Development and Application of Statistic Software Using Lean Concepts to Monitor the Performance of the Quality Assurance Department

Yesenia Burgos Diaz
Manufacturing Competitiveness
Rafael Nieves Castro, Pharm.D.
Graduate School
Polytechnic University of Puerto Rico

Abstract — The vast majority of companies have integrated the lean methodology into their work environments so they can be more efficient in their processes, eliminating and correcting errors within the manufacturing environment. An accurate way to know that the process is in control is by using statistical software to measure patterns and detect errors. However, to make these graphs or tables, one needs the human element to create them. This research paper derives from an in-depth study of different statistical software's that will help improve the manufacturing processes of a company, thus, removing waste. Currently, some programs configured can graphically give this information. With the information obtained, it can be analyzed, and conclusions can be drawn about the status of each process. It is of utmost importance since seeing these trends, certain improvement projects can be carried out to optimize the process.

Key words — Improve Performance, Lean Manufacturing, Metrics and Statistic software

INTRODUCTION

The Department of Quality Assurance is in charge of auditing the documentation that is received when the batches complete their packaging process. After the documentation is audited the product disposition area proceeds to dispose of the batches so that they can be sold to the market. In this process there have been many delays in the delivery of the lots, a substantial increase in the number of records received in the area has also been observed, proving that the department fails to deliver to the product disposition area. Not delivering those lots to the mentioned area poses a major problem for the company as it delays the release of their products to the market. This problem may be solved through the development of a tool that gives the quality assurance department personnel a live view of the lots they have in the area to improve dispatch times to product disposition. It is important to create this tool by applying the Lean methodology because one can have many metrics that can help the area improve and have more control over the products. Therefore, the research paper aims to accomplish a functioning tool that presents a live visualization of the statistics of the batch records to improve the organization of the priority of the product.

RESEARCH DESCRIPTION

Lean tools help the agility of any type of company since it allows to have a perspective of what is happening during the process through tables and graphs, which are then analyzed to improve the aforementioned process. Developing this tool is important because it helps employees to have a live view of the metrics. This tool would be a lot of help during the constant status meetings that occur in the company which will help the employees to have a real status of the quality of the batches that they will have to audit and those who were audited.

RESEARCH OBJECTIVES

Develop a tool that permits a live visualization of the amount of batch records that arrive to the area of Quality Assurance.

RESEARCH CONTRIBUTIONS

The main contribution of this research will be developing a tool that can shorten the time the department of Quality Assurance invests in making the lists with the priorities of the lots. In addition, it will eliminate the writing of emails with the status of

the lots. With this improvement everything will be documented in a table that will facilitate the work since it will be configured according to the due dates, and with the help of colors that stand out personnel will be able to find any record that is due to expire on the delivery date. Furthermore, it will be programmed to send emails with what is pending at the end of each work shift. Essentially, the tool will use statistics to create visualization of the batch records to improve the delivery of each lot.

LITERATURE REVIEW

Improvements are an important part of any company. These improvements, be it big or small, are a necessity for processes to be agile and efficient. Nowadays, the vast majority of big companies use the lean methodology developed by the Toyota company. Lean methodology has two guiding principles: respect for the people and continuous improvement. Respect for the people focuses on recognizing that those who work closely with processes or services have a voice to provide ideas to improve processes. Secondly, continuous improvement essentially is about always considering that there is space for improvement be it in processes or services. Through these two guiding principles waste can be eliminated. This methodology has currently helped many companies to improve their processes since, as a result of small changes, processes are streamlined through an organization.

Companies encourage employees to provide ideas to create continuous improvements in the manufacturing processes. It relies on employees' observations of the processes and analytical review to think of ideas to improve them, following one of the principles of the lean methodology. Through extensive observation in the area of Quality Assurance in the company, it was noticeable that the communication aspects regarding batch records needed to improve. Communication and information aspects relied on sending an email written by a person daily through the three work shifts. These situations created a waste that could be fixed through a tool that provides an analytical visualization of the

processes for employees. It is plausible to develop this tool as found in various articles where tools were developed that have as a principal objective to develop an analysis using data.

In reference [1] the authors connect to the problem statement of this research paper. The article focuses on presenting how the development of lean tools help identify areas for improvement and where one can employ this type of concepts to be able to modify the areas. The model implemented into two completely different companies, one focused on aerospace and the other on automobiles. This demonstrates the performance measurement tool is capable of being implemented on any type of company, that it is precise, and it achieves its function. It is also explained in [1] how the transformation process was since it is one of the most important parts of executing changes and because of the human factor it can be understood why they are carried out and how they will do the new processes. It is highly important to maintain the human workforce motivated and gradually creating those changes.

Furthermore, the support of management is essential because employees will be able to see that as a group, they go in one direction with those changes and that the company is improving through their hard work. These improvements to processes are necessary so that the company can be recognized for its incredible work. This tool can measure the elimination of waste in the process and the setup of equipment stops due to problems with equipment, among others. After implementing this and other metrics, constant monitoring is important, since this way they make sure that the systems were implemented correctly and meet their purposes. At the end of [1] they conclude by reaffirming that the implementation of these systems is effective to improve those areas where companies are investing unnecessary time.

In terms of waste reduction, [2] presents an example of how a company may reduce waste in processes. It also discusses the positive impacts waste reduction has on companies while also making them more competitive in their respective fields. It

highlights how companies can also implement these lean systems to their processes demonstrating that they were not able to take advantage of these tools. In this study [2], data from 63 different companies were collected and identified using three different methods. First, researchers contacted the companies that attended a conference in Croatia in 2017 as well as other companies through the list of the "Croatian Chamber of Economy". Readers can graphically observe how with the implementation of different Lean systems' they can identify waste and correct what is not working. The companies that properly implement these tools have positive results as compared to those who did not implement it correctly.

Nonetheless, it is not only about applying lean methodologies in certain tools to reduce waste and improve processes, but also about applying a lean culture. In reference [3] two frameworks for lean implementation are presented, and their effect on the performance metrics of a company. It essentially tabulates how the implementation of lean methodologies helps improve productivity, while also highlighting that companies should implement tools that measure how the changes to processes work to increase productivity. A part of what [3] explains coincides that the key to success is not only placed in the management area but also on those employees that work closely with the manufacturing processes that lean activities and metrics hope to improve. Employees that work closely with the manufacturing process are the ones that can provide ideas that may improve them, making it nearly impossible for a company to improve without them. Implementing metrics is important, for example, it gives a company a guide of how many units should be processed in a work shift, how much time should it take to change from one batch to another, or how much down tie to spend on repairs. The less time lost in certain activities is time that companies can use to increase the number of products produced, which translates to an increase in sales. The article also talks about how these monitoring systems should be implemented in, during, and after all the improvements that are made, as this will give visibility of how the processes are doing and where they can improve.

References [1], [2], and [3] concur that eliminating waste in any manufacturing process benefits the company. If time frames in these processes are improved production will increase, which helps that a company has more capacity. So, if the Lean system is implemented in any company, tools must also be implemented that help both in the visibility of metrics. These metrics should present the errors that are happening in the areas and that leads them to be less effective.

METHODOLOGY

This research aims to implement a Lean tool that helps the Quality Assurance department to improve its processes. Currently, there is no tool to help measure statistically the lots that are going to be audited using the FIFO (first in first out) methodology. As a part of the lean systems, technological applications are a part of those to be implemented for monitoring certain parameters. Finding a tool that can improve processes and eliminate waste is essential, therefore, it is important to test different statistic processors to find which provides a live view of the lots in the Quality Assurance department.

For this research, a search was carried out to determine which specialized statistical system provides all those characteristics that meet the needs and requirements to carry out this monitoring. These applications can be programmable so that graphics can be produced automatically with minimal data entry. After the search, three programs were selected to be evaluated to determine the most adequate for implementation in the Quality Assurance department. The programs are Microsoft Excel, Minitab, and Smartsheet. These programs will be evaluated in the following requirements: the functionality of the program, the complexity of programming the system so that it provides information needed, and the cost of the license per user.

The first program to be evaluated is Microsoft Excel [4], which is a spreadsheet program, a data visualization and analysis tool developed by Microsoft. This spreadsheet program can be used through different operating systems such as Windows, macOS, Android, and IOS, which makes it widely accessible. A grand majority of people have a basic understanding of how it works, nonetheless, this program can perform complex mathematical functions and can also be programmed to create tables whose information can be graphed, as well as the ability to edit and view the results in a live manner. This spreadsheet program is accessible since its subscription costs approximately $20 per user, which is a viable cost for a big company. The subscription also provides access to all of Microsoft Office suite programs such as Word and PowerPoint, among others.

The next program to evaluate is Minitab [5]. Minitab is a statistic software developed at Pennsylvania State University by a group of researchers called Barbara F. Ryan, Thomas A. Ryan, Jr, and Brian L. Joiner in 1972. This statistic software focuses more on the analysis of data and the interpretation of results as compared to Microsoft Excel. It has many functions to make different types of specific charts, such as a run chart, Pareto, trend charts, and predictive models that help companies make decisions and implement corrective measures based on the deficiencies they find. Minitab is less commercial as compared to Microsoft Excel because its licensing by the user is approximately $1,200 annually. To find an estimate for a company, it has to be submitted by email, so it can be deduced that its subscription is costly and that it will depend on the number of users. In its product description, it states that it can be used to apply the Leans six sigma methodology to reduce the eight types of waste in processes.

The last software to be evaluated is Smartsheet [6]. It is a project management and collaboration tool that offers a combination of both Minitab and Excel since it can make graphs and tables, this data can be populated, and they can change during live view in the programmable dashboard. It uses a tabular user interface such as a spreadsheet to provide a visualization of the progress of each task or large-scale projects. Among the most outstanding functions is to schedule emails that notify the users tracking that Smartsheet. These are sent automatically on the frequency that the user selects, in this way, productivity can be monitored by shift. It facilitates the analysis since the users document the information making the monitoring of the processes a continuous one. The license of this program at the corporate level is $140 per year per user, however, only the programmer has the license for it, so that other users can access and view the reports even add information without having to license them.

RESULTS AND DISCUSSION

After gathering the data, each statistic program has its pros and cons. The statistic programs observed are the following: Microsoft Office Excel, Minitab and Smartsheet. Subsequently analyzing the data will help determine which one adjusts to the needs of the department of quality assurance. Different areas were observed such as cost, efficiency and productivity graphics.

Microsoft Office Excel is a software used to view, create and edit spreadsheets. Excel permits different users to create spreadsheets, tables, and graphics with different formulas integrated into the software. In terms of cost, Microsoft Office 365 for an enterprise cost $32per user a month, this includes the different software such as Word, PowerPoint, One Note, Publisher and Access. However, the software is not cost effective for a manufacturing company and the quality assurance department. It is not cost effective because it includes programs not used in the quality assurance department.

Looking closely at the Excel software, different cons arise. When creating spreadsheets the program seems to accommodate the productivity focused on accounting. For example, entering financial records to be added, divided or subtracted. For the quality assurance department, the software does not accommodate its batch records. In the quality

assurance department, the quantity of the batch records received, pending and released are entered in the statistic program to create a visible graphic. In Excel, these graphics can be created, but it does not show the productivity of the department in terms lean metrics. Lean metrics are an essential part of a company as waste is reduced in different areas to improve productivity. Excel does not show a realistic view of the status of each batch record making the graphic useless.

The next statistic program tested was Minitab. Different results were gathered, and cons were presented after the analysis. Minitab cost exceeded the budget for the quality assurance department. This software's license cost $1,400 for each user. For instance, in the second shift there are 16 employees in the department, which would cost approximately $22,400. That is without adding the different employees and managers across shifts. The Minitab program would be too expensive for a company.

For productivity graphics this software does work for the department. However, in terms of efficiency it does not meet expectations. Minitab does not provide a dashboard. A dashboard is a place where information is presented in an accessible, visible, and accurate view. This software requires the QA to create a new spreadsheet each time information is updated, making it inefficient. The Quality Assurance department receives information of batch records of the lots in abundance across 24 hours. Meaning that the information should be updated when entered automatically without creating various spreadsheets. Therefore, Minitab does not work for the type of productivity in this department. Even though, it complies with some of the lean metric system, in terms of time and efficiency it does comply.

Finally, Smartsheet was the last statistic software analyzed. Smartsheet is a combination of both Excel and Minitab in terms of friendliness of usage. Yet, it provides much more than the previous mentioned programs as it focuses more on workflow. It is cost effective for the department as the Smartsheet license cost $300 per year. It also allows employees who do not have the license to edit

and view the graphics and tables in the software. Therefore, there is no need to buy a license for each employee of the department.

Smartsheet provides a dashboard that displays an accessible, visible, and accurate view of the information entered in the spreadsheet. As a result , the employee does not have to create different spreadsheets each time the information needs to be updated, like with Minitab. In this dashboard one can view different graphics of the entered batch records in terms of shifts, days, months and years. This complies with the lean metrics as one can identify where waste can be reduced to improve the workflow. This software seems connects with the goals of companies that use the lean methodology.

The comparison for cost per user for the researched statistics software is illustrated in Figure 1; the cost for quality department in Figure 2. Also, all other features compared between the researched statistic software are presented in Table 1.
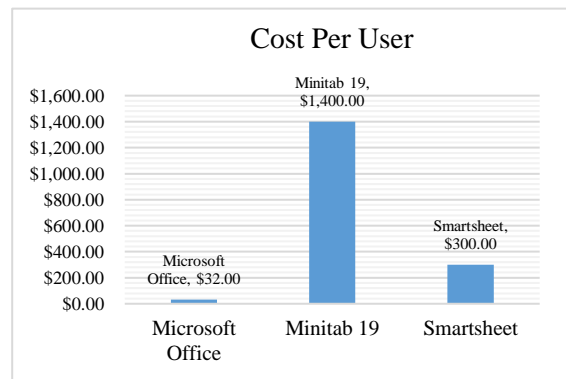
Figure 1
Cost Per User of Researched Statistic Software Graphic
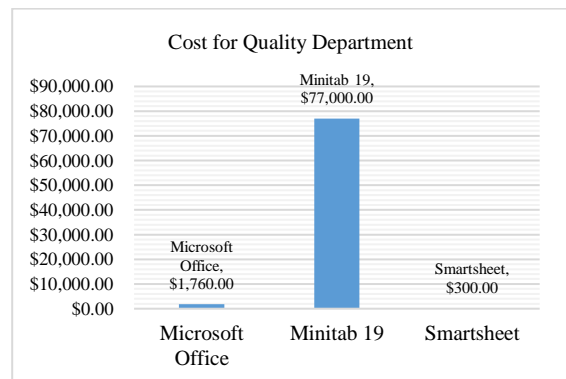
Figure 2
Cost for Quality Department of Researched Statistic Software Graphic

Table 1
Comparative Table of the Features of the Researched Statistic Software

System Features	Microsoft Office	Minitab 19	Smartsheet
Graph	✔	✔	✔
Table creation	✔	✔	✔
Dashboard			✔
Accounting tool	✔	✔	✔
Lean metrics		✔	✔
Live actualization	✔		✔
License per year	✔	✔	✔
Additional programs (email, writing, presentation)	✔		
Compatible with Windows and Mac	✔	✔	✔
Access through mobile devices	✔		✔
User friendly	✔		✔
Blog Support	✔	✔	✔

CONCLUSION

It is very important to have a system that provides updated information on the status of the Batch Records that are received in the Quality Assurance area. With this tool, the area will have an updated view of the quantity and status of the batch records that are received in the area. Through this research, a computer system can be found that helps not only count batch records but also generate statistical graphics used in the Lean Methodology to measure productivity. Calculating the data through these systems will help the department make improvement projects where the capacity of products is increased, so as not to cause a delay in product shipment. This is highly important, for instance, in a medical manufacturing company, where a delay in shipment translates to a patient not receiving a dose of their medicine on time. This delay will cause the customer to gain a distrust of the brand, resulting in the company losing income or other customers. For a pharmaceutical, patients are highly important, the work done every day is carried out in order to serve them. Customer service is an essential issue for any type of company that is dedicated to this service. That the customer is satisfied, and that the product meets not only their expectations in terms of quality but also that this product is available when the customer wants to buy it.

Through the research three statistical programs were analyzed. They were compared to measure which of them would be more suitable to perform the work needed to carry out the monitoring and perform productivity metrics for the department. After evaluating the three programs it was determined that the program chosen to be used is Smartsheet. This program was chosen out of the three for its diverse applications as well as being the most cost efficient when compared to the other two programs.

REFERENCES

[1]   A. Al-Ashaab, M. Golob, U. A. Urrutia, M. Gourdin, C. Petritsch, M. Summers, and A. El-Nounu, "Development and application of lean product development performance measurement tool," *International Journal of Computer Integrated Manufacturing*, vol 29, no. 3, pp. 342–354, 2016.

[2]   I. Leksic, N, Stefanic, and I. Veza, "The impact of using different lean manufacturing tools on waste reduction," *Advances in Production Engineering & Management*, vol. 15, no. 1, pp. 81–92, 2020. [Online]. Available: https://ezproxy.pupr.edu:2093/10.14743/apem2020.1.35

[3]   D. F. Manotas-Duque and L. Rivera- Cadavid, "Lean manufacturing measurement: The relationship between lean activities and lean metrics," *Estudios Gerenciales*, vol. 23 no. 105, pp. 69-83, 2007. [Online]. doi:10.1016/s0123-5923(07)70026-8

[4]   Microsoft, "Microsoft 365 E3," [Online] Retrieved December 11, 2020, from https://www.microsoft.com/en us/microsoft365/enterprise/e3?activetab=pivot%3Aovervie wtab

[5]   Minitab, "Licencia anual para un solo usuario," [Online] Retrieved December 11, 2020, from https://store.minitab.com/781/purl-minitab

[6]   Smartsheet, "Planes de Smartsheet," [Online] Retrieved December 11, 2020, from https://es.smartsheet.com/pricing