Lean Manufacturing Implementation to Improve Process Capability and Performance

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Abstract

Industries has been continuously evolving with the change in tendencies and market growth of products. To be capable of maintaining the organization competitiveness, in front of an aggressive market, production capability and cost reduction is desired. Company X is dedicated to the design and manufacturing of customizable packaging and promotional merchandise. It was identified some factors affecting the deliverables of the production floor, such as inefficient layout design. Lean manufacturing is a tool widely used by many industries to reduce waste in processes. Applying this tool into production processes, allows to reduce wastes in process and to reduce production costs and defect ratio. DMAIC (Define, Measure, Analysis, Improve and Control) was the methodology used to improve the outputs of the production floor of Company X. At the end of the project an improvement of 15% on the productivity was observed; in addition, the defect rate was reduced by 33%.

Introduction

After COVID-19, the demand of products, specifically packaging products, has a rapid increase. In Company X it was identified a need to operate in an efficient way, to meet customer's requirements. Production deliverables were often delayed by inaccurate planning in the production department, affecting customer satisfaction. There exist some losses of time because of an excess of movement and a lack of organized area; making difficult for operator to find the correct tools or materials to be worked on. This overwhelmed area and lack of organization affects productivity and increase the defect rate, not only for waste in time finding tools or materials, but also affects the work environment and the morale of employees. Lean manufacturing was implemented with the purpose to identify the weakness of the process to improve it and obtain better results.

Background

Some organizations get implemented Lean Manufacturing methodologies to increase profitability resulting from an increase in capability, productivity, and employee's engagement. Capacity increase can by achieved in some ways: (1) increasing the machine availability, by eliminating wastes from the process; (2) eliminating bottle neck processes and (3) making an investment to have new equipment and space. [7] To have a productive and easy-to-follow work environment, 5's practice becomes important and relevant. This is a Japanese method to organize the work area. As shown in the Figure below, 5's method consists in: (1) Sort, (2) set in order, (3) shine, (4) standardize and (5) sustain.

Problem

This research is being performed to understand and correct some issues of capability and productivity in an organization. There was identifies that there exists some wastes affecting the deliverables of the production department. The goal of this research is to reduce by at least 40% the rate of defects and re-work and increase productivity by at least 15%.

Methodology

To reduce non-value adding activities as well as wastes, often known as muda, the use of lean manufacturing techniques was decided. DMAIC approach is an abbreviation used to describe the five-step strategy which includes: Define, Measure, Analysis, Improve and Control phase, which is a cycle for continuous improvement.

In the define phase the project goal needs to be established. For this project, a Project Charter will be developed to define the problem statement, as well as the scope of the project with the desired deliverables. Main advantage of Project Charter is to clarify from the beginning of the project the objectives and the scope of the project.

Methodology

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In the measure phase, the focus was to establish a process baseline, which further will help to identify problems or process abnormalities.
The tool used was a Pareto Chart, this graphical tool helps to identify the main causes of problem and the degree of impact and significance.

On the third phase, analysis, all the results obtained from previous phases must be analyzed. A root cause analysis was implemented. Advantages of this analysis are the identification of the main causes of the problem. It is a depth study which will give the root cause and the solution can be permanent and it will avoid future defects or reduce the re-occurrence.

The improve phase's objective is to get implemented some changes in the process to eliminate the wastes identified and therefore, get an improvement in the process. Brainstorming is one of the tools to be used in this phase. In addition, approaches such as 5's must be implemented for process improvement.

In the last phase, control, any change in process need to be added to the corresponding procedures, in addition trainings to employees who works directly with those process changes needs to be conducted. Process capabilities and metrics needs to be determined and defined in this phase. Internal audits need to be performed during this phase to identify and correct any irregularity that could affect the process performance. In control phase a Statistical Process Control was performed to compare initial outputs and final outputs after improvement of processes.

Results and Discussion

The first step during the project was the Define phase, in this phase a Project Charter was developed to define the problem statement, the goals and scope of the project and the identification of team members who were working on that project.

Table 1
Project Charter

Project Charter			
Name:	Internal Project: Production Floor Capacity Improvement		
Release Date	Nov 15, 2021	Project Approval	VP
Estimated time of Completion	April 01, 2022	Project Manager	Yanairy Orama
Project Purpose			
• Increase in capacity of production • Reduce by at least 40% defect and re-work rate • Improve by at least 15% the productivity of production floor			
Scope			
All the processes within production departments, including warehouse department			
Out of Scope			
Other administrative departments and design and customer service departments			
Deliverables	Reduction of production lead time, less rate of re-work, production costs reduction.		

Another tool used to measure the current state the pareto chart. Here it can be easily identified that there are many issues that affect the production process. Space limitation results one of the most common issues affecting the performance and productivity of the production department.

Results and Discussion

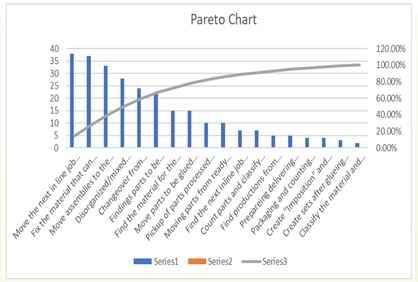


Figure 1

Pareto Chart for the Initial State

A Root-Cause Analysis was performed to identify the root cause of each one of the most significant problems

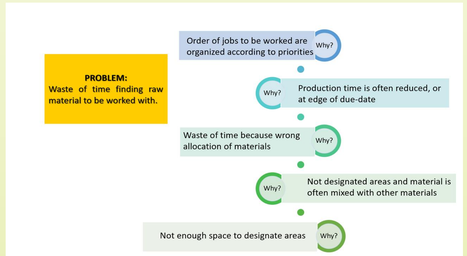
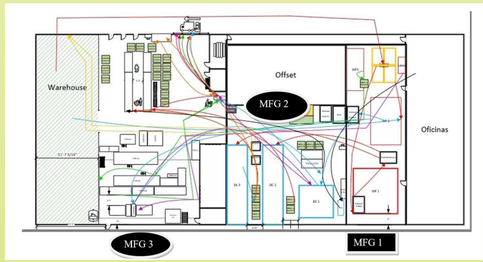


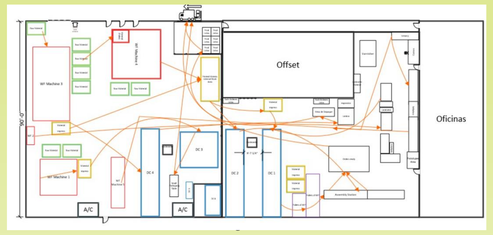
Figure 2

Root-Cause Analysis (5-Whys?)

Figures below shows the layout of the production department. The Figure 4 illustrates the initial state of the production department with the spaghetti diagram representing all of the movement needed to complete an order. Figure 4 illustrates the final state layout in which different areas was re-arranged in order to reduce the movement needed and to provided the necessary space to allocate all of the tools and material needed.



Initial State Layout



Final State Layout for production floor (Spaghetti Diagram)

Results and Discussion

Figures 5 and 6 shows a direct comparison between same area, comparing old and new layouts. It was identified a high ratio of defects and rework due to bad management of unfinished jobs and losing items from a job. This was identified by visual inspection as shown in the Figure 5, where different jobs were mixed in the same pallet. Some different order has pieces which are similar, so after being mixed is difficult to find them.

Figure 6 shows a pallet with a specific job, 5'S method allows to reduce waste of time by identification items and moving them, as the operator can now move the entire pallet, instead of moving piece by piece.

Figure 5
Old Layout

Figure 6
New Layout

Conclusions

Some operations in the production department of Company X was affected by wastes that causes errors and issues in the products generated. The production floor space was limited so there was not enough space to maintain unfinished jobs in good conditions and easy to find. To understand the status of the production floor and the direct variables that are impacting the performance, an DMAIC analysis was performed. The project was defined and studied by using the value stream map and pareto chart. The use of those tools highlighted the areas that needed strengthening. Removing the warehouse from the previous area an located it on another facility, awards space for placing the current equipment, material, and unfinished jobs in optimal positions. Moving the warehouse also allows to add more equipment to increase the production volume capacity by reducing bottleneck. After allocating the operations in the new layout designed and applying 5's method to allocate the materials and miscellaneous, the operation process presents an improvement of 33% of reduction of defects and 15% increase in productivity.

Future Work

The future work after the implementation ofthis project in Company X will be the implementation of those techniques in the warehouse department.

Acknowledgements

Thanks to the Polytechnic University of Puerto Rico Office of Graduate Affairs and Dr. Jose Morales.

References

[7] W. Abu Jadayil, W. Khraisat, & M. Shakoor, "Different strategies to improve the production to reach the optimum capacity in Plastic Company," *Cogent Engineering*, vol. 4, no. 1, 2017. Available: https://doi.org/10.1080/23311916.2017.1389831. [Accessed: April 12, 2022].