SCIENTIFIC ARTICLE

"IMPLEMENTATION OF THE DMAIC METHODOLOGY IN THE COMPANY INPROLAC SA IN THE FRESH CHEESE PRODUCTION LINE OF PRODUCTS DULAC´S FOR IMPROVING PROCESSES AND PRODUCTIVITY."

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Abstract

The purpose of the implementation of the DMAIC methodology INPROLAC SA company is to increase productivity and improve process capability of the production line of fresh cheese (500g) using statistical tools to better meet the requirements set by customers.

First an analysis of the current situation was made, the most influential variables defined in the process by the Quality Function Deployment (QFD) and the calculation of capacity indices and sigma level of the process were performed. The root cause of the problem was subsequently identified through cause-effect diagram, five Why? Analysis and Failure Mode and Effects (FMEA). With data from several alternatives were proposed and selected the most appropriate to implement and solve the problem. Finally Letters Control means and ranges ($\bar{X}$-R) were developed and comparative tables were performed before and after implementation.

KEYWORDS

DMAIC, Six Sigma, Productivity, Quality, Process.

1.Introduction

Six Sigma philosophy is an improvement tool which allows companies and organizations to be more efficient and effective and focus on customer satisfaction. This tool is applied to the implementation of a team that should propose a strategy to strengthen the capacities of the company or organization and the people who make. Six Sigma philosophy is based on five stages or phases (DMAIC) . (Herrera A, 2006 , pp . 19,22)

The main problem of the production line of fresh cheese is cheeses that exceed the prescribed weight which causes economic losses to the company.

With the implementation of DMAIC in the company INPROLAC SA process capability and productivity is improved.

2.Tools and methods

2.1 DMAIC methodology

Define phase. The problem is defined, variables and determine how it affects customer.

Measuring phase. Diagram and measure the capacity of the process, the current situation is determined.

Analyze phase. Determine how the problem is generated and confirm causes with data.

Improve phase. Evaluate and implement solutions that help reduce or eliminate the problem.

Control phase. Designing a system for maintaining and controlling the improvements implemented.

(Gutiérrez Pulido & Vara Salazar, 2009, p. 286)

2.2 Implementation of DMAIC

To implement DMAIC the following equations were used:

$C_p = \frac{ES - EI}{6\sigma}$
$C_{ps} = \frac{ES - u}{3\sigma}$
$C_{pi} = \frac{u - EI}{3\sigma}$
$C_{pk} = Min\left(\frac{u - EI}{3\sigma}, \frac{ES - u}{3\sigma}\right)$
$C_{pm} = \frac{ES - EI}{6\sqrt{\sigma^2 + (u - N)^2}}$
$K = \frac{u - N}{\frac{1}{2}(ES - EI)} * 100$
$P_p = \frac{ES - EI}{6\sigma_L}$
$P_{ps} = \frac{ES - u}{3\sigma_L}$
$P_{pi} = \frac{u - EI}{3\sigma_L}$
$C_{pk} = Min\left(\frac{u - EI}{3\sigma_L}, \frac{ES - u}{3\sigma_L}\right)$
$u + Z_{\propto/2}\,\sigma$
$u - Z_{\propto/2}\,\sigma$
$\hat{C}_{pk} \pm Z_{\propto/2}\frac{\hat{C}_{pk}}{\sqrt{2(n-1)}}$
$\hat{C}_{pk} \pm Z_{\propto/2}\sqrt{\frac{\hat{C}_{pk}^{\,2}}{2(n-1)} + \frac{1}{9n}}$
$\hat{C}_{pm} \pm Z_{\propto/2}\frac{\hat{C}_{pm}}{\sqrt{n}}\sqrt{\frac{\frac{1}{2} + \frac{(\bar{X} - N)^2}{S^2}}{(1 + \frac{(\bar{X} - N)^2}{S^2})^2}}$
$\bar{X} = \frac{x_1 + x_2 + \ldots\ldots\ x_n}{n}$
$S = \sqrt{\frac{(x_1 - \bar{X})^2 + (x_2 - \bar{X})^2 + \cdots + (x_2 - \bar{X})^2}{n - 1}}$
$\hat{\sigma} = \frac{\overline{R}}{d_2}$
$\sigma_{\bar{X}} = \frac{\hat{\sigma}}{\sqrt{n}}$
$\bar{R} = X_{mayor} - X_{menor}$
$LCS = \bar{\bar{X}} + 3\left(\frac{\bar{R}}{d_2\sqrt{n}}\right)$
$\bar{\bar{X}}$
$LCI = \bar{\bar{X}} - 3\left(\frac{\bar{R}}{d_2\sqrt{n}}\right)$
$LCS = D_4\bar{R}$
$\bar{R}$
$LCI = D_3\bar{R}$
$n = \frac{N(Z_{\frac{\alpha}{2}})^2 * p(1-p)}{(N-1)E^2 + (Z_{\frac{\alpha}{2}})^2 * p(1-p)}$
$P(X \leq x) = P(\frac{X-u}{\sigma} \leq \frac{X-u}{\sigma}) = P(Z \leq z)$
$Ts = FV * To * (1 + s)$
$\Delta\, Pr = \left[\frac{\Delta\, Productividad\ final}{\Delta\, Productividad\ inicial} - 1\right] * 100$

Table 1 Equations used in project. (Gutiérrez Pulido & Vara Salazar, 2009), (García Criollo, Estudio del trabajo, 2005).

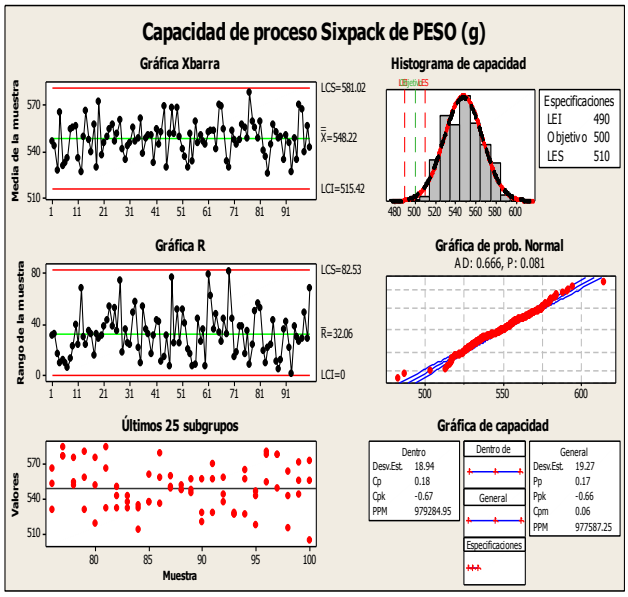
Define phase. The main problem of the production line of cheese, based on the initial analysis is that the cheeses exceed the prescribed weight which causes economic losses to the company, there are also problems of variability since the times in the thread curd, pressing and salting are not always met. The variables studied are weight and moisture.

Measuring phase. Index calculation capacity, level of sigma and productivity resulting in the following is performed:

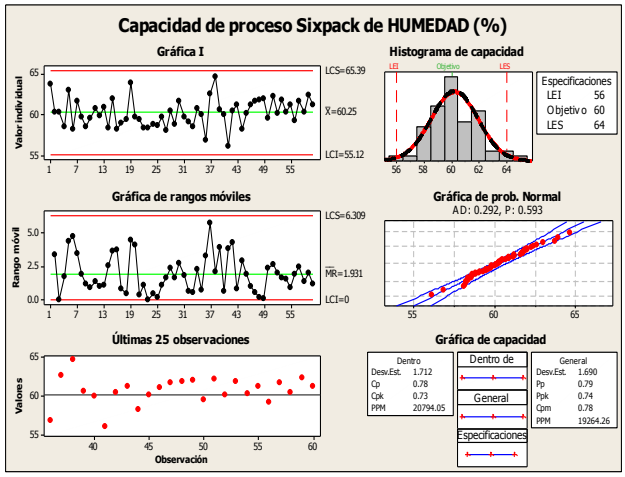
INITIAL ANALYSIS			
General.			
Indicator.		**Value.**	
Productivity monofactorial.		6.04	
Productivity multifactorial.		0.60	
Economic losses ($).		17881.51	
WEIGHT VARIABLE.		**MOISTURE VARIABLE.**	
Indicator.	**Value.**	**Indicator.**	**Value.**
$\hat{C}p$.	0.18	$\hat{C}p$.	0.79
$\hat{C}ps$.	-0.67	$\hat{C}ps$.	0.74
$\hat{C}pi$.	1.02	$\hat{C}pi$.	0.84
$\hat{C}pk$.	-0.67	$\hat{C}pk$.	0.74
$\hat{C}pm$.	0.06	$\hat{C}pm$.	0.78
K.	4.82	K.	0.06
Sigma level.	-2.01	Sigma level.	2.22

Table 2 Initial analysis results.

Below is a graphic of the process is shown to look the initial situation.



Graphic 1 Process capacity (weight variable).



Graphic 2 Process capacity (weight variable).

Analyze phase. One reason why the overdosed is given by the size of the mold and if a new mold is defined be achieved reduce or eliminated this problem. Below is a cause effect diagram.

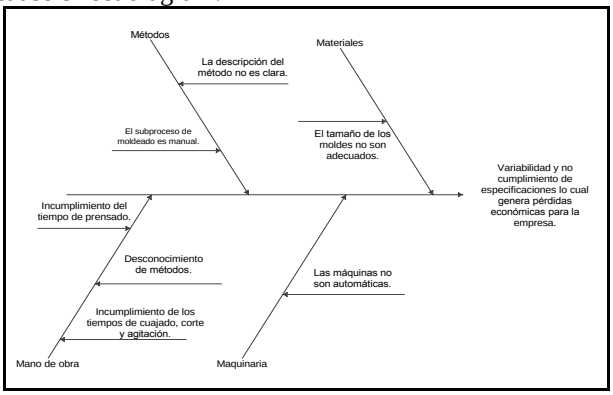


Figure 1 Cause effect diagram.

Improve phase. Changes were made in the mold also was necessary changes to the machine and the materials used for making cheese 500g , improvements were made solely to improve the variable weight since this is the main problem. The following changes are implemented.

BEFORE AFTER

Photography 1 Changes in the mold.

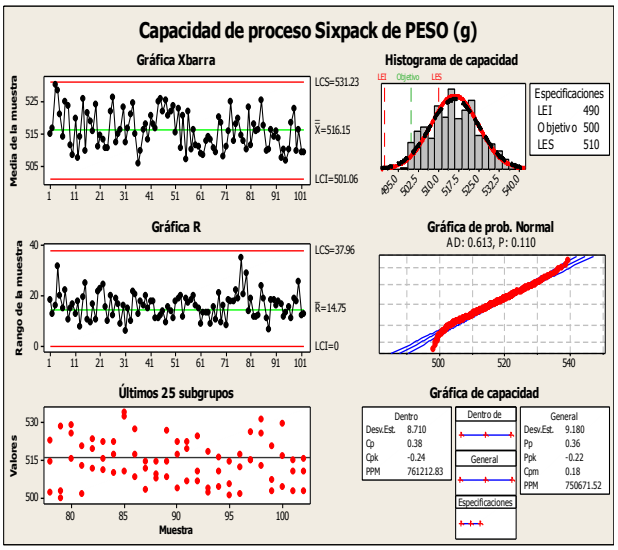
BEFORE AFTER

Photography 2 Changes in the machine.

BEFORE AFTER

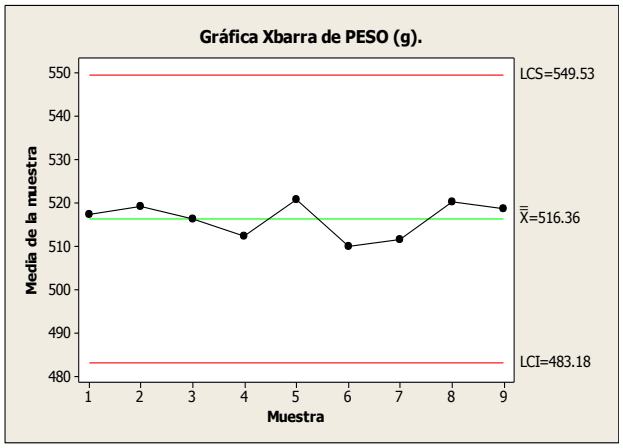
Photography 3 Changes in the materials.

Below is a graphic of the process is shown to look the improvements obtained.

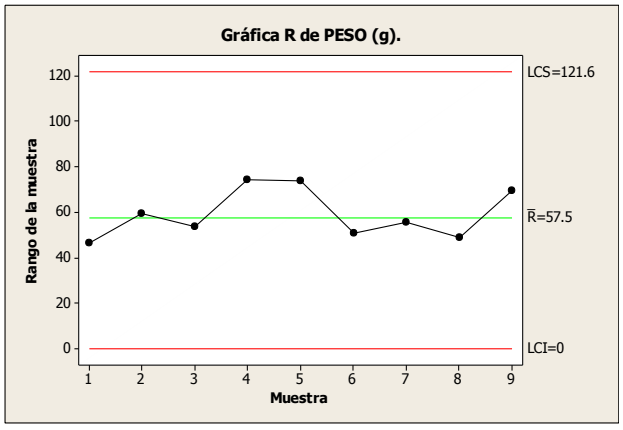


Graphic 1 Process capacity (weight variable).

Control phase. The company already has procedures and monitoring is performed on all production lines therefore tastings control means and ranges are implemented ($\overline{X}$−R).



Graphic 4 Control chart ($\overline{X}$).



Graphic 4 Control chart (R).

The control charts indicate that the process is within the control limits although the variability continues

3.Results

3.1 Indicators which were obtained after implementation of improvements

By changes outlined above the following results were obtained.

AFTER OF THE IMPROVEMENTS	
General.	
Indicator.	**Value.**
Productivity monofactorial.	7.98
Productivity multifactorial.	0.65
Economic losses ($).	4859.54
WEIGHT VARIABLE.	
Indicator.	**Value**
$\hat{C}p$.	0.35
$\hat{C}ps$.	-0.22
$\hat{C}pi$.	0.92
$\hat{C}pk$.	-0.22
$\hat{C}pm$.	0.18
K.	1.61
Sigma level.	-066

Table 3 Indicators (process improves).

3.2 Summary indicators (initial and final)

Indicators before and after of implementation of DMAIC.

INDICATORS			
INITIAL ANALYSIS		**FINAL ANALYSIS**	
General.		**General.**	
Indicator	**Value**	**Indicator**	**Value**
Productividad monofactorial	6.04	Productividad monofactorial	7.98
Productividad multifactorial	0.60	Productividad multifactorial	0.65
WEIGHT VARIABLE		**WEIGHT VARIABLE**	
Indicator	**Value**	**Indicator**	**Value**
$\hat{C}p$.	0.18	$\hat{C}p$.	0.35
$\hat{C}ps$.	-0.67	$\hat{C}ps$.	-0.22
$\hat{C}pi$.	1.02	$\hat{C}pi$.	0.92
$\hat{C}pk$.	-0.67	$\hat{C}pk$.	-0.22
$\hat{C}pm$.	0.06	$\hat{C}pm$.	0.18
K.	4.82	K.	1.61
Sigma level	-2.01	Sigma level	-0.66
ECONOMIC LOSSES			
INITIAL ANALYSIS		**FINAL ANALYSIS**	
Monthly loss	17881.51	Monthly loss	4859.54
Year loss	214578.12	Year loss	58314.48

INCREASED PRODUCTIVITY AND REDUCED LOSS	
Increased productivity multifactorial (%).	8.33
Reduced loss (%).	-72.82

Table 4 Summary indicators.

4.Conclusions

The application of DMAIC, in any company, is useful as it increases the level of product quality. The implementation of this methodology in the company INPROLAC SA allowed to increase the level of Sigma of -2.01 to -0.66, 8.33 % increase in productivity and economic losses decreased 72.82 %

5.Thanks

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