How to Connect Supplier and Customer Processes within the Manufacturing Environment

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Abstract *— Within the manufacturing industry, the inventory represents an area of continuous improvement. This asset allows the supplier to react to the variability in the requirements of its clients and / or the inefficiencies in its performance, either in the operational or administrative area. By studying the activities that occur within each workflow, we can identify opportunities for improvement between the processes of the supplier and client and establish a connection between them. Taking into account the complexity of the manufacturing process infrastructure within the medical device industry, the study focuses on the processes of distribution of finished material between the supplier and the customer's first point of consumption. Through the DMAIC (Define, Measure, Analyze, Improve and Control) research method the problem of inventory destroy the manufacturing areas are evaluated and the processes of the supplier or client are connected through the implementation of an Kanban system to reduce the inventory available and shorten the time it takes to distribute the material from its manufacture until it is consumed*

Key Terms *— Flow and Pull, Inventory Reduction, Kanban, Lead Time Reduction.*

INTRODUCTION

Flow thinking is the focus on shortening lead-time from the beginning of the value stream to the end, and on removing all barriers that impede the creation of value and it's delivery to the customer.

Pull is the concept of matching the rate of production to the rate of customer consumption (demand). Each downstream activity (customer consumption) triggers upstream activity (supplier production/replenishment). Yet pull is not feasible or cost-effective without flexibility and short lead times.

Flow and pull create enormous positive benefits in all aspects of business performance. Focusing on flow will lead to improvements, including better safety and employee engagement, more consistent quality with fewer defects, increases in on-time delivery and flexibility, and lower costs without running into the traditional trade-offs. Most importantly, daily and weekly results become more consistent and predictable

The effect of high inventory and little flexibility to react to the demand of internal customer can be a serious problem for any manufacturing scenario. This is exactly was is being observed in the shields assembly product manufacturing line. For this product, the demand does not flow from the customer to the manufacturing line planning support group. This result in a high frequency of product Shields inventory discrepancies

RESEARCH OBJECTIVES

Reducing inventory from 21 days of inventory to 16 days inventory, reduce Lead time finish good transactions and material movements, improve quality and optimize space usage Develop a standard communication method between customer and supplier.

RESEARCH CONTRIBUTIONS

The implementation of a new process of distribution of materials through the area of operations that is able to handle variability in customer demand keeping the lowest possible inventory without affecting the availability of the

product at the time the customer requires it and in the required quantities.

"Continuous improvement begins by clearly defining value through the eyes of the customers. Expectations must be clearly communicated so systems can be designed to meet customer needs. Every employee must know "what good is." Whether his or her process is creating good product or service, and they must know what to do if it is not. Improvement means the elimination of waste, and the most essential precondition for improvement is the proper pursuit of goals. We must not be mistaken, first of all, about what improvement means. The four goals of improvement must be to make things: easier, better, faster, and cheaper. Particular emphasis is placed on a quicker, more flexible response throughout the system." [1]

The best path to achieve better overall performance is to focus improvement on quality and flow. By improving quality and flow, we inevitably achieve better cost and more predictability. Cost reduction work that does not focus on quality and flow, often leads to short term countermeasures that may become barriers.

RESEARCH BACKGROUND

This design project was conducted in a Medical Device Company located in Juncos, Puerto Rico Recently the company evaluated the opportunity to manufacture one of the most important components in the manufacture of their medical devices. This component was manufactured by a non-local external supplier. In recent years the demand for medical devices (Orion and CRT-P) has increased drastically, which represents great challenges for suppliers when it comes to increasing their capacity to meet the requirements of each of these components. To mitigate the impact caused by the lack of components in the manufacturing area, the company designed a new manufacturing line that builds the shells that are used in the manufacturing line of the Orion and CRT-P devices, which in turn are assembled in the same manufacturing area. One of the company's biggest concerns is the high inventory that is stored to meet customer demand, manufacturing lines of Orion and CRT-P models. The manufacturing process of shields has a lead-time less than the time needed to assemble an Orion or CRT-P device, which adds flexibility to the manufacturing of shields and allows to establish a smaller volume inventory model, even to explore the possibility of approaching a just-in-time. Due to the fact that these medical devices are products of high demand in the market, the company needs to establish an efficient supply of shields that maintain the manufacture of medical devices in an uninterrupted way and at the lowest possible cost to guarantee the margin of savings associated with the decision to manufacture the shields instead of buying them from an external supplier.

RESEARCH METHODOLOGY

The methodology which will be followed is the Six Sigma project solving model called DMAIC (refer to Figure 2) which stands for: Define, Measure, Analyze, Improve, Control.

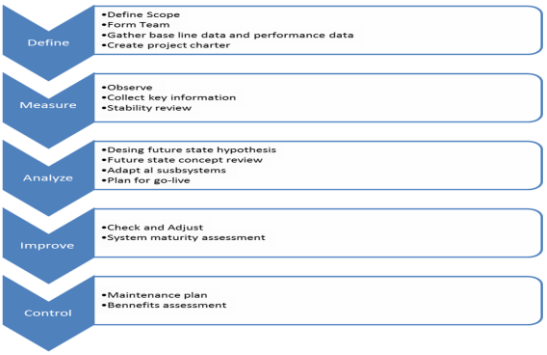

Figure 2
DMAIC Model

DMAIC process is one of the most safety and effective models of problems solving methods. During the past of the years this method has been adopted and accepted by thousands of companies that perhaps improves their processes. The method behind DMAIC consist in the involve of different areas and its commitment to obtain sustainable changes to a process or solving a problem. DMAIC

abbreviations have a purpose that is aligned with the vision of this method.

DEFINE –This first part of the method is about to developing a focused problem statement that describes in measurable terms what the project will deliver. The project begins by creating a team charter to identify team members, select the process the team will be improving and clearly define the objective of the project. The project team will then identify the CTQs to help measure the impact the problem has on the customer. This phase is completed when the team creates a process map that includes the process's inputs and outputs.

In this part the team will present a background about the problem statement. Questions like: "what the problem need to be solve?" has to be answer in accordance to the business strategies and needs. The team will identify or design a map that demonstrate the problem to be solve including the expected improvements using measurable and quantifiable data .

MEASURE – This phase begins with the identification of the key process metrics. Once the key process metrics have been specified, related process and customer data are collected. In the measure part. Measure process has four main objectives:

- Specifically define the scope of the project.
- Gather data to qualify opportunities for improvement and quantify their potential.
- Gather data to quantify the current state performance and create a measurable improvements.
- Based on the data analysis provide into what the root causes are for the problems.

The measure stage looks to measure the scope of the project end to end, this way variables can be address from the supplier and possible impacts can be avoid.

ANALYZE – Having completed the measure phase, the project team should have already establish a clear problem statement which specified what the problem is. The question that the Analyze phase has to answer is: "what is the cause of the problem?" Is not possible to make improvements to the process until the causal factors are identify.

A hypothesis can developed in this phase of the project to begin with the statistical analysis of the problem. This phase statistically reviews the families of variation to determine which are significant contributors to the output. The statistical analysis is done beginning with a theory, null hypothesis. The analysis will "fail to reject" or "reject" the theory.

IMPROVE – After the "reject" or "fail to reject" of the hypothesis an improve has to be met. The purpose of this phase is to make the required changes to ensure a solution to the problem. This phase consists of four steps:

- Generate solutions
- Evaluate solutions
- Optimize solutions
- Pilot plan and implementation.

CONTROL – Once the process problem is fixed and improvements are in place, the team must ensure that the process maintains the gains. In the Control Phase the team is focused on creating a Monitoring Plan to continue measuring the success of the updated process and developing a Response Plan in case there is a dip in performance. Once in place, the team hands these plans off to the Process Owner for ongoing maintenance.

Documentation is imperative to obtain better results, help to make people responsible and engage with new processes.

The Control Tool will maintain quantifiable controls to measure new changes and its benefits, for example: Control Charts. That chart shows the possibility of identify an unusual variation; the graph is represented by a control data and if the process is not in comply with the accepted data or criteria, plotted points will be out of range.

RESEARCH RESULTS

Although we identify as the Y of our project the high level of inventory of shields behind the manufacturing area, the areas that require the most attention are the X or the inefficiencies that make it

necessary to load this amount of inventory. This information was worked through a Fish Diagram which allows grouping the X impact areas. (Figure 3).

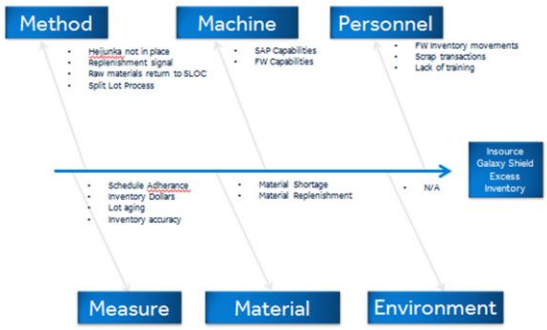

Figure 3
Fishbone Diagram

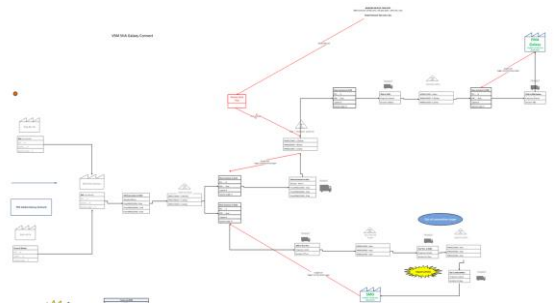

Figure 4
VSM- Finish Goods Distribution

Stability Factors	Guideline	SHA FT Line	SHA Top Line	EMA Galaxy Line
Workflow Maturity Assessment	Stable or higher	Stable	High Maturity	Stable
OA/OEE	>=80%	95%	>80%	N/A
NCR's	low	0	0	0
Downtime	<5%	< 5%	<5%	<5%
C/O	<EPEW	N/A	N/A	N/A
Quality Risk Confirmation	No critical quality risk	No Risk	No Risk	No Risk
Max process Capacity	>125% to demand	106% (Base Scenario) 117% (+1 Scenario)	TBD	N/A
Heijunka/Planning	<EPEW	Heijunka in Place	Heijunka in Place	Heijunka knowledge at non COS workflow

Figure 5
Stability Assessment

As part of a Material Replenishment system, kanban is a specific tool for controlling information and regulating materials conveyance between production workflows or processes. Kanban is coupled with Takt Time, flow processing, pull production, and level scheduling is what enables just-in-time production to be achieved in a value stream. Typically a Kanban is used to signal when product is consumed by a downstream process. In the simplest case this event then generates a signal to replenish the product at the upstream process.

Kanban provide a physical schedule tool that tightly links and synchronizes production activity between upstream and downstream workflows. Kanban combines control over movement of material with respect to both time and quantity dependent upon signals from downstream workflows. Kanban controls production in a value stream by controlling material and information flow.

To reduce inventory between the supplier and the customer a connection workflow and a Kanban need to be implemented

- Type A, or a replenishment pull system, separates workflows with a store of inventory. End customer demand is level loaded and sequenced to pull from the finished goods store at the end of the value stream. Withdrawal Kanban act as permission for downstream workflows (customers) to pull inventory from the store. Production Kanban are used to trigger replenishment from the upstream (supplier) workflows. This is the most conservative approach and offers the most protection for the Customer, but requires higher costs of inventory.
- Type B, or the sequential pull system is a "build-to-order" model, where end customer demand is level loaded and sequenced at the start of the value stream then flows through all workflows. This is the most mature pull system but requires the greatest capability in terms of stable processes and short lead time to protect the end Customer.
- Type C connection system is a "Semi-Build to Order" model where the downstream portion of the value stream follows a Type B sequential pull, while some upstream workflows follow a Type A replenishment pull. This is a good option for value stream with intermediate or mixed maturity levels – where the downstream final assembly can achieve continuous flow, but some upstream processes cannot.

In the manufacturing line of shields two different products, FT Shields and Shields Top, constructed in 2017 on average 23.8 days of inventory were charged for FT Model and 24.8 days for the Top model. By segregating this inventory through the inventory locations, an average of 3.4 days of inventory tied to the transactions and movements of materials between supplier and customer are identified. (Figure 6)

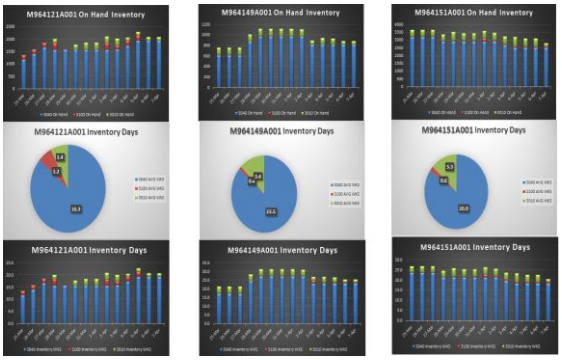

Figure 6
Average Days of Inventory

In the evaluation of the hypothesis to establish the appropriate connection between the suppliers, the type C connection is considered since this model allows to have available inventory which adds flexibility to the replenishment process and capable to absorb variability of demand in the client. Also introduces the concept of build to order at the time of supplying the replenishment signal. This is possible since the lead time of the supplier is less than the lead-time of the client. (Figure 7).

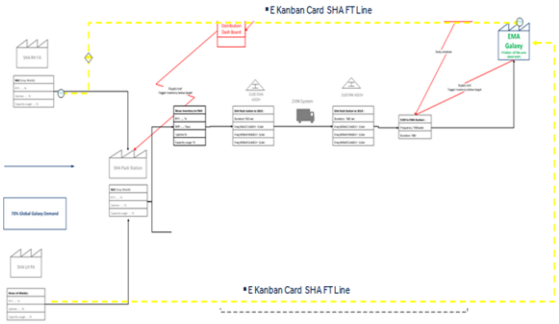

Figure 7
Type C Connection in VSM

Kanban can be a simple card with basics information such as part name, part number, Pack quantity, Storage location and Consuming location. In this case a virtual Kanban dashboard will provide specific production instructions between workflows based on upon replenishment principles. Kanban achieves this by governing both, the timing of material movement and the quantity of material conveyed. Kanban serve as visual control tool, making flow visible. See normal and abnormal status in real time. (Figure 8).

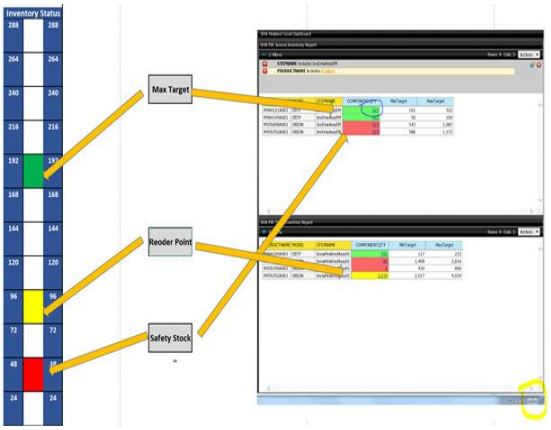

Figure 8
Kanban Dashboard

CONCLUSION

Implementing Kanban between shields manufacturing line and CRT-P and Orion customer shortened lead time in the finished goods distribituion workflow. Through the connection of the two manufacturing lines, the client has the material available for consumption in his work area and provides information of his level of inventory to the supplier in real time. The supplier can identify abnormalities within the requirements of the supplier against the level of available inventory and can make decisions under his production plan to mitigate the impact to the availability of materials. The most important improvement that this system provides is the reduction of material inventory between the supplier and the customer. After connecting the manufacturing processes of shields with your customer you get an 18% reduction in inventory costs available without generating a risk to the supply of these materials. (Figure 9).

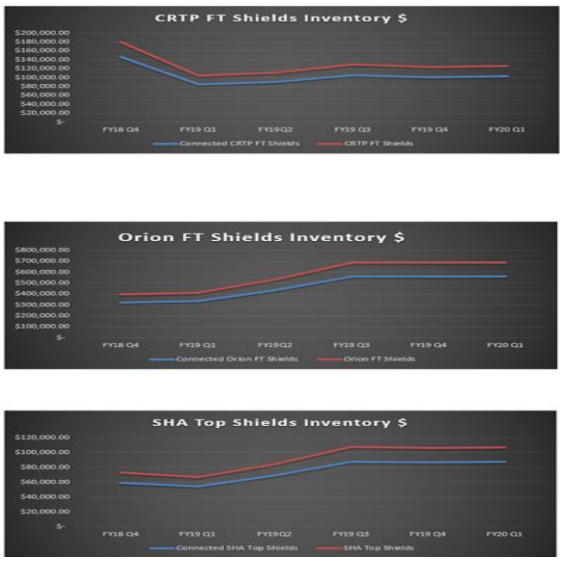

Figure 9
Inventory Dollars Reduction

Recommended Further Steps

- Reduce shields finished goods inventory targets.
- Amplify connection scope and include more supplier and customer processes.
- Establish similar replenishment systems with external suppliers.

ACKNOWLEDGEMENTS

During this past months I have gone through many difficult situations as many of the people in Puerto Rico. No matter that I stayed positive and focused in the things I wanted to achieve. This project represented a professional challenge and I am sure it will help me during my future careers expectations. I have learn a lot, many new things and terms that from now on I will put in practice.

Today I feel more prepare and conscious from a professional perspective and I can be sure that I will offer to my employers a real engagement with the improvements of processes.

I would like to give special thanks to some people that help me to achieve this goal: Dr. J. Morales Morales; Professor of Polytechnic University, San Juan, PR and Ingrid Vale; Business Process Consultant.

REFERENCE

[1] "The Shingo Prize for Operational Excellence | Model and Application Guidelines, Version 7.1," in *International Journal of Production Research*, Vol. 56 Issue 3, May 2012, pp. 1299-1312.