Improvement in the Inventory System and How to Reduce Waste

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Abstract *— Due to the recent pandemic, industries have confronted inventory problems because of all the backorders that exist with the suppliers. Consequently, industries have lacked the necessary materials to continue their processes. To overcome the problem, this research is to improve how inventory is managed by creating an evaluation system that keeps track of the current inventory and begins to order before it runs out, with optimal time so the new material arrives in time. This can be done by analyzing the inventory and how much of it is used for each process in the company.*

Key Terms *— DMAIC, Inventory, Lean Six Sigma, Productivity, Quality.*

INTRODUCTION

Based on the idea of Toyota Production Systems, Lean Manufacturing's approach to inventory is to have just enough in stock needed to manufacture any product. For every industrial, pharmaceutical, or biotechnology company, an essential part is its inventory management. This is because without or being the low stock, it could affect the production line, raise unnecessary costs, and in worst-case scenarios, affect the deadline for shipment for customers and patients. Therefore, it became a challenge when the pandemic of COVID-19 stroke, and three years of its beginning, it still has its effects on the inventory stocking of the companies. Some of the issues have been the stop of delivery from vendors, detaining production lines, and raising costs at the time of restocking.

This project will focus on improving the company's inventory system to avoid high costs and expenses and always maintain proper stock inventory.

PROBLEM STATEMENT

Many companies were affected by restocking their inventory because of the Covid-19 pandemic. It has been noted that this has been a problem for suppliers due to the high demand from client companies and increased traffic in the volume of materials and equipment. Currently, where I work, we are constantly having problems with the lack of materials due to recent events like the pandemic and natural disasters around the globe. This creates a problem during restocking because the vendors have some back orders or low inventory of their own. If the material is needed as soon as possible, it could cost triple its own price, to make the vendor prioritize your order.

RESEARCH DESCRIPTION

This research seeks to study materials and reagent usage in all the assays to establish control over how much it can be ordered each time it reaches a designated minimum limit. By doing this, the order of the product will be made before it is fully depleted in the plant. Also, this study is to help develop a tracking system that will aid at the time of alerting of this minimum limit reached for the inventory.

RESEARCH OBJECTIVES

The success of any industry depends on the continuity they have in the manufactory of their product. The inventory is one of the most crucial things that the company must have to accomplish its purpose and the lack of it could put at risk many things, like processes, schedules, costs, among other things. Due to the recent pandemic and the war that was developed, industries have some problems with getting the right amount of inventory. Therefore, this

design project aims to create a system that tracks the amount of delayed back orders, to order them upfront next time without affecting the company's space, movement, and transportation.

RESEARCH CONTRIBUTIONS

Developing a tracking system where the employees must discharge the material from inventory will give an advantage to the company because they could track when a material is running out. This helps in keeping the inventory up to date and reducing the costs of paying extra to the suppliers in order to receive it early. It will also guarantee that the inventory will comply with the safety, movement, and transportation of the employee by having what is required.

LITERATURE REVIEW

One of the most essential things any industry must possess is inventory and good management of it. Throughout the years, since the invention of Lean from Toyota Production System (TPS), many companies have followed their tools to reduce and eliminate the seven wastes of Lean, and inventory is one of them. A waste in Lean Manufacturing is considered something that does not add value to the customer and affects the cost to production. To combat this waste, Toyota developed the Just-In-Time inventory management strategy, which has as an element called the Kanban system [1]. Kanban is a method that utilizes boards and cards to help visualize the workflow of any industry and improve the efficiency and manufacturing process. It helped the industries in having enough inventory to develop their product but also ensured the safety, costs, spaces, and transportation of the company. This has been used since the (TPS) first developed it back in the 1950s, but it has been seen that this method, through the years, needs improvement.

Back then, in the 20th century, it was the perfect time for global supply chains [2]. This was because of the reduction of trade barriers and relative geopolitical stability helped the suppliers to improve their shipping methods to reduce costs in transportation [2]. But due to the recent impact of the COVID-19 pandemic, the global supply chain showed a significant vulnerability in transportation, inventory, and resource, affecting the Just-In-Time system by a lack of raw materials, reagents, materials, etc., in many industries.

It seems reliable to just order more inventory and fix the problem that way. But by doing that, you are eliminating the waiting waste but creating additional ones. Inventory management approaches indicate scientific ways to designate what to order, when, and how much to keep the storing costs low as possible [3]. Therefore, the solution to this problem needs to be something that does not contribute to other wastes, such as overstocking the area, which could also lead to safety issues.

But with a problem of inventory costing the company more money, thinking of buying new mechanisms to improve something that is out of control because of circumstances like the pandemic does not sound as cheap as before. Many companies are not hurrying to invest in new technology [4]. They prefer to expand their current inventory and better use existing software assets through change management and re-engineering of inventory management processes [4]. It is more reliable and cost-effective to study the current problem with inventory and try to fix it from the inside.

The problem of the company was the cumulative lead time of the suppliers, which is the total time elapsed that it takes a company to fill a new order from the date of entry to the delivery of the product [5]. Although there is no control over what the supplier’s delivery time will be, there could be a different approach of when is going to be the correct time to order your inventory.

Though the pandemic restrictions have reduced considerably, the backlash that was created by it is still affecting the global supply chain in every aspect of the manufacture and transportation of supplies from vendors to industries and pharmaceuticals. Therefore, a new updated method or analysis should be created to adapt to the current situation and avoid all the high costs that are happening by not having

the essential materials and the industry can manufacture their product.

Inside the analysis that can be made is utilizing the DMAIC tool from Lean Six Sigma. DMAIC is an acronym of five words: Define, Measure, Analyze, Improve, and Control, in which each one represents five steps to improve a process. Also, it establishes an order of how research for improvement can be addressed. Each word is a stage to follow.

- **Define** the problem that needs to be solved.
- **Measure** the process performance to see the frequency of problems.
- **Analyze** the root causes of the problem.
- **Improve** by establishing a strategy that eliminates the problem.
- **Control** the improved process and maintain its success.

Another critical methodology from Lean Six Sigma is the Five S's (5s), which can be defined as a methodology that seeks a clean workplace, uncluttered, safe, and organized to help reduce waste and optimize production [6]. These are five things you must do and be on the lookout for to optimize the workplace. These "S's" stand for five words in Japanese which are:

- **Seiri (organize):** Get rid of everything that is not needed in the workplace.
- **Seiton (set in order):** After eliminating what is not needed, rearrange the remains so it looks neat and organized.
- **Seiso (cleanliness):** Clean the work area, especially during this time of the pandemic; a disinfected area will ensure personnel health and safety.
- **Seiketsu (standardize):** Develop a schedule in which the previous steps of (5s) are performed daily.
- **Shitsuke (sustain):** (5s) should not be a once-a-year event; this is better if one is disciplined in doing it every day

By doing this, it will keep everything in order and help reduce and eliminate multiple wastes, improving safety and avoiding usage of expired materials and reagents.

PROJECT METHODOLOGY

This project's goal is to see the entire effects of the improvements between four to six months, to have the proper amount of inventory, and maintain it always well stocked for the laboratory of an industry. Also, developing a system that helps keep track of inventory automatically and make orders on time. **Figure 1**: This graph allows visualizing the tasks to be completed for the entire goal.

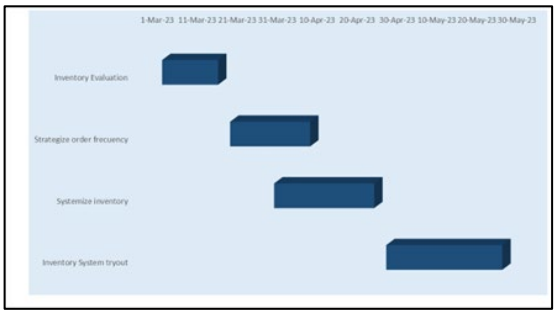

Figure 1
Gantt Chart

Firstly, every material, reagent, and miscellaneous should be studied how much in quantity of they are needed for solutions, tests, and daily use. This will give us data on how often this inventory should be ordered to have the right amount of stock in time. After we have sufficient data, a strategy will be traced to set the logistics of the periods of how often these supplies must be ordered to arrive in time and deal with the backorders that are caused by the pandemic, natural disasters, and any other unexpected situation that could delay vendors to deliver our orders in time.

Before collecting data, the (5s) method was conducted to get rid of unnecessary inventory that we had. This helped to identify and get rid of inventory that was expired and see all the materials or reagents that are no longer used. By eliminating this, more space was available to be able to order the necessary amount of inventory for the improvement without creating more waste or risks to safety. A checklist was made to facilitate the following of the steps of (5s) and was an aid to accelerate the

commitment. When everything was organized and stored in the designated spaces, all the inventory was labeled with a barcode for the system.

The DMAIC method of Lean Six Sigma will be utilized for the recompilation of problem causes, data, and improvement strategy. It will be used to determine the problem affecting the inventory and how it can be improved.

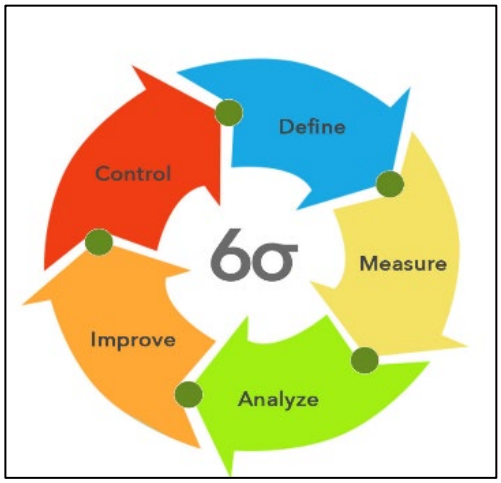

Figure 2
DMAIC

Having this data collected, a program software can be developed to track the current inventory and notify when each of our inventory materials or reagents is reducing, not waiting to finish, when it reaches a certain amount. This way, it can be ordered on time, and the company can run with what they have in stock until the new inventory arrives. After having the software developed, it must be tested to see that everything is running smoothly. The personnel should be trained on how to use the software so that every time they get and open something new from the inventory, they can lay it off from the system's inventory, so it can adequately do its purpose. When the material or reagent reduces from stock, the system will alert the corresponding personnel so they can start ordering new inventory. Also, to compare if this software functions appropriately, this can be done manually, documenting on an inventory logbook. Doing this will document the inventory needs faster by physically seeing them on their designated shelves.

RESULTS AND DISCUSSION

It is for this reason that it was decided to implement an inventory tracking system where the analyst of each test will monitor the materials and reagents necessary for it. Using the Lean Six Sigma method stages of DMAIC, gave perspective on what is going on and how to resolve it.

- **Define the problem**: The way in which the inventory was being carried out in the company was with the assignment of a technician to watch over all the inventory in the laboratory area. Not having full knowledge of the tests and how many amounts of materials were used, it began to be scarce. By the time the order was made, and the vendors had the opportunity to ship the materials and reagents, necessary tests were delayed.
- **Measure inventory**: A logbook controlled by a selected person to carry out inventory orders to the suppliers. This person will hand out the logbook to each analyst, so with their experiences in their assay; they can give a clear picture of how many materials they used on a monthly basis. This inventory will have barcodes that are programmed with the tracking system. The analysts will determine how many of these materials are required to use in a month. With this, it was determined what was the minimum limit for each material or reagent.
- **Analyze inventory**: This data collected will be analyzed to begin to program the tracking system, which is going to alert the person in charge when it is the moment to order each material. For this to succeed, each analyst must scan off the barcode of the inventory.
- **Improve inventory with tracking system**: Having all this data collected, the inventory was uploaded to the tracking system. The system will alert you every time a material or reagent reaches the assigned minimum limit. For example, Sodium Chloride is the most used reagent in the laboratory and in a monthly basis, is used between 800g to 1000g in total for every mobile phase that is prepared. The company

buys bottles of 250g. Therefore, the proper number of bottles to have in the plant is twenty, and every time it drops to twelve bottles, eight more should be bought.

- **Control of the inventory for the future**: It is crucial to cultivate the practice for every analyst being responsible for their assay inventory. This way, the tracking system will always be updated and alert in time to make an order and not affect any assays.

As the time for optimization was during in-process tests, and we cannot start from zero on all tests, we could see the slow improvement of this new practice. We can notice in **figure 3** that they were five assays being impacted by late-delivered supplies. These were the assays that were impacted by the vendors not having enough stock to deliver fast or high-demanding products.

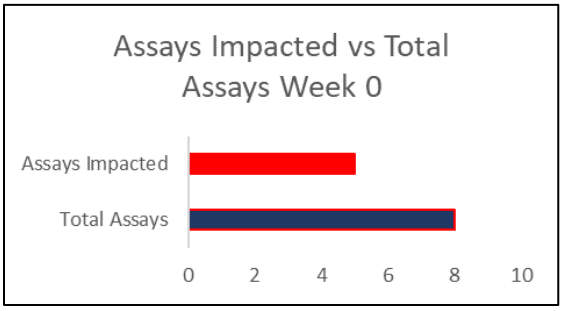

Figure 3
Assays Impacted vs. Total Assays (Week #0)

Figure 3: This graph shows the impact of late deliveries from vendors to the company at the beginning of the improvement process.

After three weeks, we saw a decrease in the impacted assay, as shown in **figure 4.** Here only two of the eight assays remained impacted, but one of them was still late because one of the reagents lots came with a problem from the vendor, and they recalled it. This got us into action, and a new strategy to follow is not just ordering the amount needed but also not ordering all the materials from the same lots.

Figure 4: This graph shows the impact of late deliveries from vendors to the company at the third week of the improvement process.

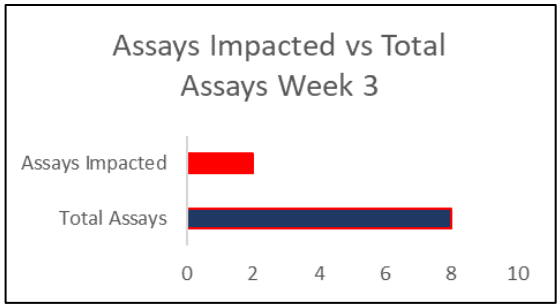

Figure 4
Assays Impacted vs. Total Assays (Week #3)

By the end of the second month, they were not a single assay impacted by inventory as shown in **figure 5** and every order it's been made just in time.

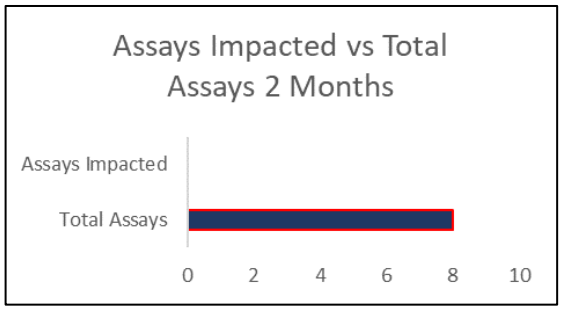

Figure 5
Assays Impacted vs. Total Assays (2 Months)

Another positive result was waste reduction and elimination, which helped not to raise unnecessary costs. Cost reduction in buying inventory has been noticed since the company does not have to pay extra to acquire it.

By doing this exercise with the inventory, we also get to know what materials and reagents are not required to have a lot of them stored. Having much quantity could lead to having to get rid of unused, expired materials, and with this we avoid that outcome.

CONCLUSION

This research has been a success thanks to the help of all the analysts that are laying off the materials out of the system and scanning the barcode that was labeled on the inventory. This could represent a problem if they stop doing this practice, as the system will be blind to the movement of the materials, and it should be considered as part of the employee goals for motivation and part of their

schedule so they have the time to do it. Also, using the same analysts as data collectors of the inventory used in their assigned assays also helped save the costs of hiring inventory-dedicated personnel. Meanwhile, some analysts questioned the extra work implanted; they also recognized that they know better about the materials that are being used for specific assays. Work balance is made for them so they can comply with the corresponding time of execution. At first, it was hard work, but if this continues to be implemented, it will be a lot easier in the future because it will be only a matter of updating the information of the material and reagents. Another positive outcome of the research was our problem with the defective lot, which gave us the perspective to buy different lots from vendors to ensure we do not have the same problem of lacking inventory.

It is ideal to follow the First In, First Out (FIFO) method. This method uses the oldest materials or reagents in the inventory first and the newest later. By doing this, the inventory would not be at risk of being expired without using them. This will also maintain control over how much to buy at the same time to avoid unnecessary loss. By utilizing the inventory tracking system, various wastes can be reduced and eliminated, such as inventory, transportation, and waiting. The waste of inventory occurs when a company overstocks materials and reagents to have "just in case" inventory. This could lead to having half of it expired and taking additional space in the storage location. Transportation would occur if all of those unused reagents reached their expiration date, and the company needed to pay extra to transport them for safety procedures. For the waiting waste, this system's purpose is to help the company to avoid waiting for an order due to a material or any reagent going out of stock in the company. This inventory tracking system will reduce costs in the supply of materials and reagents.

Besides helping the company's economy by reducing unnecessary costs, it also helps boost its reputation. It is very hard, especially for a pharmaceutical or biopharmaceutical, to explain to a client or regulatory agency that some tests are delayed due to a lack of reagents. Our highest standard is to bring the most effective and professional results to our patients, and inventory should not be an excuse to deliver.

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