves using wood pallets that weren't being used and transformed a compartment cart in to separate shelves, and used the railing of the cart to mount on the wall and create an additional shelf space. The different colored bins of the compartment cart were also used to group different item types by color. For example, yellow bins were used for conduit items, blue bins were used for junction box items, and red bins were used for miscellaneous hardware bits. ***Figure 11*** show an image on bottom right corner of the compartment cart that was transformed into separate bins and shelf space. All in all, Chiarez and I sorted through the different items in the warehouse shelves and tool area, created more open space for different work stations and inventory items, designated specific locations for different items, and labeled each shelf and bin accordingly. The next phase of this improvement project was to test if our project had been effective.

Figure 11 The image above shows the initial conditions of the warehouse shelves and tools area before the warehouse improvement project began. It also includes the standard lead

time of 8 min which is the time it took an employees to start unloading an item and then finish and return it to its designated location.

Figure 12 The images in this figure show the after conditions of the warehouse tools and shelves areas and shows the labeled shelves, open space, new shelves, and work stations. The image also shows that after conditions were improved the new standard lead time was 3.5 minutes.

Results and Usability Study

Once the warehouse improvement project had been implemented a direct time motion study was conducted to test whether or not the time to load and unload items after a construction build had changed. Similar to the initial time study conducted in the define phase of the DMAIC process, employees were timed from when they unloaded an item from the construction trailer and finished returning an item to its location or original condition. The initial lead time for staff to load and unload after a build was about 8 minutes per task or activity. However, after implementing the improvement project in the warehouse space the lead time decreased to about 3.5 minutes per task or activity. The time study revealed that the change was significant, and construction staff would being saving about 4.5 minutes with the

new changes. In addition, to verifying that lead time had changed it was also important to test how legible the warehouse space was to others.

Reducing the lead time for construction staff to load and unload after a build was the initial goal, Chairez and I set to improve. However, we came to realize that it would also be beneficial to create a usability test to see how legible the space was to someone who isn't necessarily familiar with the warehouse. We thought that if we had really standardized and simplified the warehouse space then that meant that anyone could find what they needed and find their way around the warehouse. So we decided to work on designing a usability test. We figured that this would be a beneficial study to conduct because it could not only tell us how well we improved the space but also reveal some great insight as to how we could continue to improve the warehouse space. The fundamental principle of Lean Six Sigma is continuous improvement which is why this usability study was so important.

The design of the usability study was that at least two GRID Alternatives staff members not in the construction department, would participate and each receive the same sample Bill of Materials for a random installation build and ask them to locate the items on the list. The participants would have 15 minutes to find as many items as they can and would also be provided with a map of the warehouse shelves and tools areas to help the get a better understanding of the space. **Figures 13 and 14** below show the sample BOM and maps used for the study.

BILL OF MATERIALS

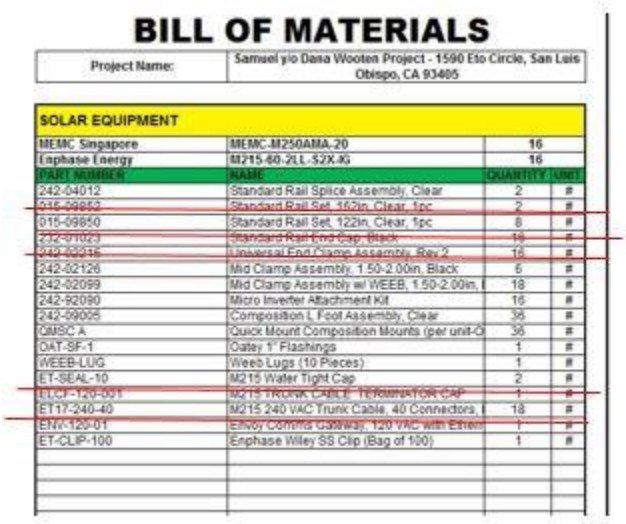
Project Name:	Samuel y/o Dana Wooten Project - 1590 Eto Circle, San Luis Obispo, CA 93405		
SOLAR EQUIPMENT			
MEMC Singapore	MEMC-M250AMA-20	16	
Enphase Energy	M215-60-2LL-S2X-IG	16	
PART NUMBER	**NAME**	**QUANTITY**	**UNIT**
242-04012	Standard Rail Splice Assembly, Clear	2	#
015-09852	Standard Rail Set, 162in, Clear, 1pc	2	#
015-09850	Standard Rail Set, 122in, Clear, 1pc	8	#
232-01023	Standard Rail End Cap, Black	16	#
242-02215	Universal End Clamp Assembly, Rev 2	16	#
242-02126	Mid Clamp Assembly, 1.50-2.00in, Black	6	#
242-02099	Mid Clamp Assembly w/ WEEB, 1.50-2.00in,	18	#
242-92090	Micro Inverter Attachment Kit	16	#
242-09005	Composition L Foot Assembly, Clear	36	#
QMSC A	Quick Mount Composition Mounts (per unit-O	36	#
OAT-SF-1	Oatey 1" Flashings	1	#
WEEB-LUG	Weeb Lugs (10 Pieces)	1	#
ET-SEAL-10	M215 Water Tight Cap	2	#
ELCF-120-001	M215 TRUNK CABLE TERMINATOR CAP	1	#
ET17-240-40	M215 240 VAC Trunk Cable, 40 Connectors,	18	#
ENV-120-01	Envoy Comms Gateway, 120 VAC with Ethern	1	#
ET-CLIP-100	Enphase Wiley SS Clip (Bag of 100)	1	#

Figure 13 The sample BOM list that was used for the Usability Study.

Figure 14 Illustrations of the warehouse set up in the uncovered shed area in the warehouse. This figure was used in the usability study to familiarize participants with the space.

When we tested the usability study we had a two participants' one from the workforce and development department and the other from the headquarters team. Neither of these participants were familiar with the logistics and set up of the construction warehouse space. Chairez and I led the study and we gave each participant maps of the warehouse space and a Bill of Materials. They had 15 minutes to find as many items on the list and in the end the

results were: workforce and development participant found 9 out of 17 items on the list and the headquarters intern found 11 out of 17 items on the list. ***Figure 15*** below shows the BOM with red lines for the missing items that the headquarters intern missed.



BILL OF MATERIALS

Project Name:	Samuel y/o Dana Wooten Project - 1590 Eto Circle, San Luis Obispo, CA 93405		
SOLAR EQUIPMENT			
MEMC Singapore	MEMC-M250AMA-20	16	
Enphase Energy	M215-60-2LL-S2X-IG	16	
PART NUMBER	NAME	QUANTITY	UNIT
242-04012	Standard Rail Splice Assembly, Clear	2	#
015-09852	Standard Rail Set, 162in, Clear, 1pc	2	#
015-09850	Standard Rail Set, 122in, Clear, 1pc	8	#
242-01003	Standard Rail End Cap, Black	16	#
242-02216	Universal End Clamp Assembly, Rev 2	16	#
242-02126	Mid Clamp Assembly, 1.50-2.00in, Black	6	#
242-02099	Mid Clamp Assembly w/ WEEB, 1.50-2.00in, I	18	#
242-92090	Micro Inverter Attachment Kit	16	#
242-09005	Composition L Foot Assembly, Clear	36	#
QMSC A	Quick Mount Composition Mounts (per unit-O	36	#
QAT-SF-1	Oatey 1" Flashings	1	#
WEEB-LUG	Weeb Lugs (10 Pieces)	1	#
ET-SEAL-10	M215 Water Tight Cap	2	#
ET-CP-120-001	M215 TRUNK CABLE TERMINATOR CAP	1	#
ET17-240-40	M215 240 VAC Trunk Cable, 40 Connectors, I	18	#
ENV-120-01	Envoy Comms Gateway, 120 VAC with Ether	1	#
ET-CLIP-100	Enphase Wiley SS Clip (Bag of 100)	1	#

Figure 15 The list of BOM from the usability test of the headquarters intern who got 11 out of 17 items correct.

The usability study revealed some insightful recommendations to continue improving the warehouse space and conditions. For instance, the study results themselves showed specific items on the bill of material that were difficult to find for both participants which indicates that perhaps they weren't placed in a legible or intuitive location or need to be labeled differently. In addition, the design of the study itself gave Chairez and I the idea to putting up maps of the shelves and tools areas for construction staff to also see and reference to not only help them find items but also know where items are expected to be returned and kept. Another idea, that came to mind was making modifications to the bill of materials and group certain items on the list to reduce the amount of walking back and forth finding items in different locations. All in all, the usability study was very helpful because it really helped reinforce the Lean Six Sigma philosophy of continuous improvement.

Adapting Lean Six Sigma to GRID Alternatives

Implementing Lean Six Sigma at the GRID Alternatives warehouse was effective and we were able to demonstrate a positive change. However, realistically it is important to think what impact did this warehouse improvement project have on the organization as a whole and how can Lean Six Sigma be adapted so that GRID Alternatives, the nonprofit organization not just the warehouse can implement this practice. Lean Six Sigma is a very practical and applicable methodology however it does require to be modified depending on the project and especially the organization. The case studies previously mentioned in this report highlighted the importance recognizing and paying attention to the unique characteristics of the project or organization you wish to apply Lean Six Sigma to. That is why it is important to understand that the culture of an organization in order to begin to adapt lean six sigma accordingly. GRID Alternatives is a laid back and casual organization and the best way to encourage Lean Six Sigma practice is to model the behavior. This can be done as simply as posting images or maps of how a certain area is expected to be maintained. In addition to modeling the behavior it is very important to communicate to staff or team members what the goals are and explaining Lean Six Sigma in way that is relevant and applicable to them, such as continuing to make tweaks to task to make it easier and less time consuming to do. Also, feedback and input from staff and team members is very helpful to make the practice more beneficial for both parties. Improvement projects should be a continuous team effort and really encourage participation, and especially in a nonprofit organization where the team dynamic is so strong. Lastly, it is important to be flexible and resourceful, nonprofits face constant variability and random factors that it is best to learn to work with what you've got and be open minded to change.

Conclusion

Lean Six Sigma is a process improvement methodology that is transitioning from being a not just a manufacturing technique but also a practice that is being developed in service based industries. The nonprofit industry is a service based sector that can particularly benefit from the Lean Six Sigma Methodology. Nonprofits faces numerous challenges and constant variability on a daily basis that the need for standardization, steady process flow, and consistency is crucial. A couple case studies in the nonprofit sector have been documented, however there continues to be a need for further research. That is why this report serves as an addition to the existing implementation research of LSS. I applied Leans Six Sigma tools and the DMAIC process to develop an improvement project at the GRID Alternatives warehouse. I applied more than one tool for each step in the DMAIC process to gather as much information as I could about the current state of the warehouse and also came up with an implementation plan with Carlos Chairez, the warehouse manager. We then implemented our plan and were able to verify an improvement of 4.5 minutes. We were able to reduce lead time from 8.5 minutes per task in loading/unloading after a build to 3.5 minutes. In addition, to improving lead time we also designed a usability study to test how legible the warehouse space was to a non-construction staff member. The results from this study came to show that there is still a work to be done to continue to improve the warehouse space. The study specifically highlighted items that weren't necessarily intuitive to find and also gave us insight on that perhaps we could also improve the Bill of Materials spreadsheet layout as well incorporating layout maps in the warehouse for employees to reference. The usability study was extremely important because it really helped reinforce the philosophy of continuous improvement in Lean Six Sigma. Lastly, in the end I was able to take a step back and reflect on the bigger picture and yes we were able to implement a Lean Six Sigma

process improvement project at the GRID Warehouse but how does that relate to incorporating and adapting Lean Six Sigma for GRID. Adapting Lean Six Sigma to the GRID Alternatives culture means flexibility, open communication, resourcefulness, standardization, and team effort.

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