

# QUALITY CONTROL ANALYSIS WITH SIX SIGMA-DMAIC METHOD IN EFFORT REDUCE NUMBER OF SUGAR PRODUCTS AT PT. PG. GORONTALO

I.A. Nuh Kartini<sup>1)</sup>, Dwi Jayanthi Syarief<sup>2)</sup>

<sup>1)2)</sup>University of 17 August 1945 Surabaya, Indonesia

<sup>1)</sup> E-mail : ida.ayu.aries@gmail.com

<sup>2)</sup> E-mail : dwijayayanthi@gmail.com

Submit : 30<sup>th</sup> July 2018 , Revised : 7<sup>th</sup> September 2018 , Accepted : 8<sup>th</sup> September 2018

---

## ABSTRACT

*Companies need to maintain and improve the quality of products derived by applying a good quality control, because quality is an important factor in improving satisfaction and loyalty consumers, as well as PT. PG .Gorontalo ; Six Sigma methods that have high discipline can help develop and deliver near-perfect products. The purpose of this study was to determine how the value of sigma PT .PG . Gorontalo and what factors of product defects. In this analyzis , researchers took 3 months of data production and analyze the Six Sigma DMAIC method. Researchers examined / analyzed using a questionnaire and the report of production to help get the material of analyzis. From this research , it has been showed that the presence of defects of products in the production process ofPT. PG. Gorontalo at 5.664, 72 DPMO. It is also known that the cause is the human factor , machines, methods, materials, and environment. Based on these results , we can conclude that the value of sigma PT. PG. Gorontalo is located at 4 to 4.5 sigma, the factor most dominant cause of disability is due to lack of proper vacuum pressure.*

*Keywords : quality , six sigma , and the cause of disability*

---

## I. INTRODUCTION

In order to improve the quality of its production, the company undertook various steps with attention to various sides such as technology, management, raw materials and others. Basically the success of a company is the acceptability of the company's products is accompanied by high consumer satisfaction as well. Therefore, quality control is needed by the company in order to maintain and improve the quality of products produced, because quality is an important factor in increasing customer satisfaction and loyalty

Pande, et al (Prayisno, 2009) Six Sigma is a way of measuring the process, the goal is near perfect, presented with 3,4 Defect Per Million Opportunities (DPMO), an approach to changing organizational culture, one of the methodologies

in an effort to improve towards Six Sigma targets is DMAIC (Define, Measure, Analyze, Improve, dan Control) which provides a step in finding the problem, identifying the cause of the problem until finally finding a solution to fix it. As a step in using this DMAIC method, it is necessary to describe the performance of a process, namely through process control chart (Process Control Chart) and fishbone diagram.

PT. PG. Gorontalo is one of the companies producing sugar crystal and drops. Crystal sugar is a sugar produced from sugarcane juice mixed with water imbibisi and other chemicals through several stages and processes so ready to be marketed or sold. While the drops are the remaining water from the sugar crystals after washing thick sap with chemicals. PT. PG. Gorontalo implements high quality standards in its production activities. To produce a quality

product, various production planning and production system is done with high technology and also need to be done high supervision also so that the quality of the sugar is maintained and defective product not reaches the hands of consumers. However, after 3 months of observation before the start of the study, there has been an increase in the number of product defects. This is the background of the analysis of the results of sugar production at PT. PG. Gorontalo to prevent the increase in the number of defective products.

The study of Amalia Nurullah, Lisye Fitria, R. Dayari Adianto (2014) gives results from where the sigma value changes by 0.185, DPMO change of 15742.926 and COPQ change by 30%. The change of number in this research shows that DMAIC stage can give better suggestion in improving yarn quality 20S. The research of Shabrina Rahma Permatasari, Nasir Widha Setyanto, L. Tri Wijaya Nata Kusuma (2013) gives result that DMAIC analysis, got 5 CTQ (Critical To Quality) that is cracked, broken, gopel, burnt and porous. Setting optimal levels of Taguchi experiments, 8 hours of drying time, 9 hours of combustion time, clay composition: sand (80%: 20%) and milling 3 times. By using the optimum level setting, the sigma level value increases at each CTQ, a decrease in the percentage of defects from 11.96% to 6.88%, and the QLF value decreases from the actual condition.

Anupama Prashar (2014) gave results that After defining, measuring and analyzing stages, it was found that the use of extreme tolerances and cross-fitment of the root cushion causes failure of the cooling fan assembly. A recommendation made in the most important period is to improve the phase to design a suitable software bearing against the increased cross-fitment of the pads and to obtain a hydraulic jig with an electronic jig instead of a manual jig. The value in carrying out recommending this solution deviates from the truth for the assurance of continuity of inr lacs 34 per year. Because it is a chronic problem, the company estimates this to be a recurring savings.

Based on this background then the main problems in this study are: (1) What is the value of sigma at PT. PG. Gorontalo? And (2) What is the most dominant factor causing disability in production?

## RESEARCH METHODS

### Population and Sample

The population in this study are all products produced from the sugar production process for 1 year. While the sample in this research is the result of sugar production on for 3 months

### Variabel dan Operasional Variable

#### 1. Process control

Measurements on a continuous scale and are the most sensitive measure to identify the causes of reduced sugar quality. Generally, the quality criteria of sugar (GKP) that we follow include water content, polarization, color solution, crystal color, SO<sub>2</sub> content, conductivity ash and large grain types. In particular, the quality control of sugar in this study is the process of controlling the large type of sugar grains at PT. PG. Gorontalo

#### 2. Six Sigma

Six Sigma is a calculation to classify companies to a certain level to improve the quality of sugar production

#### 3. Product Defects

The product is said to be defective if the point on the control process graph is outside the UCL and LCL limits, so there is a need for follow-up to reduce the number of defects in sugar production process

### Analysis Method

Statistical Quality Control. To know the process deviation that occurs through Xbar-R Chart

## II. RESULTS AND DISCUSSION

### Define

Sugar size is an important component in the production of sugar so that the resulting size will determine the quality of sugar production. Based on the identification of the problem done before, it was identified that the size of the sugar produced was not in accordance with the company standard so that the main cause of the product is said to be defective.

### Measure

At this stage performed performance calculations of DPMO (Defect Per Million Opportunities) and converted into sigma level. The calculations performed are as follows:

$$D \text{ (amount of Defect)} = 1.123,5$$

$$U \text{ (Number of units)} = 198.333$$

$$O \text{ (Number of Opportunities)} = 1 \text{ (1 production per)}$$

day)  
 DPMO = ?  
 $DPMO = (D / (U \times O)) \times 1,000,000$   
 $DPMO = (1.123,5 / (198.333 \times 1)) \times 1,000,000$   
 = 0.005664715  
 = 5.664, 72 DPMO

From the calculation can be seen that the DPMO value is equal to 5.664, 72 so obtained sigma value between 4 sigma - 4.5 sigma.

**Analyze**

At this stage the product defect analysis is performed by making a control map for the production of sugar. From r chart and x chart can be seen graph of defect of production result and how development of stability of production result.

1) R chart

UCLR =  $D4R\text{-bar}$   
 =  $1,541 \times 2,88$   
 = 4,44  
 CL = R-bar  
 =  $86,5/30$   
 = 2,88  
 LCLR =  $D3R\text{-bar}$   
 =  $0.459 \times 2.88$   
 = 1,32

**Graph R Bar Chart**



In experimental subgroups 7, 17, and 21 there has been a production defect for the range of sugar products where R mean number 17 has values below the LCL R bar chart and R mean numbers 7 and 21 have values above the UCL R bar so it can be concluded that there were 3 defects in production of 30 trials indicated by the mean R being outside the boundary of the R bar chart.

2) X chart

UCLX =  $X\text{-doublebar} + A2R\text{-bar}$   
 =  $12,48 + (0.153 \times 2,88)$   
 = 12,92  
 CL = X-doublebar  
 =  $374,50 / 30$   
 = 12,48  
 LCLX =  $X\text{-doublebar} - A2R\text{-bar}$   
 =  $12.48 - (0.153 \times 2.88)$   
 = 12,04

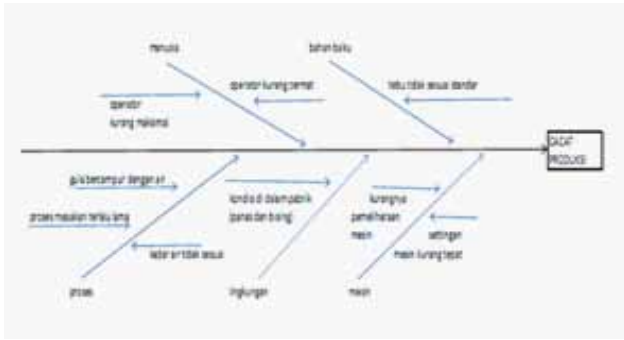
**GraphX Bar Chart**



In experimental subgroups 5, 17, and 26 there has been a production defect for the average yield of sugar production where X mean number 17 has a value below the LCL X bar chart and X mean numbers 5 and 26 have values above the UCL X bar finished it can be concluded that there were 3 defects in production of 30 trials indicated by the X value of the mean being outside the X bar chart.

3) Fishbone diagram

After the analysis of product defects, then will be discussed the cause of the unstable parameters. Therefore, fishbone diagram is formed or cause-effect diagram which is a diagram that serves to identify the causes of the problem that occurs in this case is the instability of sugar production process. Here is a fishbone diagram that maps the cause of the disability of the sugar production. Causes are categorized by 4 M 1 L or human, methods, machine, material, and environment.



- a) **Man**  
It is a resource that is strong enough but lacks awareness of tasks and responsibilities, this is what makes human resources into one part that often became a significant constraint. PT. PG. Gorontalo enforces a policy of training when employees are recruited and no follow-up the next day, this policy that causes less trained and underprivileged workers. Employee saturation due to the monotonous work cycle and lack of supervision on employee performance during the production process affect the employee one of them decreasing the level of discipline in carrying out production activities that will affect the resulting product.
- b) **Work Method / Process**  
PT. PG. Gorontalo has a standard written work procedure to minimize errors and damage. However in practice, employees often do not follow established procedures, such as employees are not careful in giving the composition of water on the sugar so that the sugar becomes mixed by water and water content is too high. In addition, sometimes the cooking time also exceeds the company's specified standards resulting in a product defect
- c) **Raw material**  
Decreasing the level of raw materials becomes an obstacle because the storage process is too long from the age of raw materials come to enter the production process, the next obstacle where the storage of raw materials that exceed the standard capacity makes the age of raw materials to be shorter, this problem leads from the process of supervision minimal on every human resources in charge so that the quality of raw materials is not maintained or experiencing damage

d) **Machinery and Equipment**  
PT. PG. Gorontalo has a decrease in the maintenance process of the machine periodically, this resulted in many production process failures and make system errors. Basically PT. PG. Gorontalo already has a fairly clear SOP, but the field application is less adhered

e) **Environment**  
Irregular air cycle makes the environment of PT. PG. Gorontalo become hot so disturbing the production process, the volume of engine noise is too high it should be able to be responded by the management so as not to mengganggu production process

4) **Failure Mode and Effect Analysis (FMEA)**  
FMEA is a procedure used to identify and prevent potential consequences that can be generated from the causes and failure modes that occur. FEA is formed to provide recommendations for failures that have occurred so that later can be done an improvement so that the results obtained can be in accordance with the desired. Through FMEA also can know the biggest failure mode in process that can be caused so that in the end can be more attention in process of its quality improvement. Based on the identification of factors through the diagram fishbone penyebab, then FMEA made to know the causes of potential stability of production. Here FMEA is formed to find the biggest potential cause that can arise from process instability and recommendations that can be given to the value of stable production.

Table RPN

	FAILURE	SEVERITY	OCCURANCE	DEFECTION	RPN
KERIKIL	OPERATOR	2.8000	3.2000	3.8000	34.048
	KRISTALISASI	2.4000	3.6000	3.4000	29.376
	PUTARAN	5.4000	6.0000	6.0000	194.4
ABU	OPERATOR	2.8000	2.6000	5.0000	36.4
	PUTARAN	4.6000	2.4000	5.8000	64.032
	TEKANAN	6.8000	6.2000	6.6000	278.256

From the following FMEA table it can be seen that the potential cause with the highest RPN value is 278,256. The value of RPN owned comes from pressure, So it can be said that the most influential factor in the production especially the size of sugar is the pressure vacuum.

### Improve

At this stage, will be planned improvements in the production process to improve quality. The method used is 5 W 1 H. metode ini dibuat untuk memperjelas pelaksanaan rekomendasi yang akan dilakukan yang mencakup tujuan rekomendasi, orang-orang yang melakukan rekomendasi, kapan rekomendasi akan dilakukan, dan lain-lain. Melalui pertanyaan what, why, where, when, who, dan how. Based on the recommendation from FMEA and the making of 5W 1H, there are three recommendations proposed in order to achieve stability of production result by improving the quality of process stability, that is:

- a. Make a checklist sheet, to ensure the operator performs the procedures that should be done
- b. add standard sugar production information followed on Work Order
- c. Giving response of sugar production to operators so that operators know the results of work that he has done and can be a meaningful input for the next production process.

### Control

Next at this stage, documentation is made for matters relating to the proposed recommendations for continuous quality improvement

- a. Create checklist sheet with new concept, including for machine check and quality of human resources
- b. Designing a communication flow diagram between production managers and operators
- c. Make a report of the production of sugar to be evaluated periodically.

## III. CONCLUSIONS AND SUGGESTIONS

From the discussion, it can be concluded that PT. PG. Gorontalo has a sigma value between 4 sigma up to 4.5 sigma. This is evidenced from the DPMO value of 5,664.72 and the control chart R bar has a upper limit (UCL) of 4.44 and the lower limit (LCL) of 1.32 with three times the point indicating the existence of a product defect. It is proved that R mean numbers 7, 17, and 21 have a production defect for the range of sugar products where R mean number 17 has values below the LCL R bar chart and R mean numbers 7 and 21 have values above the UCL R bar so it can be concluded that there is 3 times

the production defect of 30 experiments shown by the mean value R being outside the boundary of the R bar chart. While for the X bar control chart has the upper limit (UCL) of 12.92 and the lower limit (LCL) of 12.04 with three dots indicating a product defect. It is proven that X number 5, 17, and 26 have a production defect for the average yield of sugar production where X mean no 17 has a value below the LCL X bar chart and X mean no 5 and 26 has a value above the UCL X bar so it can be concluded that there is 3 times the production defect of 30 experiments indicated by the X value of the mean being outside the bar X bar.

Based on the fishbone diagram, it is known there are several factors causing product defect, that is human factor, work method / process, raw material, machine and equipment, and environment. From the FMEA method, it can be known to bring the highest RPN value of 278,256 which is owned by the pressure factor, so it can be concluded that the most dominant factor causing disability in sugar production is the lack of proper vacuum pressure.

As for suggestions that can be given to PT. PG. Gorontalo, namely: (1) The supervision and selection of sugarcane raw materials should be further improved so as to minimize defects in the production, (2) It is necessary to supervise the operators so that the operator works carefully and maximally; (3) Needs skill training on the operator and employees others who directly work in the field during the production process to avoid lack of machine information.

## REFERENCES

- [1] Anonim. Goesth dan Davis.1994. [http://carapedia.com/pengertian\\_definisi\\_kualitas\\_info2173.html](http://carapedia.com/pengertian_definisi_kualitas_info2173.html). Di akses tanggal 15 Oktober 2014
- [2] Anonim. Philip Kotler. [http://shvoong.com/business-management/technology-operations-management/2071971-sejarah-sigma/Diakses\\_pada\\_tanggal\\_15\\_Oktober\\_2014](http://shvoong.com/business-management/technology-operations-management/2071971-sejarah-sigma/Diakses_pada_tanggal_15_Oktober_2014)
- [3] Ariani, Dorothea W. 2004. Pengendalian kualitas statistik (Pendekatan Kuantitatif dalam Manajemen Kualitas). Yogyakarta: Penerbit Andi.
- [4] Daryanto, Sidik.2009. Usulan Perbaikan Kualitas Produk Dudukan Magnet Dengan

- Metode Enam Sigma. Di akses pada tanggal 20 Oktober 2014
- [5] Gaspersz, Vincent. 2001. Total Quality Management. Jakarta : PT. GramediaPustaka Utama.
- [6] Gaspersz, Vincent. 2002. Pedoman Implementasi Six Sigma Terintegrasi dengan ISO : 2000, MBNQA, dan HACCP. Jakarta : PT. Gramedia Pustaka Utama.
- [7] Muis, Saludin. 2011. Metode 6 Sigma (Menciptakan Kualitas Produk Kelas Dunia). Yogyakarta : Graha Ilmu.
- [8] Nasution, Arman Hakim. 2006. Manajemen Industri. Yogyakarta :Penerbit Andi
- [9] Nurullah, Amalia ( Institut Teknologi Nasional Bandung) ; Fitria, Lisye; Adianto, Hari (2014), Perbaikan Kualitas Benang 20S Dengan Menggunakan Penerapan Metode Six Sigma-DMAIC Di PT. Supratex. REKA INTEGRA Vol 2, No 1 (2014): Edisi Kelima. Publisher: REKA INTEGRA
- [10] Shabrina Rahma Permatasari, Nasir Widha Setyanto, L. Tri Wijaya Nata Kusuma (2013), Penerapan Metode Six Sigma Dengan Pendekatan Metode Taguchi Untuk Menurunkan Produk Cacat (Studikusus : Sentra Industri Genteng Tanah Liat Desa Pacar Peluk, Kecamatan Megaluh, Kabupaten Jombang) Implementation of Six Sigma Method With Taguchi Method Approach To Reducing Product Defects(a Case Study in the Industrial Centers of PacarPeluk Clay Tile, Megaluh, Jombang)
- [11] Anupama Prashar, (2014) “Adoption of Six Sigma DMAIC to reduce cost of poor quality”, International Journal of Productivity and Performance Management, Vol. 63 Issue: 1, pp.103-126, <https://doi.org/10.1108/IJPPM-01-2013-0018>
- [12] Heizer, Jay & Barry Render (2011). Manajemen Operasi. Edisi Sembilan. Buku Dua. Diterjemahkan oleh Chriswan Sungkono. Jakarta: Salemba Empat
- [13] Heizer, Jay & Barry Render (2010). Manajemen Operasi. Edisi Ketujuh Buku 1. Jakarta: Salemba Empat