Improve Compliance to Schedule

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ABSTRACT

One of the most difficulties in manufacturing is to explain the production colleagues the importance of following a production schedule and deliver product on-time to the next process. The facility in where this research project was conducted, had have a compliance to schedule within an average of 79.1% in the last eleven months, which it is expected to be 95% or above. This low performance to schedule is causing delivery issues from the dye house to the sew plant. In some instances, air shipments and overtime happened, to ensure the distribution center received the product to be able to deliver to the customer on the agreed date. This research project was performed applying the Six Sigma, DMAIC methodology. The structure of the DMAIC methodology truly helped in find out the root cause of the actual problem that was affecting the compliance to schedule. At the end of the project, the compliance to schedule was improved and sustained to 100% for 4 consecutive weeks.

INTRODUCTION

The company requested not to reveal the name, so the name that will be use is Company ABC. The Company ABC manufactures women's underwear. The main process of the supply chain is knitting, dyeing and sewing. Lately, knitting has been a bottleneck of the supply chain. The process has been unable to deliver the specific items in the production plan on a weekly basis. This is resulting in delays to the dye house (dyeing), to expedite and keep the flow of the product to sewing based on the pre-defined process lead time. The opportunity is causing additional cost to the company such as overtime, an increase on orders in backlog and unplanned air shipments to fulfill customer orders.

BACKGROUND

The facility of the Company ABC located at the eastern side of Puerto Rico. The ABC Company is a division of a well-known international clothing company in the United States. The Company strategy is to sell more, spend less and increase profit. The main processes of the supply chain are in different countries.

PROBLEM STATEMENT

Lately, knitting has been a bottleneck of the supply chain. The process has been unable to deliver the specific items in the production plan on a weekly basis. This is resulting in delays to the dye house (dyeing), to expedite and keep the flow of the product to sewing based on the pre-defined process lead time. The opportunity is causing additional cost to the company such as overtime, an increase on orders in backlog and unplanned air shipments to fulfill customer orders.

OBJECTIVE

- To apply the Lean Six Sigma techniques and tools to increase the schedule compliance of knitting to 95%.
- To revise and analyze the whole process, since receive the production schedule until goods are transfer to the dye house.
- To identify the variables affecting the compliance to schedule.
- To address the underlying causes of having the compliance to schedule below the company goal.
- To apply solutions that causes of having the compliance to schedule below the company goal.

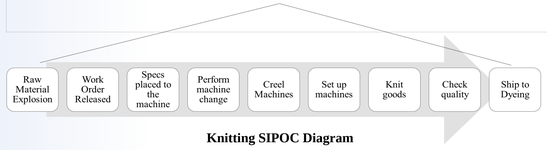
METHODOLOGY

- The project was carried out using the Six Sigma DMAIC methodology,
- A kaizen event was conducted to aim on improvements on the compliance to schedule.
- Data collected from historical and current data of the process. The data was analyzed to understand what factors were affecting the performance of knitting in terms of compliance to schedule
- The following Six Sigma Tools were used: SIPOC, Critical to Quality (CTQ's), Process Map, Time Series Plot (Run-charts), Cause and Effect Diagram, Pareto Chart, 5 Why's Technique, Sample 2 t-test, Project Plan, Histogram and the Probability Plot.

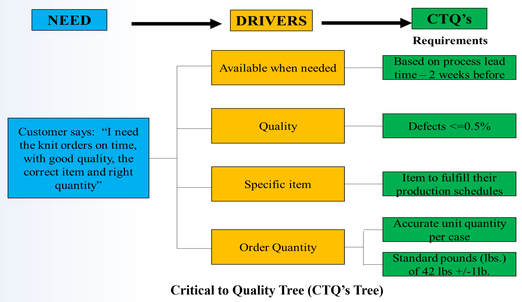
RESULTS AND DISCUSSION

Define

Supplier	Inputs	Process	Output	Customer
Yarn Vendors	○ Yarns ○ Product Specs ○ Work Orders		Knitted blanks specific by item / style / size	Dyeing (Dye House)



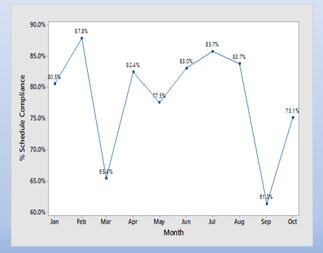
Knitting SIPOC Diagram



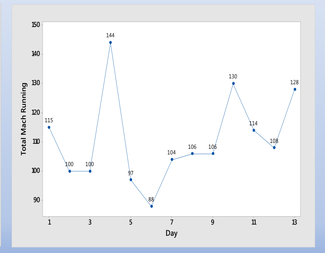
Critical to Quality Tree (CTQ's Tree)

Measure

The data displays the compliance to schedule sin January to November 2017 which had have been in average 79.1%. The production schedule suggested having a total of 190 machines running at 70% efficiency to be able to manufacture, 320,000 units per week, and the plant is being able to run a total of 113 machines. The waste has increased as well to 4.41% and the goal is 3.0%, which represents 38.7% more than the one included in the product standard cost. The dye house has complained because the lack of blanks from knitting, caused that they cannot meet sewing orders and compliance to schedule is in 78.1% in average, when goal is 95% or above.



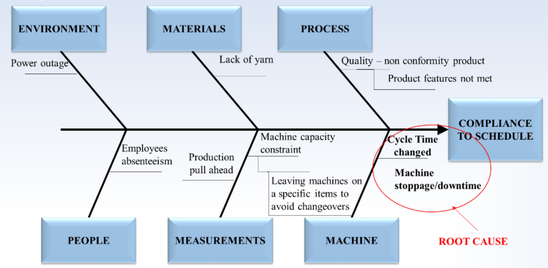
Knitting Compliance to Schedule



Total machines in production vs. total of machines available in the facility

RESULTS AND DISCUSSION

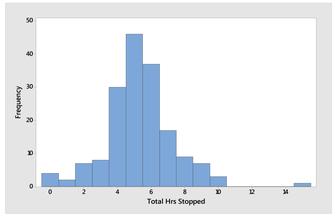
Analyze



Compliance to schedule – Cause & Effect Diagram

5 WHY's	
Cause 1 **Machine Stoppages / Downtime**	**Cause 2** **Cycle Time Changed**
Why does the machines stoppages impact the compliance to schedule?	**Why the cycle time impacts the compliance to schedule?**
Machines don't run because unplanned stop	*When machine has mechanical issues, instead of leaving the machine stop, it is run at a higher cycle time.*
Why machines stop?	**Why the machines have mechanical issues?**
Machine stop because improper operation.	*Lack of preventive maintenance (PM's).*
Why machines are not working properly?	**Why are not preventive maintenance offered?**
Because of lack of preventive maintenance.	*There is not a schedule for machine PM's.*

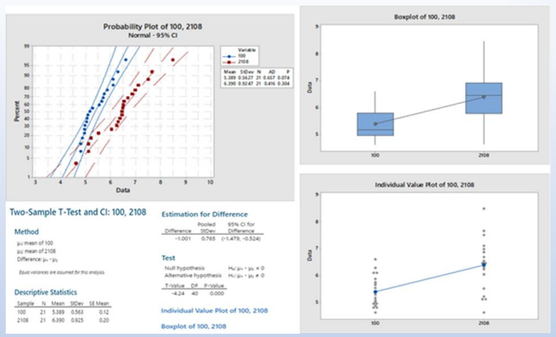
5 Why's for the 2 potential causes driving the compliance to schedule



Histogram of the hours of machine downtime

Top 10 machines with the highest downtime

The analysis demonstrated that machines were idled between 4 to 7 hours to repair and to complete a changeovers. The major offender defects causing delays on changeovers are barre and excess yarn, with 42.9% and 33.3%, respectively.



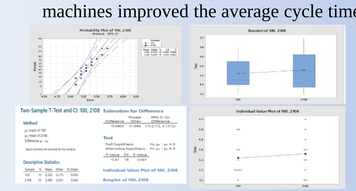
2 Sample t-Test of one of the style with the highest volume

The results of the 2 samples t-test were that the p-value (it was assumed an equal variance) was 0.007, which it's less than the alpha level of 0.05, therefore, the conclusion was that there was a significant difference between the means of both machines. It was encountered that the cycle time of the machine 2108 was 1.3 minutes more than the cycle time standard of 5.1 minutes. On regards to machine 100, the average was closed to the standard cycle time

RESULTS AND DISCUSSION

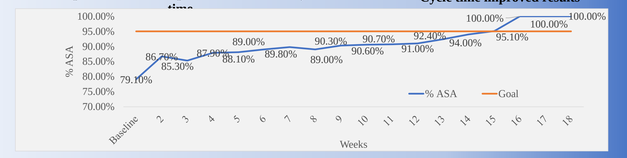
Improve

- Developed the preventive maintenance schedule.
- Added to verify air leaks as part of the PM's activities.
- An assessment was made to understand current machine conditions. One of the findings of the assessment performed was that 55.6% of the machines were identified with mixed needles.
- PM given first to the machines being the biggest offenders.
- A board was developed to illustrate the machine layout of the area and communicate the priority to repair machines.
- Cycle Time improved: The 2 samples t-test concluded that the p-value (it was assumed an equal variance) was 0.641, which is higher than the alpha level of 0.05, therefore, the conclusion was that there is not a significant difference between the means of both machines. Both machines improved the average cycle time by 1.3% and 16.12%.

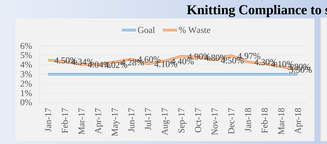


2 Samples t-test after improvement made on cycle time

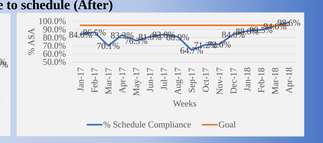
Cycle time improved results



Knitting Compliance to schedule (After)



Knitting % of waste (After)



Dye House Compliance to schedule (After)

Control

- Established a time series to monitor the compliance to schedule daily.
- Machines conditions discussed in the daily stand up meetings.

CONCLUSIONS

The usage DMAIC helped to encounter the root cause affecting the weekly compliance to schedule. The compliance to schedule was affected by the machine conditions driven by the lack of preventive maintenance. The absence of preventive maintenance was causing, machines to work unproperly, machine downtime, delays to complete a machine change over., increase on waste and cycle time changes to be able to run the machine at least at a longer cycle time. One limitation is that the facility doesn't has a system to schedule preventive maintenance, the actual system is manually and there is a challenge to perform analysis. For future research, it is strongly recommended to continue to evaluate the actual system to schedule the preventive maintenance and try to incorporate an electronic system that fits the facility needs, to schedule, monitor and analyze PM's data. The benefit associated is to strengthen the current process, analyze machine performance, reduce waste and eliminate that the system depends of one person.

REFERENCES

[1] What is Six Sigma, net? (2018). *Cycle Time*. [Online].Available: http://www.whatissixsigma.net/cycle-time/

[2] Six Sigma, i. (2018). *What is Six Sigma*. [Online]. Available: https://www.isixsigma.com/new-to-six-sigma/getting-started/what-six-sigma/

[3] ASQ Learn about Quality. (2018). *Fishbone (Ishikawa) Diagram*. [Online]. Available: http://asq.org/learn-about-quality/cause-analysis-tools/overview/fishbone.html

[4] Control Charts. (2018) *Run Charts: A Simple and Powerful Tool for Process Improvement*. [Online]. Available: https://www.isixsigma.com/tools-templates/control-charts/run-charts-a-simple-and-powerful-tool-for-process-improvement/

[5] Diagrams, Fishbone. (2018). *Determine the Root Cause: 5 Whys*.[Online]. Available:https://www.isixsigma.com/tools-templates/cause-effect/determine-root-cause-5-whys/