Use of Quality Management Tools to Improve the Operations of a Flag Production Company

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Abstract *— The objective of this research is to improve the operations of a Flag Production Company by the use of Quality Management techniques. Small companies have been struggling these days on being competitive against big chains. The success of small companies relies on how they manage on achieving operational excellence. The main purpose of this research consists in determining which activities generate waste in FFTU flag production. This project was developed by following the guidance offered by the Six Sigma strategy phases of Define-Measure-Analyze-Improve-Control (DMAIC) along with the integration of the Lean Manufacturing tools. SIPOC high level mapping will aided in determining where to concentrate the efforts. Value Stream Mapping activities will help identify the cycle time of the process and what will be the outcome of a future improved value stream. Visual Management activities aid the production by obtaining the necessary tools when needed and to guaranty safety work conditions.*

Key Terms *— DMAIC, Lean Six Sigma, Value Stream Mapping, Visual Management.*

PROBLEM STATEMENT

Small companies have been struggling these days on being competitive against big chains. The success of small companies relies on how they manage on achieving operational excellence. A state of performance excellence is achieved by greater levels of quality. It is known that small companies tend to have bigger prizes than big companies so the only way to obtaining a place on the market share is by improving their processes. Customers often accept paying more for products of greater quality. It is vital for the success of a company to adhere to quality transformation initiatives to maintain some competitive advantage. For example, by understanding the value stream of a product you can identify areas of opportunity for improvement. Operation in production shall flow without interruption and all the requirements for the product production shall be available at all times to the employees.

Research Description

"Flags for the Universe (FFTU)" is a local company whose main business is the sale, production and delivery of custom made flags. Flags are symbols from countries and also serve as a way of publicity. FFTU customers are primary private companies that want to advertise their services. Currently FFTU do not have a method for identifying waste in production, reducing inventory or improving process efficiency. Waste by definition means anything that does not add value to the customer or to the production. It is proven that quality has an impact in short and long range regarding revenues, mostly positive effects.

The main purpose of this research consists in determining which activities generate waste in FFTU flag production. By identifying the areas of opportunity it is expected that a leaner production will be achieved. Another benefit of the process improvement will be the optimization of FFTU processes taking into account the limited resources.

Research Objectives

The objectives of this research consist in identifying the FFTU non value added activities and transforming them into value added activities or just removing them from the process. Waste removal will be done through the use of the Lean Tools. Overall process improvements, 5S, visual aids, Value Stream Maps (VSM) among others are tools that will enable waste reduction.

Research Contributions

Reduce production turnaround time to aid the final product being delivered on time. The optimizing of the available production materials will contribute to increase revenues. Process Optimization will facilitate the overall production with less use of human effort, less time and less use of available space, while achieving customer expectations.

LITERATURE REVIEW

Many companies have started quality improvement techniques as a way to gain a place in the market share or to keep their current revenues. Operational excellence of a company can be acquired by the implementation of quality initiatives such as Six Sigma and Lean Manufacturing. This project was developed by following the guidance offered by the Six Sigma strategy phases of DMAIC along with the integration of the Lean Manufacturing tools. Six Sigma was established by Motorola as a metric for defect reduction and quality improvement. Six Sigma quality levels offers an indicator of how often defects are likely to occur: a higher sigma quality level indicates a process that is less likely to create defects [1].

Lean Manufacturing is used in conjunction with Six Sigma to determine the value in the operations and to reduce the waste in the process. It focuses on viewing the flow of the product, identifying the waste and removing it from the flow hence resulting in value added production activities. Lean is the process of optimizing systems to reduce costs and improve efficiency by eliminating product and process waste [2].

To define the problem within the Define Phase a Suppliers, Input, Process, Output and Customer (SIPOC) diagram will be developed. A SIPOC is a high-level map showing a process's primary suppliers, the inputs received from them, and the process that adds value to those inputs. That process produces an output that is intended to meet or exceed customer requirements [2].

The techniques of VSM will help identifying where the waste is located. This tool will aid engaging the Measure Phase. In addition to the VSM, it will be implemented the first three "S" of the 6S: Sort, Straighten and Shine. Sort will help identifying the needed tools, materials, and supplies. The unneeded items will be separated and/or discard. Straighten is for assigning the work area items into the correct area for an easy and immediate retrieval. The third S, Shine, is for having the work area clean.

In the Analyze Phase the VSM current state will be analyzed to determine which activities can be modify or remove from the value stream to improve process flow. At the Improve Phase the future state of the VSM will be developed. The future state of the VSM is a visual representation of the improved process. At this stage all the non-value added activities and the process waste are removed from the stream. A reduction of the process time and cycle time are observed. The final Phase will consist of maintaining the control of the process, Control Phase. To help maintaining control the remaining three "S" of 6S will be implemented.

Standardize, the fourth S, is done to help avoid failing to achieve the previously implemented three "S" at the Measure Phase. The purpose of standardizing is to prevent repeating the first three "S". This could cause unnecessary rework. A checklist is usually used as an effective way for monitoring the cleaning and inspection of the work areas and equipment. Sustain, the fifth "S", is achieved by the continuous actions for work improvement for a defined period of time. The last "S", Safety, is proposed with the intention of assuring a safe place for the workers. A free for hazards ambient will reduce the opportunities for accidents in the workplace.

METHODOLOGY

The structure for this research will be provided by following the Six Sigma structure of DMAIC. The Juran Lean Roadmap [2] was used as guidance

for the implementation of Lean Manufacturing into the DMAIC structure.

Define Phase

The idea of this phase is to know where the company is positioned in terms of their current processes and costs. One of the most important tools in this phase is the SIPOC diagram. This high level mapping will provide FFTU a background of their suppliers, what inputs they provide, process steps of production, the output that result from the process and the customers. The purpose of the SIPOC is to define the boundaries of the research.

Measure Phase

The objective of this phase is to collect the necessary data for the determination of the problem location within the process. The SIPOC will be measured in order to obtain a detail process map. This map, the VSM, will depict the complete FFTU process from start to finish. A typical name for it is the Current State Map (CSM). To develop the CSM is imperative to collect the necessary data. Data collection will lead to understanding the amount of time spent in each of the process steps activities. To complement the Measure phase another lean tool will be used, "6S". This method is a visual management technique that is used to eliminate or reduce unnecessary inventory, equipment, and tools from the workplace. The Juran Lean Roadmap suggests using the first three "S", Sort, Straighten or Set in Order and Shine on the Measure Phase. To Sort within the FFTU premises all the items that are not needed for production will be disposed, this will enable the identification of the items that are required for production and the available quantity. As for "Set in Order", the remaining necessary articles will be stored in a way that will be easier to use. The arrangement of the needed items with the corresponding labeling will facilitate their use and will eliminate the time personnel are searching for that article. One benefit of setting in order is that it avoids the purchase of existing items and the excess inventory. For "Shine", basically means to clean the work areas and the products that are used for the production. The idea is to have items ready to be used when needed. Shine must be plan as a daily activity or weekly, so it is important to incorporate systematic inspection procedures.

Analyze Phase

The data collected from the previous phase through the VSM will be analyzed. The idea is to find which activities creates value to the customer, the ones that do not create value and cannot be eliminated from the process, and the ones that not create value and can be eliminated from the process. The first step in analyzing the VSM is to delete the steps that do not create value and it feasible to delete those steps. The steps that cannot be eliminated will be perfected to reduce the waste associated with that particular step.

Improve Phase

The improve phase will consist in the design of the process changes and flow. In this phase the process is improve by the removal of the waste identified in the previous Measure and Analyze phases. At this point the process should have been optimized by the use of data analysis technique and standardization to create the Future State new process.

Control Phase

This phase is for the control of the improved process (Future State) to ensure any deviation from the process gets corrected before it generates waste or defects. To achieve this, the process is constantly monitored and control systems are deployed. Standardize, one of the visual management techniques of "6S", is used as a method to maintain the first three "S", Sort, Set in Order and Shine. Setting the standardized conditions is important to prevent falling in the previous state. Checklists are usually used for the maintenance of the previous "3S". It is important that all the members of FFTU production integrate the habits of maintaining the previous "3S". All the employees should be accountable and be

responsible of the implementation of the "3S". Sustain, the fifth "S", is for the making the habit of maintaining the established procedures. FFTU members shall commit to sustain the previous activities. The management shall create working conditions to enable personnel follow and practice "5S". Employees shall make it part of the daily routine. The last S", Safety, is one of the most important ones because the health of the employees could be at risk. FFTU shall develop safe working conditions that do not put in risk the life or health of the workers.

RESULTS AND DISCUSSION

The results will be presented following the DMAIC structures discussed in the previous section.

Define Phase

The tool used to define the problem is the SIPOC. This high level mapping will aided in determining where to concentrate the efforts. Refer to Figure 1 for the FFTU SIPOC Diagram.

SIPOC				
Suppliers	Inputs	Process	Outputs	Customers
Alonso & Sobrinos	Yarn (*Hilo*)	Producing Flags	Attaching fabrics	Client
Alonso & Sobrinos	Fabric	Order	Defines flag shape and colors	
Arts & Grafics	Pattern	Operator Notification	Guides the flag design	
FFTU	Sewing Machine		Manipulates yarn to attach fabrics	
FFTU	Seamstress (*Costurera*)	Produce Flag	Machine user	
Alonso & Sobrinos	Belt	Pack Flag	Flag support	
Home Depot	Rope			
	Eyelets	Delivery		
AEE	Power		Drives machine	
Customer	Order	Receive Payment	Flag ready to be delivered	
			Invoice	

Figure 1
FFTU SIPOC Diagram

The SIPOC in the previous figure can be analyzed working from the Customer going backwards until reaching the Suppliers. The purpose is to view what is necessary to deliver the product that the customer requested. The diagram on Figure 1 is useful to keep a clear scope of the project. Additionally, it highlights the areas that can be improved. Finally, it helps focusing on the customer. The Inputs on the SIPOC are those strictly necessary for producing a flag. Suppliers are the facilitators of those inputs. To avoid delays in the process, alternate suppliers must be identified. The Process shown is at a satellite level. Detailed process is presented in the Measure Phase by a Value Stream Map. Outputs from the process are those that compile the final product which is a flag.

SIPOC final step is when the flag reaches the customer. Typical FFTU customers are banks, fast food chains, car dealers and government offices among others. A robust process will enable FFTU on acquiring additional customers hence expanding their revenues.

Measure Phase

For the measure phase the Value Stream Map was developed by interviewing all the key contributors in FFTU. The administrative personnel were interview to outline the pre requisites steps for producing a flag. These steps go from customer requesting a quote up to the creation of Sewing Control Order. The cycle time of performing those activities is about 85 hours. For the flag production processes, the team of seamstress was interview to determine the cycle time in processing each flag. Is important to document that only one type of flag was use to benchmark the production. It was determined to use the most sold flag, the Flag of Puerto Rico. Refer to Figure 2 for a Puerto Rico flag with all the components.

Figure 2
Puerto Rico Official Flag Components

Producing a typical Puerto Rico flag takes about 4 hours per seamstress. At the final steps, the

flag is generated and is ready for final delivery. The carrier of the company was interview to capture the time it could take to deliver the flag to the customer. The final steps represent a cycle time of about 24 hours. Refer to Figure 3 for FFTU Current State Value Stream Map.

Figure 3
FFTU Current State VSM

To complete the Measure Phase the Visual Management tools where used. The Six "S" first three "S": Sort, Set in Order and Shine. For Sort, items that were not required for production, or that were not in used were disposed. Refer to Figures 4 to 6 for sorted items.

Figure 4
Unwanted Items

From Figure 4 it can be appreciated that a kitchen cabinet was stored at the entrance of the office. Both cabinet and table were discarded. In Figure 5 the back of the workshop is packed with items that are serviceable mix with items that are not.

Figure 5
Unwanted Items

Figure 6 shows a closer view of the discard items. There is a document cabinet hidden at the corner. Boxes on top of the cabinet prevent the use of it.

Figure 6
Unwanted Items

The next visual management activity is "Set in Order". All of the remaining items after sorting were classified and arranged in a form that they could be easily accessible. The idea is reduce the

time spent searching for the required materials. Refer to Figures 7 to 9 for the results for "Setting in Order".

Figure 7
Frequency of Use Arrangement

Figure 7; the document cabinet that was hidden in Figure 6 is now released from all the unnecessary items that were blocking it. The new location is closer to the office area facilitating its accessibility. Figure 8 shows the store area in the office. Final flags were arranged by size color and country. Each group was properly label to facilitate its location.

Figure 8
Frequency of Use Arrangement

Figure 9; flag sewing pattern where placed in one location. Each box was labeled. Labels contain a list naming the patterns that includes the flag size.

Figure 9
Outlining Strategy

The last Visual Management activity in the Measure Phase is Shine. The idea is to have all the materials, working condition and tools ready to be used. It was assigned a daily cleaning routine to all employees. Before the shift ends, the employees are required to clean their respective areas. Refer to Figures 10 to 11 for "Shining" results.

Figure 10
Shine

In Figure 10, the measuring tables and surrounding were cleaned from material that could mark new flags. Figure 11; FFTU main structure was painted. All the externals walls were painted to protect the wood from the rain and to give an additional sharp look.

Figure 11
Shine

Analyze Phase

The VSM Current State presented in the Measure Phase was analyzed to determine were the process is getting flow interruptions. In addition, the cycle time will be quantified to understand what is the total cycle time of the process. From the process start it can be notice that the initial steps prior to production are consuming a large amount of time from the cycle. The Purchase Order (PO) process takes a maximum of 72 hours. That time can be reduced if an electronic system is placed. One idea is to have the ability of receiving electronic payments. At the same time, an internet page for the company can be developed to manage the customer inputs and sent an automated quote to the customer. The electronic transfer of information will accelerate the pre-production steps of the value stream.

Moving more into the stream, the actual production steps were analyzed. The use of sewing patterns for all flag components can be reduce or eliminated with the standardization of the flag measurements. If patterns are required, the quantity can be reduced if a projected patter is view on the measurement table. If the seamstresses use a projection, they can eliminate the need to search for multiple patterns. Another step that can be eliminated is cutting the fringes and other flag components. This can be possible if fabrics get previously pre-cut. The seamstress can pulled the pre-cut forms and use them. This eliminates several cutting operations.

It was identified that there are 4 yarn threading and bobbing operations across the workflow. Each of those operations are required because of the differences on the items being sew. There are two types of machines required from sewing a Puerto Rico flag: the zigzag type and the double needle type. Each seamstress manages one zigzag and one double needle sewing machines. The triangle and the star are sew with the zigzag machine. The fringes and the belt are sewed by the double needle machine. Since each flag component have different colors, the seamstress need to change yarns before sewing another item.

There are 4 seamstresses in FFTU for a total of eight machines being used. The amount of sewing machines can be minimized with the allocation of one machine per component for the use of all seamstresses. This also reduces the multiple yarns threading and bobbing. One double needle can be set up for sewing the blue fringes and another one for sewing the red fringes. A third double needle will be required for sewing the belt. As for the zigzag machines, one should be separated for the blue triangle and another for the white star. Overall, this will require the use of only 5 sewing machines instead of 8. Three less sewing machines can result in the increase of available workshop space, lower electrical bill, or the availability of the 3 machines for alternate tasks.

Improve Phase

The results from the previous phase will help guide in the design of a more robust and less time consuming value stream map. This improved workflow is called the Future State VSM. Refer to Figure 12 for the Future State VSM. The cycle time of the process can be reduced from 113 hours to 26 hours. That is a cycle time reduction of over 76%. The application of software's and electronic payments can decrease significantly the cycle time. In addition the standardization of certain tasks can contribute on cycle time reduction.

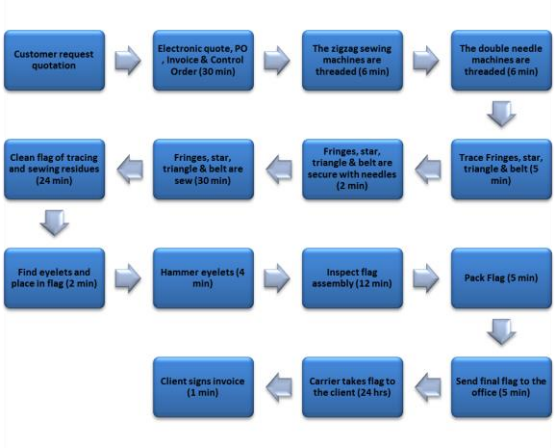
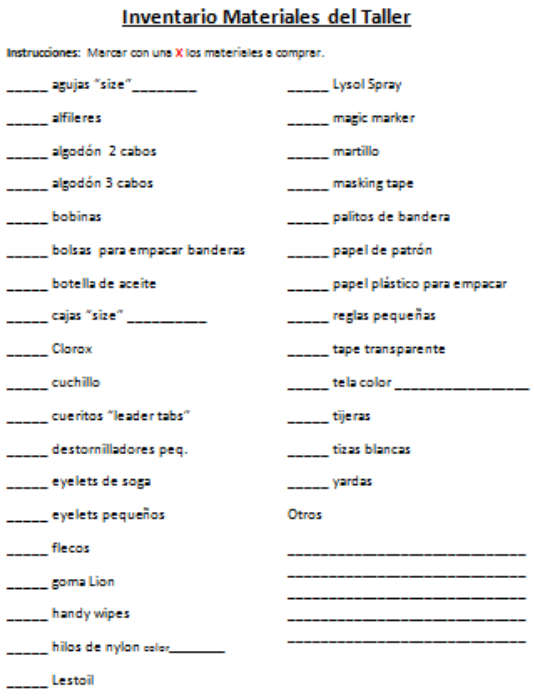


Figure 12
FFTU Future State VSM

Control Phase

Controlling the process can be made by ensuring all the previous visual management activities get followed and sustained. Standardization places a key role in ensuring control. FFTU will integrate checking for all of the visual management activities. Checklists will be used to maintain and sustain the 3S level. Refer to Figure 13 and Table 1 for checklists.



Inventario Materiales del Taller

Instrucciones: Marcar con una X los materiales a comprar.

_____ agujas "size"_____
_____ alfileres
_____ algodón 2 cabos
_____ algodón 3 cabos
_____ bobinas
_____ bolsas para empacar banderas
_____ botella de aceite
_____ cajas "size" _____
_____ Clorox
_____ cuchillo
_____ cueritos "leader tabs"
_____ destornilladores peq.
_____ eyelets de soga
_____ eyelets pequeños
_____ flecos
_____ goma Lion
_____ handy wipes
_____ hilos de nylon color_____
_____ Lestoil
_____ Lysol Spray
_____ magic marker
_____ martillo
_____ masking tape
_____ palitos de bandera
_____ papel de patrón
_____ papel plástico para empacar
_____ reglas pequeñas
_____ tape transparente
_____ tela color _____
_____ tijeras
_____ tizas blancas
_____ yardas

Otros
_____
_____
_____
_____
_____

Figure 13
Standardize Checklist

Table 1
Sustain Checklist

Taller	Si	No	Observaciones
El kit de primeros auxilios esta accesible.			
El kit de primeros auxilios contiene todos los medicamentos básicos. (alcohol, curitas, triple antibiótico, gazas, otros)			
El extintor no está expirado y se encuentra accesible. (ver fecha)			
Todas las áreas están debidamente rotuladas e identificadas. (no fume, cuidado)			
Los receptáculos no se encuentran obstruidos, ni tienen objetos flamables al lado.			
Las cajas de patrones están debidamente alineadas.			
Las máquinas y equipos están apagados.			
Las máquinas están protegidas.			
Los materiales están todos en su lugar.			
No hay alfileres, ni objetos punzantes en el piso.			
Se botó la basura.			
Las áreas lucen limpias y recogidas.			
Las puertas y ventanas están debidamente cerradas.			

Control Phase last Visual Management tool is Safety. FFTU is committed to ensuring the health and safe work environment conditions for their employees. Since FFTU works with sewing needle and pins it was mandate that all seamstress wear appropriate shows to prevent a pinch. The Checklist is Tables 1 contain categories for ensuring safety. Refer to Figure 14 for Safety features.

Figure 14
Safety Equipment

While performing the visual management activities it was noted that the fire extinguisher in Figure 15 was empty and that it was being held by harness. A new fire extinguisher was ordered. Replacement extinguisher will be place in a form

that it can be easily retrieved in case of an emergency.

Figure 15
Safety Equipment

CONCLUSIONS

The research and analysis on how to improve the operations of a flag production company demonstrated that small companies can achieve performance breakthrough. The use of some of the tools from Lean Manufacturing and Six Sigma provided a solid structure for defining the project. High level mapping such as the SIPOC provided a definition of the flag production process. FFTU Current state value stream has a cycle time of about 113 hours. Most of the cycle time is being spent on administrative tasks. The visual management activities from Lean Manufacturing helped identified and discard items that were not needed in the workshop. Remaining items, tools and materials where classified and stored based on their needs and use. After analysis of the value stream it was noted that the process can be improved with the use of technology. By using software's the administrative tasks cycle times can be significantly reduced. Several flag production activities were repeated consuming additional time that creates no value. The repeated activities across the workflow can be combined to reduce the overall cycle. The results of the implementing of this research could lead the company to increase their revenues.

All companies shall implement the use of the Lean Six Sigma tools. It is recommended the use of the tools following the DMAIC structure. Each phase contributed in the development of the project. The Define Phase helped view the satellite level process of FFTU. The Measure Phase identified each of the current production process to quantify the process cycle time. Visual Management activities help organize the production tools and have them available for its immediate use. While in the Analyze Phase areas with opportunity for improvement were identified. Improve Phase Future State map documents a 76% reduction in cycle time. Control Phase provides the methods for ensuring the process will not return to its original state.

In a future research, it is recommended to investigate the possibility of improving the process for all the other types of flags that FFTU produces. Also, it can be investigated if a manufacturing type of set-up can be implemented. Methods such as First In First Out and One Piece Flow.

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