Increase the Efficiency and Capacity of the Manufacturing Process for Product X Applying Lean Six Sigma Methodology

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Abstract *— This project was done in a food manufacturing industry that sells its product in bags. This company has many products, but this work was made focused in one product that represent 50% of the production and is packed in five different bag sizes. The main focused is on the packing area were 9.38% of the product is wasted and the capacity depends on the product they are packing. Lean Six Sigma was used. Lean in order to eliminated waste and Six Sigma to improve the capacity of the packing area. The methodology used is the DMAIC five steps (Define, Measure, Analyze, Improve and Control), even though this project is not implemented at the time, the solutions are explained. At the end of this project new procedure are develop and the Standard Operational Procedures (SOP) is in schedule to be developed. As a result of the additional capacity that is expected to be gained, time will be liberated to perform trainings and schedule preventive maintenances in the packaging area.*

Key Terms *— Capacity, DMAIC, Lean, Six Sigma.*

PROBLEM STATEMENT

At this moment the manufacturing department is not able to hit the efficiency target set for the region. The efficiency in the manufacturing of product X is at an average of 82.6% when it should be maintained at 84.5% (Figure 1). The difference between the target and the actual is 1.9%, this represents about 3,585 kg per month or 43,020 kg per year which represents a cost of $5,339.00 per month and $64,000.00 per year. If the process was under control, the difference between the actual efficiency average and 100% it would be 17.56% at a perceptual cost of $2,708.00 this cost would represent $47,568.00 a month.

SCOPE

This project will cover the production rate of one product from the process area up to the packaging area. The product comes in five different bag sizes 18oz, 12.5oz, 8.5oz, 2.5oz, and 1.5oz. This manufacturing plant makes several other products.

OBJECTIVE AND CONTRIBUTION

The objective of is to increase the efficiency of the product by 1.9% passing form 82.6% to 84.5%. The expected impact will be and approximate $64,000.00 a year in savings.

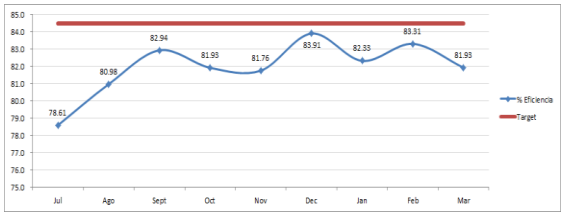

Figure 1
Efficiency Statistics

BACKGROUND

Process

The complete process under evaluation is resume as follow (Figure 2):

- Process production area: this area start with the raw materials and finished with the finish product ready for packaging.
  - Cooking area
  - Washer area
  - Mill
  - Dough sheeter

    - Oven
    - Cooling conveyor
    - Fryer
    - “Tombola”
- Inclined conveyor: the finish product is slightly cool and taken to the start of the packaging process.
- Transportation tray conveyor (Roflo): the product is continually being separated in to small batches. This machine works as a feeder for the next step.
- Weighting machine: the finish product is weighted in one of the different 5 bag sizes.
- Bag Maker (TNA): a bag is cut from a roll and partially seal, the pre weight product is place and the bag gets completely seal. [2]
- Automated box packager (TCP): the final product is inspected for quality and any damage bag is put aside, then the good product is put in to a box ready for shipment.

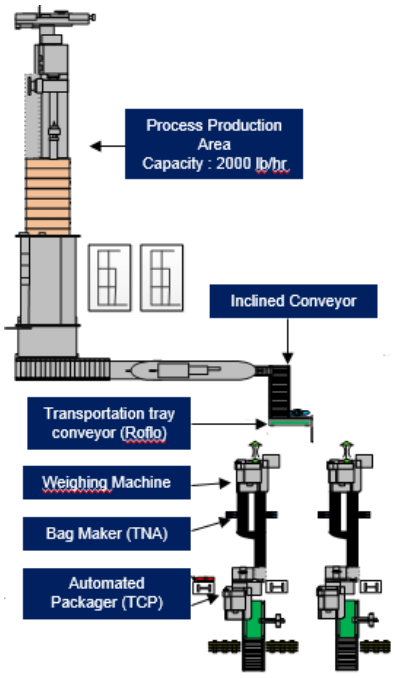

Figure 2
Process Area

Lean Six Sigma

Lean Manufacturing pursues to achieve a competitive advantage through cost reduction and efficient service of customer demands by improving flow in the value stream and eliminating waste. [4]

Six Sigma is a methodology of process improvement that is typically followed by the DMAIC approach. This methodology purpose is the reduction of process variability. For business management this methodology is considered a culture of making constant improvements. [1]

DMAIC

DMAIC “can be thought of as a roadmap for problem solving and product/process improvement”. [3] This methodology is applied by walking through five steps, for this project only the first four steps were accomplished and the improve phase was left with solutions for future implementation. These five steps can be delineate as follow:

- **Define:** Is the phase where initiates the understanding of the customer needs. This process is used to identify the areas of improvement where the project is developed, following the six sigma strategy.
- **Measure:** The data needed to fully understand the areas of improvement is collected. For this a data collection plan needs to be developed.
- **Analyze:** All the data collected is used to identify the causes of the areas of improvement by the use of mathematical and statistical analyses.
- **Improve:** Solutions are developed to target the causes found in the areas of improvement. These solutions are implemented based on a plan design to cause no negative impact on the areas of improvement.
- **Control:** Procedures are established to avoid any future recurrence and make the changes made in the areas of improvement maintainable.

Appling the DMAIC roadmap will result in better process that will cause less waste achieving more cost efficient production.

RESULTS

On every step of the DMAIC methodology, already describe above, different tools were used to achieve the desire goals. Only the first four steps are presented.

Define

The SIPOC is generated to have a general view of the process and help identify the opportunities and areas of improvement. It also shows who are the customers and the deliverables.

The complete process is explained in the SIPOC but this project will be focus in the following areas of production:

- Roflo
- Weighting machine
- Bag Makers (TNA)
- Automatic box packer (TCP)

The max capacity of the process it 20,000 pound per hour the product includes; seasoning, corn, oil and cal to make the final product (Figure 3).

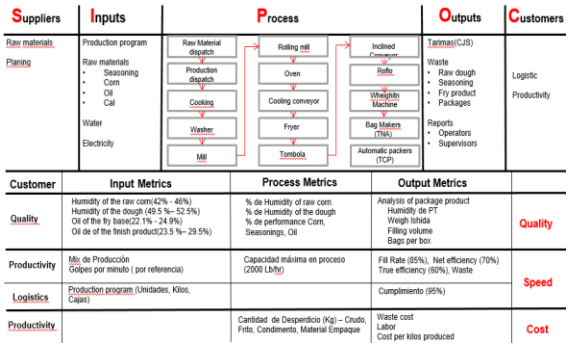

Figure 3
SIPOC Diagram

Measure

The total efficiency in the process was calculated by dividing the standard consumption/actual consumption of the materials use to make the final product. The average value of efficiency of the process is 83.5% (Figure 6).

The measurement shown that 14.87% product lost is Corn and Oil and the lost between those two in the packaging area represents de 9.38% of the total lost in the process. With this percentage, on the packing area it understandable that most of the waste of materials occur in packaging.

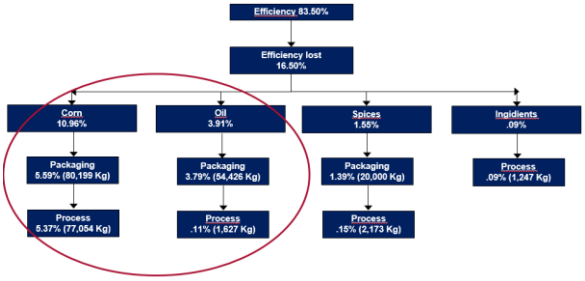

Figure 4
Efficiency Statistics

Weekly the average order is 11,731 boxes of five different bag sizes, each boxes carries only one type of bag (1.4oz, 12.5oz, 2.4oz, 8.5oz, and 18oz) this represents 50% percent of all the products made in this manufacturing plant. Together the 1.4oz and the 2.4oz boxes represent the 58.3% of the average order per week. (Figure 5)

When the production has a good mix between sizes, the packaging area can run at full capacity of 2,000 pounds per hour. However do to the variety of the orders is not always possible to have that capacity. (Figure 6)

The actual process is running two Automatic box packaging (TCP) of five units. For each TCP there are two Bag Makers (TNA) and each one is divide in two bag making areas because the TCP can only run one size of bag at a time each bag maker have to run the same size of bag.

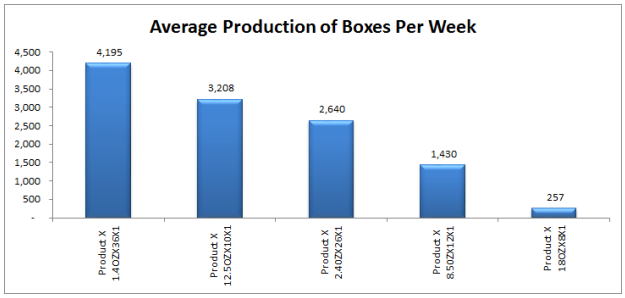

Figure 5
Average Production

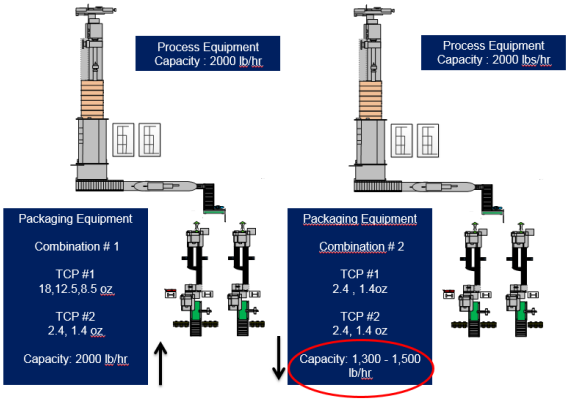

Figure 6
Process Map

Analyze and Improve

The Analyze and improve steps are presented together do to the impossibility of implementing the changes in the process at this time.

What is affecting the efficiency in the production of the product X? What is affecting the capacity of the packaging line? To help answer these questions a brainstorming was conducted and the results where put together in three different group based by their affinity:

- First group
  - Bag seal break
  - Packaging operators experience
  - Absence of maintenance
- Second group
  - Low TNA speeds
  - Packaging capacity
  - TNA availability
  - TNA availability
  - Inadequate mix of bag production
  - Priority changes
- Third group
  - Production delay
  - Overproduction
  - Product Changes
  - Operation failures
  - Absence of maintenance

The first two group were the main focus of the actions suggested in the project.

The Fishbone diagram is another tool used to help understand the cause and effect in the main components of the process. (Figure 7)

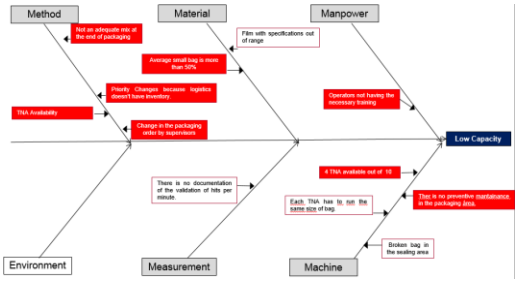

Figure 7
Fishbone Diagram

With the examination of the data at hand the two main target are:

- Elimination of waste product to increase the efficiency.
- Improve the capacity of the packaging area.

To help reduce the waste to a minimum a new process is going to be implemented. A large quantity of finish product, thrown away at the end of the packaging area, is happening do to:

- Damage seal of the bags
- Under or over filled of the bags
- Bags are cut out of the lines
- High volume of small bags production

At this time, there are bags that are thrown away with products with no damage that can be sold. To fix this problem and not throw away good product a container is going to be placed at the end of the line so the operator can cut the damage bag and put the product in a container. The operator then will take the product and placed in the inclined conveyor for the product to enter the packaging area again. To standardize this operation a new Standard Operational Procedure (SOP) will be created and all supervisor and operators will be trained. This SOP will include detailed information about:

- Persons assign to this task
- Equipment needed to perfume this task
- Maintenance plan for the new equipment
- How to handle the product

- Step by step route instructions
- Time required for the product to be but back on the line
- Data collection plan

To improve the capacity of the production of this product made especially in the small size bags being 58.3% of the 50% percent of the total production of this manufacturing facilities more TNA will be made available. (Figure 8). This action won't represent any capacity lost for other productions because only one product can be cooked at the same time this will make the other equipment that is not at use available for the production of the product in question.

By making more TNA available it will be possible to make a better mix of productions between the five sizes of bags. Although the production supervisor and the logistic department will create a plan and engage in regular meeting in regards of the inventory available to help minimize changes in the orders.

Production in the manufacturing facility is always in time but with this changes it will help free some time for training activities. Training is very important in this area where some of the operators are new and other have been doing the same task for a long time using their own procedures. The inconsistency of the operators is not in accordance with good manufacturing procedures that were established by the company.

Another advantage of the additional capacity is the implementation of preventive maintenance procedure that was not on schedule for the packaging area. The Maintenance Engineer will be asked to develop Standard Operational Procedures for the preventive maintenance of the packaging area. This procedure will be scheduled so it won't impact the production time of any product.

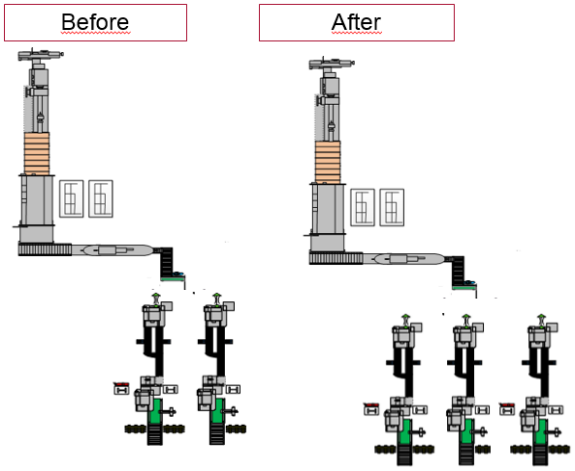

Figure 8
Fishbone Diagram

CONCLUSION

The solution established on this project are supposed to reduce the waste of the product in the process and help growth the capacity of the packaging area by establishing new Standard Operating Procedures.

At the end of the implementation, all personnel will be required to be trained in the new procedure. The projected savings are projected to be around $64,000.00 dollars and very little capital investment is needed. The results of this projects translates into two main projects recollecting the product inside the damage bags and putting that product in the line to be repacked and making available two more bag makers (TNA) for the production of the product that was assessed. This product represents 50% of the total production of the manufacturing facility.

The Lean Six Sigma DMAIC methodology was successfully applied in this project and in a future the complete Improve and Control steps will be executed to know the exact outcome of the solutions presented.

The solutions presented will represent:

- More time: this time will be used to train personal and to perform preventive maintenance.
- Less waste: product that is actually being thrown away is going to be put back in the packaging line.

- Balanced line: between production area and the packaging area with both area performing at 20,000 pounds per hour.

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