Engineering Standard Work Proficiency Reports Automation for the Aerospace Industry

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Abstract *— The study was conducted in an Aerospace Industry located in Isabela, Puerto Rico. The objectives of this project were to eliminate report errors and to reduce the report development from 5 days to less than 1 day. A Value Stream Mapping was created to provide real values of times that a task or process takes to be completed. To reduce those times, Macros were created to automatize the process and a new Value Stream Mapping was created to show the new times that takes to perform the same previous tasks. Data was collected and analyze to verify if the process comply with the Industry and clients requirements. After a month of data collection, the data shows a dramatic reduction in the process errors that previously were created manually and the time to develop the report was reduced from 5 days to 1.2 days with s yearly cost savings of $97,760.*

Key Terms – *Automation, DMAIC, Lean, Six Sigma*

BACKGROUND & PROBLEM STATEMENT

Aerospace Industry utilizes various methods to measure and track the expertise of their employees and the progress of approved technical courses. Aerospace Industry calls this level of expertise the Proficiency Level (PL). The PL level is divided in 4 stages being the level 4 the most experienced. Supervisors track the PL level of their employees to make better decisions of who is capable of make certain types of work. The way that the supervisors track their employees is making a monthly report of the PL level. This report is 100% manually made and it takes 5 day to develop after receiving the data from the organization. Due to that the report is manually made, frequent errors has been encountered after finish them compromising quality, budget and delivery time. The purpose of this investigation is to automate the way that this report is made. This automation will improve the quality of the report because no errors will be made, the report will be made in less than a day improving savings and productivity of the employee because he can be assigned in other tasks in the time that he was supposed to be working with the report.

LITERATURE REVIEW

This project will be conducted in a Aerospace Company located in the West side in Puerto Rico and is about an automation of a series of reports related to employee capability levels of doing certain types of works. According to Paul Dickinson *"automation is having technology do things for you so that you don't have to". A good starting point is to automate the things that the Company don't want to spend time doing. Some of these tasks include: sorting e-mails into folders, de-cluttering your hard drive, updating all of your social media profiles etc. These little monotonous tasks can begin to take up a significant part of our day. There are many, many tutorials on automating tasks. From having an e-mail provider that automatically sort your emails with labels, or having a program record what you do in Microsoft Office® and then repeat that when necessary. Any task that you can think of that is repetitive can be done with a computer. That is one of the purposes and advantages of a computer; carrying out repetitive monotonous tasks so that the users don't have to. Automation has two purposes that are closely related. They are improving customer*

service and ensuring the survival of the enterprise".[1] Think about an intelligent system that can improve the relation of client-customer, a system that can lower the managing costs and a system that saves times across the process. All this characteristics can be achieved by automating the process to improve customer service. [2][3] Modern eras were technology is a key of growth shows that the business world is more difficult to grow from day to day. For that purpose, the knowledgeable use of automation is a real key to efficiently managing, competing and generally surviving in such dangerous and difficult times by improving their outputs with an involved quality to the customer.

There are several advantages of automating business process [2][3]

- **Reduce Production Cost** - A quick return on investment outweighs the initial setup costs.
- **Decrease in Part Cycle Time** – A lean manufacturing line is crucial for increasing efficiency.
- **Improved Quality and Reliability** - Automation is precise and repeatable. It ensures the product is manufactured with the same specifications and process every time. Repairs are few and far between.
- **Better Floor Space Utilization** - By decreasing a footprint of a work area by automating parts of a production line, companies can utilize the floor space for other operations and make the process flow more efficient.
- **Saves Local Jobs** - Instead of moving a company to a location with lower labor costs, the incorporation of automation in a few key areas is desire. This will increase product through-put and increase profit so managers can keep their company in the current location.
- **Stay Competitive** - Reduction in schedule and cost attracts customers. Automation helps provide the highest throughput with least amount of spending.

There are several tools for conduct an investigation in order to reach the problem that is occurring. One of these methodologies is the KAIZEN method.[4][5] According to the AVETA Business Institution "Kaizen is not about changing the basic system; it is aimed at optimizing the existing system. The approach promotes learning, building capabilities and improving processes through constant study to exploit improvement opportunities. The controls are maintained by following the standard operating procedures (SOPs). When the improvements are done, the SOPs are changed accordingly. All levels of management are involved in Kaizen. Kaizen projects are not a long and drawn-out; they are often limited to a short period of time. They are a perfect part of the Lean manufacturing process, as the model followed is that of PDCA (Plan-Do-Check-Act). Kaizen events can be carried out to continuously eliminate waste and improve the value of the process. Thus, if properly planned Kaizen events are undertaken in a Six Sigma project, they can help achieve great results". A Kaizen event typically has between 3 to 5 days of duration. To apply a Kaizen event, first determine whether there is an existing work standard for the process subject to improvements. It is important to have the work standard to use as a base for improvement. If there is no written work standard, it needs to be created. Then identification what measures exist that tells how well the process is currently operating will be recommended. It is important to understand the current level of success of each work process is seeks to improve so that it can be measure whether it have been improved and, even before that, to detect where to focus improvement efforts. Learning about target work process is needed. The project manager should get and study the work standard. It is recommended to walk the work process with someone who is very knowledgeable of it. Identify the work process measures that match the company's priority improvement objectives. It is these measures you will target for improvement by uncovering the waste that is compromising the work process's level of success. If the company has not defined such objectives, look for the work process measures most related to achieving the

company's priority business results. Document a scope for the proposed application of Kaizen. A scope defines the focus, boundaries, and expectations for performing a Kaizen event.

There is another tool that has the purpose to redesign a process and make a leaner one. This tool is called Value Stream Mapping (VSM).[6] Value stream mapping is the simple process of directly observing the flows of information and materials as they now occur, summarizing them visually, and then envisioning a future state with much better performance. Value Stream Mapping is based on the fundamental principle of Lean Manufacturing. Lean Manufacturing or Lean is a manufacturing term used to describe a manufacturing, industrial or service operation which operates with little or no type of waste, thus making the operation very efficient and only consisting of value adding steps from start to finish, as can be seen in a value stream map.[6] The term “lean” centers on the idea that if a customer is purchasing a good or service, then customer is only willing to pay for the value added "steps" in making or delivering such a service. This principle states that any activity or action which does not add value to the product is a form of waste and must be eliminated or minimized. Value is added any time the product is physically changed towards what the customer is planning to purchase. Value is also added when a service is provided for which the customer is willing to pay. If we are not adding value, we are adding cost or waste. The value stream is the set of all specific actions, both value added and non-value added, that are needed to take a product through the information and production flows of a manufacturing operation. The value stream map follows the production path from beginning to end and shows a visual representation of every process in the material and information flows, the maps show the linkage between information flow and material flow for the product family. The value stream map development process consists of the following two steps, development of the Current State and development of the Future State. The Current State Value Stream Map shows how the shop floor currently operates and serves as the foundation for the future state changes.

The map starts with the shipping area and works back through the process to the suppliers. You need to start with one product family otherwise the map will be too complicated. The Future State Value Stream Map shows how the shop floor will operate after lean improvements have been implemented. The Current State Value Stream Map serves as the starting point for developing the Future State. The goal in developing the Future State Map is to make the flow continuous and to eliminate as much waste as possible. Lead time is shortened as much as possible by implementing lean techniques. The flow in the Future State Map is built around the takt time, or how frequently a unit must be completed to meet customer demand. Takt time is simply the available working time per shift divided by the rate of customer demand per shift.

PROJECT METHODOLOGY

This project will be performed using various tools that are successful keys in lean manufacturing. The use of the VSM tool will help in the design of new or optimized way to perform the reports in a high quality, low cost and error free manner. The employees that will be associated with the implementation must be trained according the tasks assigned to them. Employees must know why the process will be investigated and the outcomes in terms of quality and costs.

The first step is to identify the problem, why it is occurring and what is the reason for the concurrence. The root cause of the problem can be identified using the 5 Why’s tool. This is a tool that makes the “Why?” question almost 5 times to get to the root cause. Sometimes, it takes less than five questions and in rare cases, more than 5 questions are needed to get to the root cause. It is important for the successful of the event to perform a data collection to ensure that the problem identified is the major offender of the process. That data collection will be compared at the end of the process with the data taken after the

implementation of the automation tool. With the root cause of the problem identified, then a current state map of the process is created in order to apply changes for improvement. This current state map is one of the stages of the value stream mapping. In this stage, the value-adding suggested the steps be drawn across the center of the map and the non-value-adding steps be represented in vertical lines at right angles to the value stream. Thus the activities become easily separated into the value stream which is the focus of one type of attention and the "waste" steps another type.

In the case of automation, all processes that are made manually are waste and the processes that are made automatically are value added process. Lead time is very important in the application of the VSM tool. The lead time will give a concrete structure about the real process execution time. The objective is to reduce that lead time to make the process more optimized and more efficient. After the current state map creation, a future state map will be created showing the optimized process and the new lead times according to the robustness of the automation tool created. The automation of the report will consist on a Macro created in a compilation program. Several tests will be conducted to the improvement tool for its validation and accuracy. After validation, data needs to be collected within the new process, and then this data is compared with the data of the previous process to identify the amount in terms of percent (%), of the optimization achieved. Employees are trained in the new process to make sure that it gets standardize and with continues optimization.

RESEARCH PROJECT RESULTS & DISCUSSION

The analysis of the data collected during various months was made utilizing various six sigma tools like the Pareto Charts and the Value Stream Mapping.[6][7] A DMAIC was performed to conduct the project in an efficient way. A DMAIC is a 5 phase's process to solve problems in a robust way. A DMAIC was utilized to solve the problem of this project that was conducted in an aerospace Industry.

Define

The Problem statement for this project is: Proficiency Reports are 100% manually made and it takes 5 day to develop after receiving the data from the organization. Frequent errors has been encountered after finish them compromising quality, budget and delivery time. These reports are made for a Jet Turbine Engine manufacturer located in U.S. and the Critical to Quality process are the data analysis for each employee to be tracked. The main objectives and scope of this project are to minimize the report development time from 5 days to less than 1day, to improve quality to 100% error free report and to improve savings by > 80%. A Project Charter was created to establish the project objectives, project goals, assign tasks, the roles of the Project Manager and how the project will be conducted. The Project Charter is included in Appendix A.

Measure

For this phase of the DMAIC, data was obtained each working day during a period of three weeks while the reports are manually created in a normally basis. The data that was obtained includes the time that each step of the report takes to be done, the number of defects in each of the steps and the time between each phase. This data was analyze in a utilizing a Pareto Chart to obtain which of the process are the top offender in mistake and errors made. While creating the report, a Current State Value Stream Mapping was created to see the overall process and the times that it takes to make each of the process.

Data collected from each process step was analyzed using Pareto Charts and the top offender was selected to be in the process of data collection. The Pareto Charts below shows the quantity of defects obtained in each of the process steps for the 3 weeks of data collection (Figure 1, 2 and 3)

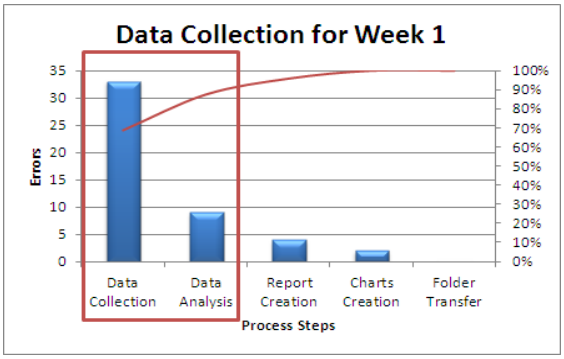

Figure 1
Pareto Chart of Defect for Week 1

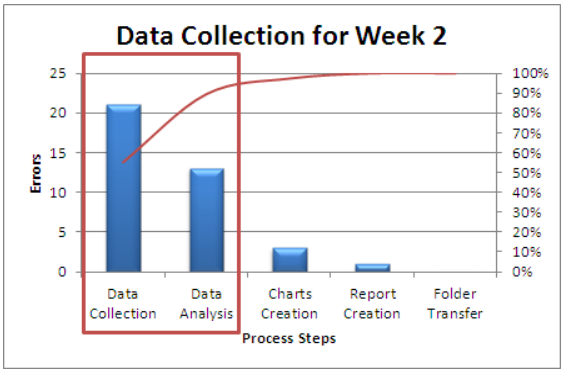

Figure 2
Pareto Chart of Defect for Week 2

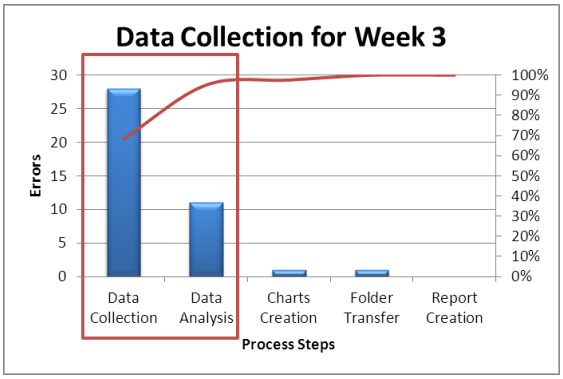

Figure 3
Pareto Chart of Defect for Week 3

After 3 weeks of data collection, there is sufficient information to begin the third DMAIC phase, The Analyze Phase.

Analyze

In this phase, the 5 why's tool will be used to determine why too many errors are obtained when in the Data Collection and the Data Analysis steps of the project. For the Data Collection step of the project, after the application of the 5 why process, yields that the problem is the collection of the data in a manually basis. The 5 Whys for the Data Collection Process is below.

- Symptom: Too many errors when downloading the data. Why?
- Symptom: Data is too long to process and takes too much time to process. Why?
- Symptom: Data is downloaded manually from the system. Why?
- Symptom: No standard Work is created for the project and thus, no automation tool can be implemented. Why?
- Symptom: Customer requirements changes from month to month.

The 5 whys tool for the Data Processing step yields to the same problem. Data is manually downloaded because the process is not standardized and no Standard Work is created.

Knowing that the problem basically is for the manual process of the project, an improvement automation tool will be implemented in order to reduce the errors to 0 and to significantly download the process time of obtaining the data from 3 full days to a 5 minutes automatically process. The results of this implementation will be discussed in the next DMAIC Phase, The Improve phase

Improve

After analyzing the data collected, the manually process step is what was creating the number of errors and mistakes in the process. To prevent these errors to ever occur again, a tool was implemented to substitute the manual downloading step into an automated process. This was possible by the creation of a Macro in Visual Basic software. This Macro was created to substitute every single step that was performed manually. The Macro itself, with a touch of a button, go to the database to obtain the data for the almost 200 employees of the organization, it sorts the data corresponding to each employee and feed a database that is used for charts creation. After this implementation, data was collected for 3 weeks in

the same manner as the original one and Pareto charts were created to see the reduction in error quantities (Figure 4, 5 and 6). Also a Future State Value Stream Mapping shows the new times that are needed to execute the process steps.

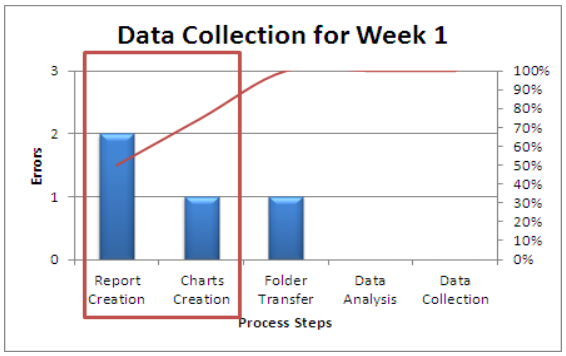

Figure 4
Pareto Chart of Defect for Week 1 after Improvement Implementation

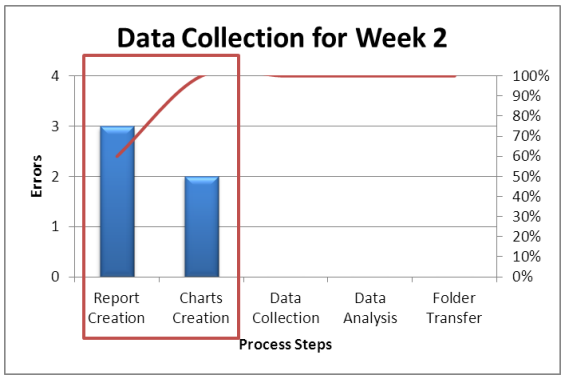

Figure 5
Pareto Chart of Defect for Week 2 after Improvement Implementation

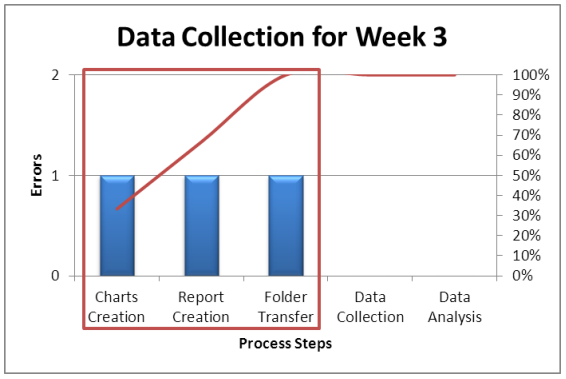

Figure 6
Pareto Chart of Defect for Week 3 after Improvement Implementation

As can be seen, the steps that were originally causing the errors in the process were reduced to 0 defects in both process steps. The time that was needed to create the report was drastically reduced to less than two days.

Control

After the improvement implementation, data was collected to analyze the behavior of the whole process with the new automation tools. After this analysis we observed that the process was controlled. New Standard Works instructions were created in order to have the process executed in a controlled manner and checklist were created to verify the process when all steps are finished. A process control chart was created to see the behavior of the process before the improvement implementation and after the improvement implementation.

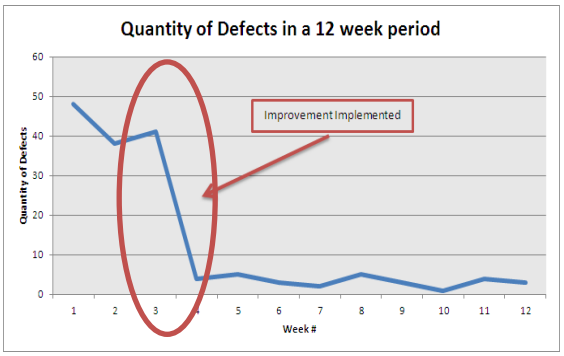

Figure 7
Defects per Week before and after Improvement Implementation

Results

After implementing the 6 sigma DMAIC phases to the reports creation of the Aerospace Industry we obtain excellent results in terms of quality and cost reduction. Before the 6 sigma implementation it takes a whole week to finish the Proficiency Report before sending it to the client. The cost of this report before the improvement implementation was $1,880/week ($47.00/hour X 40 hours) having a year cost of $97,760. After the improvement implementation the cost to the client

is $586.00/week ($47.00/hour X 12.46 hours) having a year cost of $7,027.00 that is a cost reduction of $90,733. This is a percentage reduction of 92%. The quality of the reports was dramatically improved (0 defects in the Data Collection and Data Analyze) due to the automation tool created.

CONCLUSION AND RECOMMENDATIONS

After an intensive study and data recompilation, it is demonstrated that the 5 phases of the Six Sigma Methodology are a great tool for process improvement implementation and analysis. As in this case, companies can implement process improvement projects utilizing these tools to get the most efficient, leanest and high quality process while reducing drastically the time and costs of operations. Reducing cost operation can yield in more savings that can be implemented in research and technology projects in the same company.

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