Improve the Lay-Up Process by Reducing 15% of the Documentation Errors within Six Months using Kaisen and/or DMAIC Six Sigma Tool

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Abstract *— From August 2017 to October 2017 (3Q2017) the documentation errors (including lay-up errors and mixed styles) were 96% average in one Distribution Center at the west coast. DMAIC methodology was applied including lean principles to find the root cause of these documentation errors. A Kaizen exercise was executed to identify potential solutions to improve the current process. During the Kaizen exercise a SIPOC diagram was used to identify all relevant elements that can support the improvement of the process. As a result, layup error category was targeted to be improve because has a lot opportunities. Cause-and-effect relationship (fishbone diagram) was used to identify a range of potential solutions to the problem. Solutions were evaluated and prioritized by using a Pick Chart. Five actions items were proposed for improvement and a reduction of 17% was reached for the documentation errors (including layup error and mixed styles categories). Also, an increase of 24.70% for the Output per Hour (OPH), a reduction of 34.78% from shrink and an increase of 0.02% in the accuracy data. These results support to achieve the 15% goal of layup documentation errors reduction proposed by this project within 6 months period.*

Key Terms *— Accuracy Data, DMAIC, Kaizen, KPI's, Lay-up Process, Lean Principles, OPH, Pick Chart, Shrink, SIPOC.*

PROBLEM STATEMENT

An improvement in the Lay-up process is needed to reduce at least by 15% of the documentation errors such as: incorrect count / cartons (miscount or calculation error), incorrect vendor or prepack, create error and mixed styles. The documentation errors are identified in two groups: lay-up errors and mixed styles. Currently, the documentation errors (including lay-up errors and mixed styles) were 96% average from 3Q2017 (Aug to Oct 2017). As a result, a modification (Document issue to report the event and correct the discrepancy) is required to correct the error and reduce the shrink impact. Therefore, the improvement of these ones will be caused a benefit in reducing shrink and increasing the productivity of the building.

Lay-up is the first step in processing an order after it is received. Lay-up may involve sorting and counting by style, size and color.

RESEARCH DESCRIPTION

This research is to reduce at least by 15% the documentation errors such as: incorrect count / cartons (miscount or calculation error), incorrect vendor or prepack, create error and mixed styles in one Distribution Center at the west coast. Currently, the documentation errors (including lay-up errors and mixed styles) were 96% average from Aug to Oct 2017. The completion of this project will be caused a benefit in reducing shrink and increasing the productivity of the building.

RESEARCH OBJECTIVES

To illustrate the trend executed for documentation errors during the lay-up process. To determine the factors associated with increased number of documentation errors during the lay-up process. To establish the methods and/or systems used to control the Lay-up errors reduction.

RESEARCH CONTRIBUTIONS

This project supports two Company's Key Performance Indicators (KPI's) for Operational Excellence as shrink and Output per Hour (OPH).

This should also be a model to other Distribution Centers (DC) within the same Company experiencing the same problem, as well as to other companies. By reducing the number of documentation errors in Lay-up, the number of quality errors reported in the Accuracy Report will be also reduced, and the OPH will continue to grow by avoiding redundancy steps. As a result, the effectiveness will be increased and the profits of the company too.

LITERATURE REVIEW

Lay-up is the first step in processing an order after merchandise is received in a warehouse. Lay-up may involve sorting and counting by style, size and color. Therefore, it is very important to perform right the first time the layup steps to achieve the company goals such as reduce shrink and increase productivity. As a result, the documentation layup process in this project should be improved to reduce the number of documentation errors and the number of quality errors reported in the Accuracy Report and increase the Output per Hour (OPH) by avoiding redundancy steps.

According to the Lean Six Sigma Black Belt Handbook (Six Sigma Operational Methods) and Six Sigma Handbook (Fourth Edition); DMAIC methodology is a powerful five-phase approach to addressing a process that needs improvement. DMAIC stands for Define, Measure, Analyze, Improve, and Control (Figure 1):

D – Define the goals of the improvement activity. The team answers the question "What is important to the business?"

M – Measure the existing process. The team determines how the current process is performing compared to the requirements. The team answers the question "How are we doing with the current process?"

A – Analyze the process to identify ways to eliminate the gap between the current performance of the process and the desire goal. The team determines what is wrong with the process. The team answers the question "What is wrong with the current process?"

I – Improve the process. The team finds solutions to the problem and conducts a pilot on the selected solution to determine feasibility. The team answers the question "What needs to be done to improve the process?"

C – Control the new process. Institutionalize the improve process by modifying policies, procedures and other management systems. Use statistical tools to monitor stability of the new process. The team implements the solution and transfers the ownership of the new improved process to the responsible owner. The team answers the question "How do we guarantee performance so that the improvements are sustained over time?"

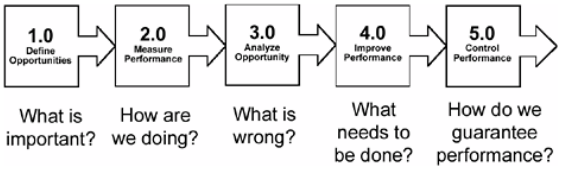


Figure 1
DMAIC Flow and Associated Questions

By using DMAIC methodology the team knows what comes next in the project since all steps are outlined. DMAIC is a structured problem-solving methodology widely used in business using Lean Six Sigma.

Six Sigma and Lean are really part of the evolution that quality, productivity and process improvement initiatives have taken over the last 20 years. Each approach has its own unique perspective regarding performance improvement. But the goals are the same: better, faster, cheaper, more meaning in work, and don't harm the environment.

A variety of approaches exist to implement lean initiatives, including 5S, Kaizen and Lean teams. In this project the Kaizen tool supports the improvement of the project. Kaizen is the Japanese word for "continuous improvement" (Masaaki Imai). This improvement tool was introduced into the U.S. in the mid 1980s. Pratt & Whitney, General Electric, and a number of other U.S. companies were early practitioners. In

Japan, Kaizen is the foundation for all improvement endeavors: TQM, Quality Circles, Quality Function Deployment, etc. The Japanese Kaizen process emphasizes continuous, ongoing improvement. If you walk into a factory or service operation, it should not be operating the same way it was a year before. Things should change, becoming faster, better, and cheaper. Kaizen incorporates a process view in addition to the traditional American pursuits of innovation and results [1].

A SIPOC diagram is a tool used to identify all relevant elements of a process improvement project. It starts simply, as a row of five headings: Suppliers, Inputs, Process, Outputs, and Customers. The team builds on it as the project progresses, adding lists and other details [2].

The fishbone diagram is a visualization tool for categorizing the potential causes of a problem in order to identify its root causes. The fishbone diagram looks like the skeleton of a fish (Figure 2).

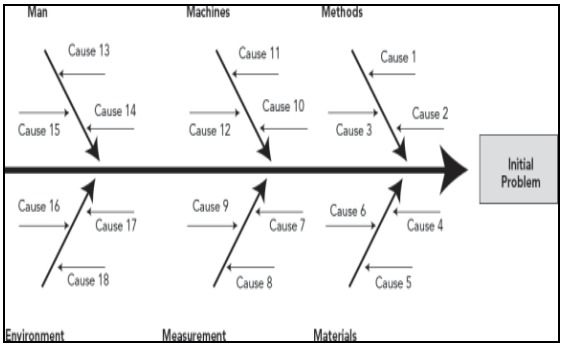


Figure 2
A Generic Fishbone Diagram

The main problem is entered in the nose. Ensure that it is well explained. It could include graphs or a photo if this helps with understanding of the issue. The bones (or spines) originally had only the "4 M's." Once, all problems were reduced to one of the four: man, machine, material, or method. This is not an unrealistic assumption. Eventually, measurement was added to highlight how critical it is to have an understanding of the reliability, reproducibility, and accuracy of the measuring system. Environment was added to make people consider the location of a tool and the impact of its surroundings on the operation [3].

A PICK chart (Possible, Implement, Challenge and Kill chart) is a visual tool for organizing ideas. PICK charts are often used after brainstorming sessions to help an individual or group identify which ideas can be implemented easily and have a high payoff.

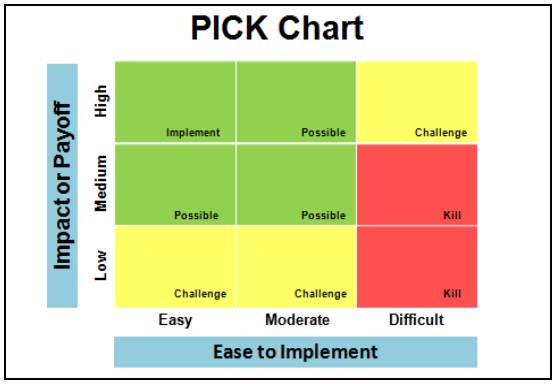


Figure 3
A Generic PICK Chart

It is expected to benefit the current process of this project by taking advance of these methodologies that has been developed in the last decades. By using Lean Six Sigma tools and methodologies this process can be improved by reducing the number of documentation errors in Lay-up, the number of quality errors reported in the Accuracy Report will be also reduced, and the OPH will continue to grow by avoiding redundancy steps. As a result, shrink will reduce and productivity of the building will increase.

METHODOLOGY

The DMAIC methodology was performed to accomplish the objectives of this project. First phase of the DMAIC methodology is the Define phase. This stage set the goals of the improvement activity and selects the team to support the project. The team answers the question "What is important to the business?" During this phase was presented to the team the trend the documentation errors and defined the problem statement.

In the Measure phase was determined how the current process was performing compared to the requirements. The team answers the question "How are we doing with the current process?" One (1)

report issued from the Merchandise Control (MC) Team was used to collect data (6 months) related to Layup documentation errors. This report is the Modifications Report.

During the Analyze phase was identified ways to eliminate the gap between the current performance of the process and the desire goal. The team determines what is wrong with the process. The team answers the question "What is wrong with the current process?"

A fishbone diagram was used to categorize the potential causes of the problem (what so many layup documentation errors) in order to identify its root causes.

Following step is the Improve phase where a Kaizen exercise was executed to identify potential solutions to improve the current process. The team answers the question "What needs to be done to improve the process?" During the Kaizen exercise a SIPOC diagram was used to identify all relevant elements that can support the improvement of the process.

Cause-and-effect relationship (fishbone diagram) from Analyze phase was used to identify a range of potential solution to the problem. Solutions were evaluated and prioritized by using a Pick Chart exercise.

Then, Control phase was executed which is the final phase of the DMAIC methodology. During this step procedures and/or policies was developed to keep the improvements in the process. The team answers the question "How do we guarantee performance so that the improvements are sustained over time?" The reports issued from the MC team were used to monitoring the process on a monthly basis.

Below is presented the Gantt chart for this DMAIC:

Table 1
DMAIC Gantt Chart

Step Number	Milestone	Estimate due date
1	Define	1wk Nov 2017
1.1	DMAIC Team selection	1wk Nov 2017
1.2	Presentation execution	1wk Nov 2017
1.3.1	Trend for the documentation errors	1wk Nov 2017
1.3.2	Define the Problem statement	1wk Nov 2017
1.3.3	Research methodology	1wk Nov 2017
2	Measure	2wk Nov 2017
2.1	Retrospective Data Analysis from Modification Report (6 months) (from May 2017 to Oct 2017)	2wk Nov 2017
3	Analyze	4wk Nov 2017
3.1	Fishbone Exercise	4wk Nov 2017
4	Improve	4wk Nov 2017
4.1	Kaizen exercise	4wk Nov 2017
4.1.1	SIPOC exercise	4wk Nov 2017
4.1.2	Pick chart exercise	4wk Nov 2017
4.1.3	Action Plan	4wk Nov 2017
5	Control	4wk Apr 2018
5.1	Methods and systems establishment	3wk Mar 2017
5.2	Data Analysis from Modification Report (6 months) (from Nov 2017 to Apr 2018)	4wk Apr 2018

RESULTS AND DISCUSSIONS

First phase of the DMAIC methodology is Define. During this phase the team to support the project was selected and the goals were established for the improvement activity.

In addition, the trend for the documentation errors and the problem statement was presented to the team. The documentation errors (including Lay-up error and mixed styles categories) were 96% from August 2017 to October 2017. Refer to Figure

4 (Trend of documentation errors in Layup Process during 3Q2017) for more details.

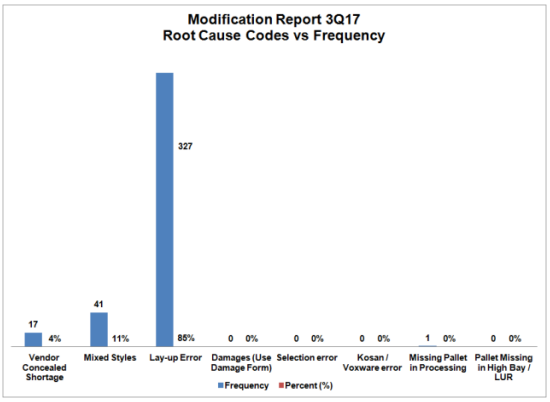


Figure 4
Trend of Documentation Errors in Layup Process during 3Q2017

Therefore, During the Measure phase the Modification Report issued from the Merchandise Control Department was used to confirm the percent reported from August 2017 to October 2017.

Consequently, retrospective data from 6 months (from May to October 2017) was trend and the documentation error reported 88% where the Layup error category was confirmed as the biggest contributor to the documentation errors with 79%.

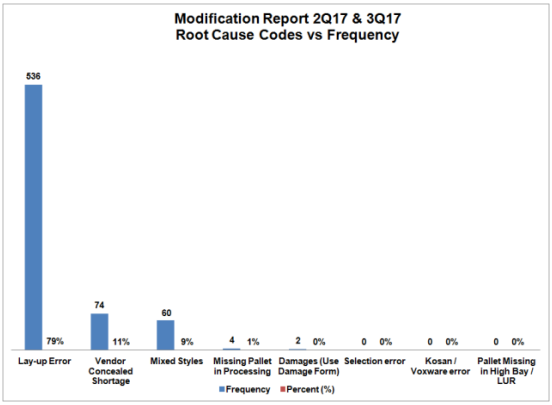


Figure 5
Trend of Documentation Errors in Layup Process during 6 Months (May to October 2017)

In addition, a Pareto chart was prepared and showed that Layup error category is 80% of the Modification Report root cause. For that reason, layup error category was targeted to be improve because has a lot opportunities.

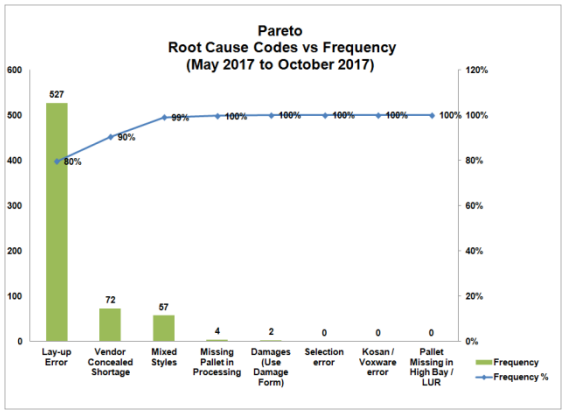


Figure 6
Pareto: Root Cause Codes vs. Frequency during 6 Months (May to Oct 2017)

Also, a Pareto chart was created to identify the contributors within the Layup error category and miscount was the biggest one with 90%.

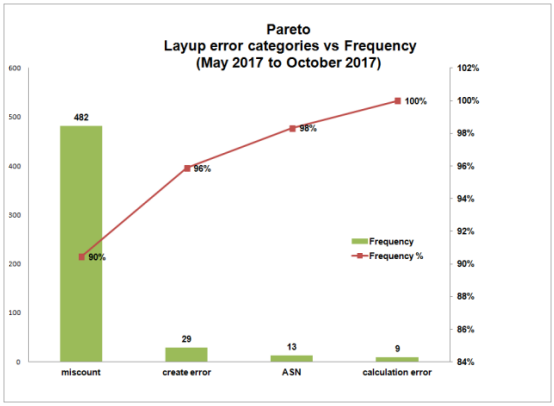


Figure 7
Pareto: Layup Error Category vs. Frequency during 6 Months (May to Oct 2017)

Information collected during the Measure phase was used to performed a Cause-and-effect relationship during Analyze phase and identify the potential root cause of the miscount as part of the Layup error category. The tool used for the Cause-and-effect relationship was the fishbone diagram. The fishbone identified that the three potential root causes were: No using calculator and attempting to calculate in their head or on paper; No performing all counts and; doesn't know how to read DCPO so information is wrong on the DCPO.

During the next phase (Improve) a Kaizen exercise was executed to identify potential solutions to improve the current process. During the

Kaizen exercise a SIPOC diagram was used to identify all relevant elements that can support the improvement of the process.

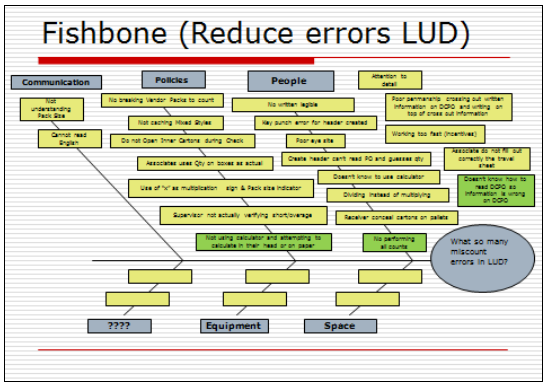


Figure 8
Fishbone Diagram

Therefore, a SIPOC diagram was created, as can be seen in Figure 9

SIPOC Diagram below, Counts (units / cartons) in the Process for this project is the area to be improved.

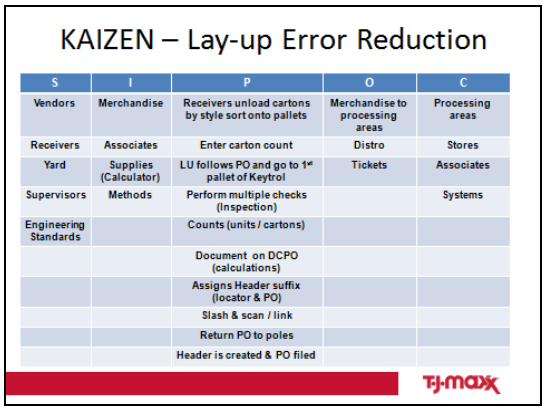


Figure 9
SIPOC Diagram

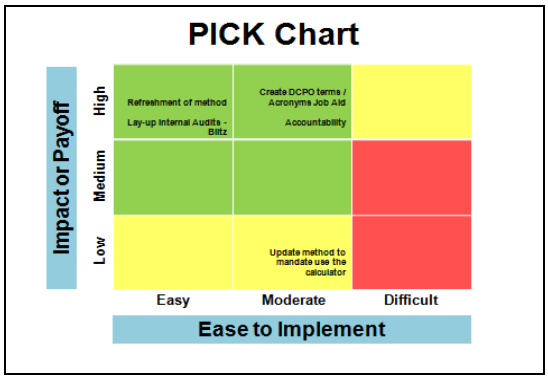
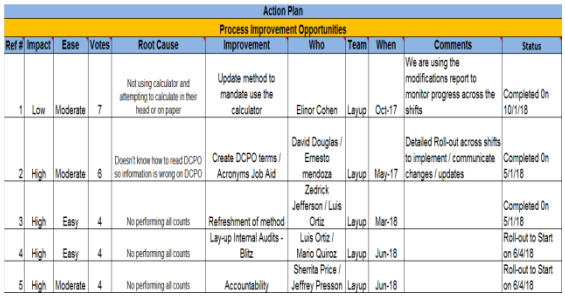


Figure 10
PICK Chart

Cause-and-effect relationship (fishbone diagram) from Analyze phase was used to identify a range of potential solution to the problem. Solutions were evaluated and prioritized by using a Pick Chart exercise (refer to figure 10).

As a result, an action Plan was established with the following potential solutions: Update method to mandate use the calculator; Create DCPO terms / Acronyms Job Aid; Refreshment of method; Lay-up Internal Audits / Blitz and; Accountability.

Following the details of the Action Plan established:



Action Plan

Process Improvement Opportunities

Ref #	Impact	Ease	Votes	Root Cause	Improvement	Who	Team	When	Comments	Status
1	Low	Moderate	7	Not using calculator and attempting to calculate in their head or on paper	Update method to mandate use the calculator	Elnor Cohen	Layup	Oct-17	We are using the modifications report to monitor progress across the shifts	Completed On 10/1/18
2	High	Moderate	6	Doesn't know how to read DCPO so information is wrong on DCPO	Create DCPO terms / Acronyms Job Aid	David Douglas / Ernesto mendoza	Layup	May-17	Detailed Roll-out across shifts to implement / communicate changes / updates	Completed On 5/1/18
3	High	Easy	4	No performing all counts	Refreshment of method	Zedrick Jefferson / Luis Ortiz	Layup	Mar-18		Completed On 5/1/18
4	High	Easy	4	No performing all counts	Lay-up Internal Audits - Blitz	Luis Ortiz / Mario Quiroz	Layup	Jun-18		Roll-out to Start on 6/4/18
5	High	Moderate	4	No performing all counts	Accountability	Sherrita Price / Jeffrey Presson	Layup	Jun-18		Roll-out to Start on 6/4/18

Figure 11
Action Plan

During the Control phase the following methods and systems were established: the Layup method was updated to mandate use the calculator; Job Aids (Layup Acronyms, Inspection % matrix, Attributes and Layup Departments) for the layup process were issued; Refreshment of the layup method was performed with all associates; Layup internal Audits / Blitz will be performed; Accountability process regarding the modifications Reports will be performed.

In addition, the documentation errors (including layup errors and mixed styles categories) were reported as 79% during 6 months (November 2017 to April 2018) after incorporated the previous methods and systems (refer to figure 12).

Therefore, a reduction of 17% in documentation errors was obtained in comparison with the 3Q2017 (August 2017 to October 2017) where 96% was reported (refer to figure 4). Also, a Pareto chart was prepared and showed that Layup error category is 70% of the Modification Report root causes (refer to figure 13).

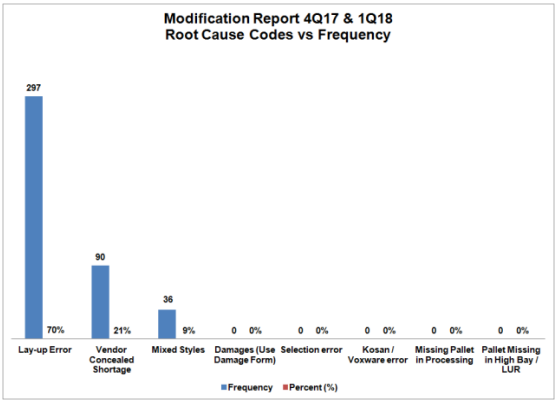


Figure 12

Trend of Documentation Errors in Layup Process during 6 Months (November 2017 to April 2018)

Therefore, a reduction of 10% in layup error category was obtained in comparison with the previous 6 months (May 2017 to October 2017) where 80% was reported (refer to figure 6).

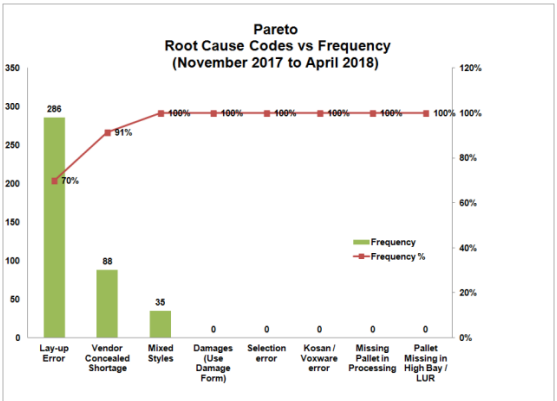


Figure 13

Pareto: Root Cause Codes vs. Frequency during 6 Months (November 2017 to April 2018)

Pareto chart was created to identify the contributors within the Layup error category and miscount was the biggest one with 50% (refer to figure 14). Therefore, a reduction of 40% in miscount category as part of the layup error category was obtained in comparison with the previous 6 months (May 2017 to October 2017) where 80% was reported (refer to figure 7). Since at the moment of this design report the team is still working on the action items for the implementation of the improvements (refer to figure 11). The Modification report reported from MC team is used as a tracking tool on monthly basis.

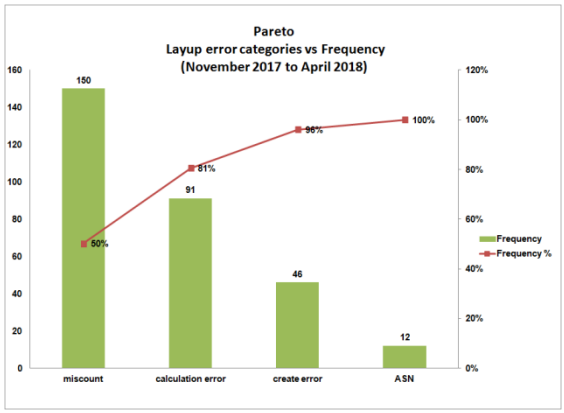


Figure 14

Pareto: Layup Error Categories vs. Frequency during 6 Months (November 2017 to April 2018)

Below is a table with the final results for 6 months period before (May to October 2017) and after (November 2017 to April 2018) the improvement project.

Table 2

Results Comparison (6 months period) before and after Improvement

Parameter or KPI	Before Improvement	After Improvement	Improvement
Documentation errors (including Layup and mixed styles categories)	96.00%	79.00%	17.00%
OPH	85.80%	110.50%	24.70%
Shrink	$1,134,445	$739,886	34.78%
Accuracy data	99.88%	99.90%	0.02%

CONCLUSIONS

During this design project the documentation errors from the Layup process was studied for improvement. The documentation errors reported from August 2017 to October 2017 including Lay-up error and mixed styles categories were 96%. During this study lean principles were applied to improve the documentation errors by 15%. DMAIC methodology was used to go over the process where a Kaizen study was performed including a SIPOC, Fishbone diagram and PICK chart to improve the process.

Five actions items were proposed for improvement following lean principles and are currently being worked by the selected team for future implementation. From the results of the improvement process the following results were

obtained: a reduction of 17% was reached for the documentation errors (including layup error and mixed styles categories), an increase of 24.70% for the Output per Hour (OPH), a reduction of 34.78% from shrink and an increase of 0.02% in the accuracy data.

These results support to achieve the 15% goal of layup documentation errors reduction proposed by this project within 6 months period.

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