Quality Control Analysis Using Six Sigma Method to Reduce Post Pin Isolator Riject in Natural Drying Pt Xyz

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Abstract:- This study aims to analyze the product failure of the type of pin post insulator product, as well as to find the main cause and to propose improvements at PT XYZ using the Six Sigma method. This research was conducted only in parts of the production process that have a high failure rate such as in natural dryingsections. This study uses a Six Sigma methodology approach with tools such as Fishbone diagrams and Pareto diagrams. This research is a quantitative descriptive exploratory method. The results of this study were the type of cracked lip crack caused by the vaccum is unstable in finishing section, with the improvement of cleaning the vaccum duct and routine maintenance vaccum duct in finishing machine. For the type of cracked middle skirt crack caused by the auger on pugmill machine being worn, between the dimensions of Honggote (HG) in the forming and Sita in finishing are not matching, with corrective actions: repairing pugmill machine, vaccum duct in finishing section, repairing sita so that HG and sita are matched and conducting routine test and periodic maintenance. The conclusion of this research is that quality control using the six sigma method can reduce the rejection level and increase the six sigma level.

***Keywords**:- Six Sigma, Quality Improvement, Fishbone Diagram, and Ceramic Insulator.*

I. INTRODUCTION

This company is one of the industries in the industrial sector in the field of medium voltage ceramic insulators, namely the production of 22 kV pin post insulators.In April 2020, the company had a Pin Post production failure in the sections natural drying is 2.49% and the company also targets a rijek level for the natural drying at 0.5%. Thus it is necessary to control product quality to achieve production defect targets.

Researchers chose quality control using Six Sigma because "Six Sigma is a new management tool used to improve Total Quality Management, very focused on quality control by exploring the company's overall production system which aims to eliminate production defects" (SHIFT Indonesia, 2017). Six Sigma is considered better than other methods such as Total Quality Management (TQM), TQM is a method for implementing and managing overall quality improvement activities in an organization (Usman).

Many researchers have previously researched quality control using the Six Sigma (DMAIC) method in various industries but only a few have researched quality control using the Six Sigma method in the ceramic insulator industry. Previous researchers explained the application of Six Sigma in the water industry (Didiharyono, Marsal&Bakhtiar, 2018), the application of six sigma in the electronic goods industry, namely the Blue-Ray Disc Player (DonyAriefWidiatmoko), the application of six sigma in the car painting industry (Mohhamed A Rahman, AKM Mohiuddin&Hanani Abdullah, 2015), the application of six sigma in the construction industry (Molly Thomas &I.Porcia, 2017).

This study will analyze any failures in the production section of pin post ceramic insulators, as well as find the main causes of the failure of the product and provide suggestions for its repair. This research is also to determine the value of SQL (Sigma Quality Level) in the productionnatural drying section of pin post ceramic insulators.

II. THEORETICAL REVIEW

A. Control

Control is a process by which managers monitor and regulate how an organization and all its members carry out the activities needed to achieve organizational goals efficiently and effectively (Jones and George, 2003).

B. Quality

Juran (1995) defines three qualities that are used, namely:

1. Quality is the specialty of a product that answers consumer needs.
2. Quality is free from defects
3. Quality is compatibility with the intended use.

C. Defect

Good quality according to the manufacturer is if the product produced by the company is in accordance with the specifications determined by the company, while bad quality is if the product produced does not comply with the predetermined standard specifications and results in a damaged product (Wahyu, 2009).

D. Six Sigma-Introduction and overview

At the end of 1970, Dr. Mikel Harry, a senior engineer at Motorola's Government Electronics Group, started an experiment to solve the problem using statistical analysis. Using Motorola's GEG is starting to show dramatic improvements: products are designed and produced faster at less cost. He then wrote this method in a paper entitled "The Strategic Vision for Accelerating Six Sigma Within Motorola", Dr. Mike Harry was then assisted by Richard Schroeder, a former Motorola executive, to develop a data-driven change management concept. The result of this collaboration is a simple quality measurement tool, which later became a philosophy of business progress, known as Six Sigma.

Six sigma is a management tool used to replace Total Quality Management (TQM) which is very focused on quality control by exploring the company's overall production system (AchmadSutawijaya& Lenny Nawangsari, 2019). The six sigma method has been widely applied in order to improve performance, such as the manufacturing industry (Linderman, et al., 2003), health and safety (Rimantho&Cahyadi, 2016; Sanjit, et al., 2011), environmental management systems (Calia, et al., 2009).

III. METHODOLOGY

The research methodology used in this research is a case study research with the aim of describing the application of Six Sigma to the ceramic manufacturing industry in natural drying section. This study uses primary data, namely data that is directly obtained and collected in the research area, such as: the condition of the materials used, work instructions and data of employees who work in the production department, while secondary data is data obtained from indirect sources that have been previously made. and used for research processes such as: process flow data and employee competency matrices.

Data collection techniques using interviews with several employees in the drying section of nature, observation (direct observation) and documentation. The samples in this study were all internal reports on the production section of ceramic insulator pin post in the natural drying section. In analyzing and calculating data using the six sigma calculator and the minitab18 application.

IV. RESEARCH RESULTS

There are five stages of DMAIC as a characteristic of Six Sigma, and these five phases have been implemented by the Motorola company (George, et al., 2004), including:

1. Define Phase

The purpose of this step is to clearly define the problem and what the impact of the problem is on customer satisfaction, stakeholders, employees and organizational probability.

a. Process Flow

Figure 1 shows a production process flow diagram, namely a diagram showing the general flow of the process and equipment of a pin post ceramic insulator plant.

b. SIPOC Diagram

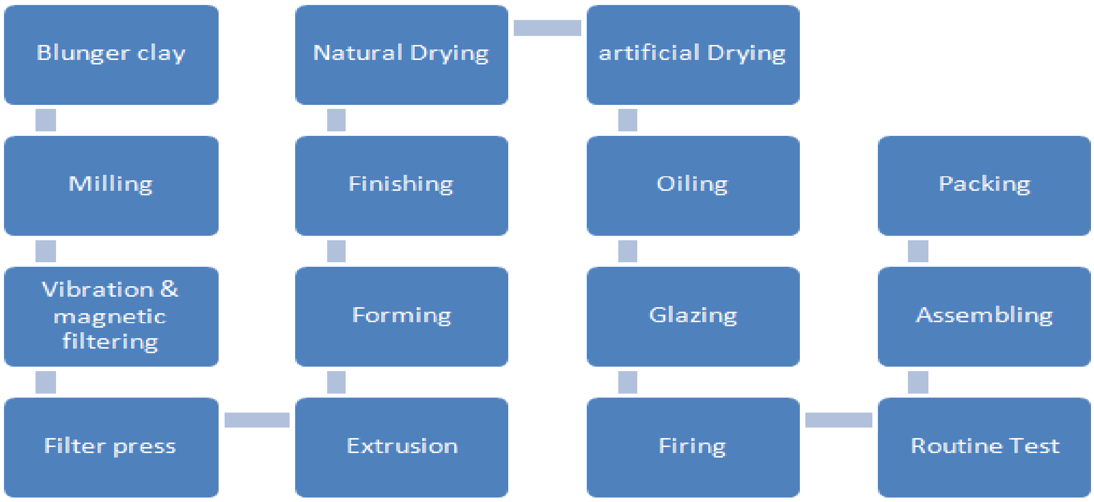
Figure 2 shows a diagram of SIPOC (Supplier, Input, Process, Output and Customer), which is a tool for identifying the flow of raw materials, machinery, production processes, finished product output until the receipt of goods by the customer for the natural drying section.

c. Critical to Quality (CTQ)

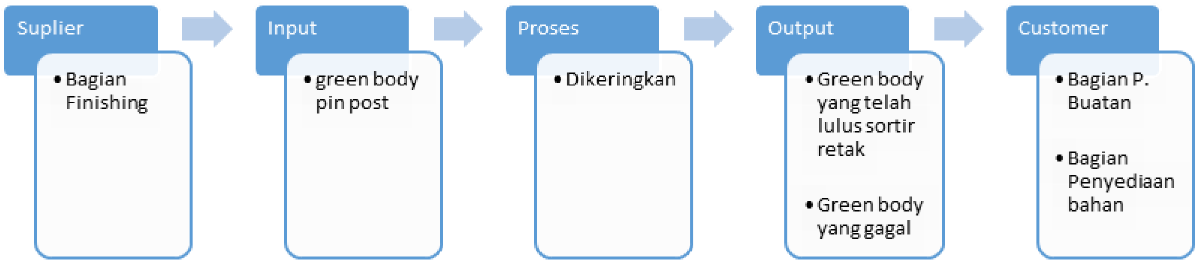
Critical To Quality (CTQ), namely the requirements of QC to achieve customer satisfaction so that there are no complaints from the previous process. Table 1 shows the Critical to Quality (CTQ) production of pin post ceramic insulators in the natural drying section. Table 2 and Figure 3 show the definition of the defect type of the product.

d. Identification of Problems

In data collection and problem identification, data was obtained in April 2020, there were products that failed in the production of pin post in some parts of natural drying by 2.49% and the company targeted a rejuvenation level value of 0.5%. Thus it is necessary to control the quality of production so that the level of production defects can meet the target value of rejection.



(Source: Data processing company, 2020)
Fig1 :Process Flow of Making Ceramic Pin Post Insulator



(Source: Data processing company, 2020)
Fig 2 :SIPOC diagram produces Pin Post ceramic insulator in Natural Drying section

Table 1: CTQ natural drying section

Natural Drying Section		
Quality characteristics	Performance Requirement	Type of defect
Compatibility of visual conditions	Nothing cracked	RA RRT RBR RL1 RL2 RD1 RD2 RRA

(Source: Data processing company, 2020)

Table 2 :Defect Definition Table

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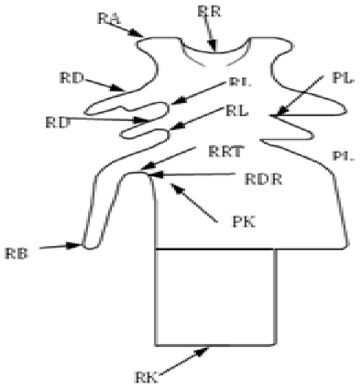
No	Code	Name Reject	Definition
1	Form	Reject form forming	The flak from forming because the shape does not match the image on the leg (tilted leg / dent)
2	Slip	Slip	When it is formed by the finishing machine, the finishing knife stops halfway when it forms.
3	RA	Cracked Head	Cracks at the edge of the upper leaf for the marking part of the pin post
4	RBR	Cracked Lip Skirt	The crack in the middle arch in the skirt from the pin post
5	RRT	Crack Middle Skirt	The crack in the center of the radius in the skirt.
6	RRA	Top Radius Crack	The crack in the first neck from the top of the pin post
7	RK	Cracked Legs	Crack the base of the leg of the pin post
8	KTR	Dirt	Dirt sticking to the pin post surface but the dirt comes from the burning kiln.
9	RD1	1st Leaf Crack	That is, the cracked edge of the first leaf
10	RD2	2nd Leaf Crack	Namely the crack at the edge of the second leaf
11	RL1	1st Neck Crack	The crack in the first neck from the top of the pin post
12	RL2	2nd Neck Crack	The crack in the second neck from the top of the pin post
13	PB	Broken Body	That is, the pin post is split in two, between the leg and the body or between the first neck and the second neck with the feet
14	RDR	Crack In Skirt	Cracks in the radius in the skirt, into the body (sideways and not in the middle of the radius)
15	LM	Laminate	Cracks in the body of the pin post. The fractions looked twisted
16	SOMPEL	Sompel	That is a small fraction in a certain part of the pin post
17	PUNTIRAN	Twist	The twisted fracture of the leg due to the forming / pugmill
18	TB	Paste Material	The remaining material that sticks during the forming process (usually attached to the inside of the pin post skirt)
19	PK	Broken leg	The pinpost leg was broken with the body and skirt
20	PL1	1st neck fracture	Fracture of the first neck from above the pin post as a result of mechanical stress
21	PL2	2nd neck fracture	Fracture in the second neck from the top of the pin post as a result of mechanical stress
22	C.GLZ		Spot without glaze or insert small objects on the glaze layer and small holes. Where the provision is that the total glaze defect area in each insulator unit must not exceed:
			$100x\frac{D\ X\ F}{2000}$ mm2
			And every single glaze defect must not exceed:
			$50x\frac{D\ X\ F}{20000}$ mm2
			D = largest diameter of the insulator
			F = The creepage distance of the insulator
			So for pin posts, the total glaze defects must not exceed:
			100 x 170 x 534/2000 = 4539 mm2
			And every single glaze defect must not exceed:
			50 x 170 x 534 / 20000 = 226,95 mm2.

(Source: Data processing company, 2020)



(Source: Data processing company, 2020)
Fig 3 :Types of Pin Post defects

Table 3 :Production data of pin post insulators in April 2020

Bagian Proses	April 2020			Target Rijek
	Total produksi	Rijek	% Rijek	
Natural Drying	21.556	532	2,47	0,50%

(Source: Data processing company, 2020)

e. Project Chapter

The Project Charter is: A formal statement on the "business issue" of the Project Sponsor and a summary document that allows all stakeholders to review the project and commit to supporting it.Table 4 shows the project charter and goal statement.

Table 4 : Project Chapter

PROJECT CHAPTER	
BUSINESS CASE	OPPORTUNITY STATEMENT
The production project in April 2020 in the natural drying section did not reach the target. actual rejection of natural drying in April 2020 was 2.46% while the target set by the company was 0.5%.	The production project in April 2020 in the production section did not reach the target set by the company, as a result, production in April lost 424 pieces of product (1.96% of April 20 production).
GOAL STATEMENT	PROJECT SCOPE
"Reducing pin post production in the natural drying section from 2.49% to 0.5 at the end of semester 1".	Scope : Production in the finishing section, natural drying, oiling, burning and routine tests.

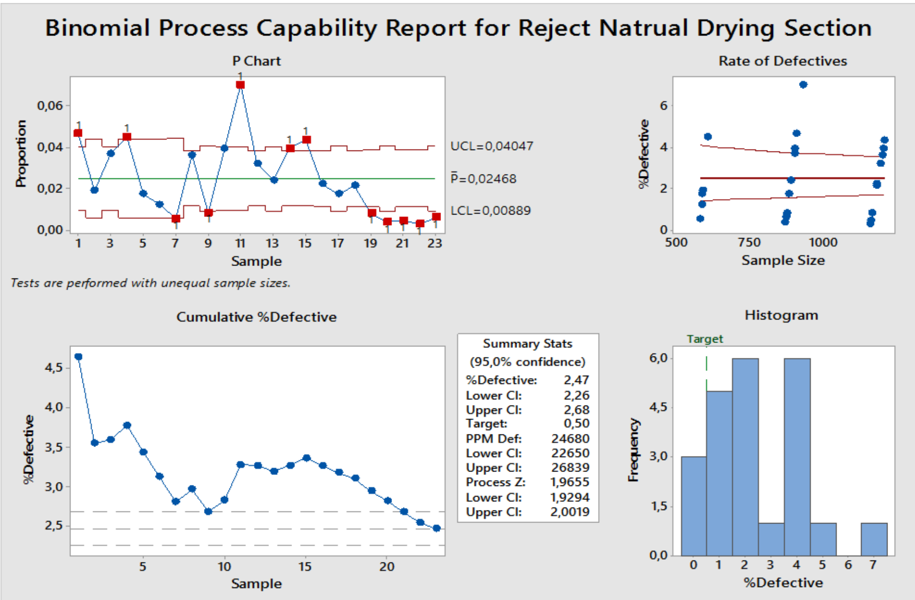
(Source: Data processing company, 2020)

2. Measure Phase

The measure phase consists of finding and executing the data that has been collected to establish the basics of improvement and measuring the CTQ as the target process and calculating the sigma level value.

a. Production Control Chart

To create a control chart and binomial capabilities of each production section, researchers used the help of the Minitab 18 application. Figure 4: shows the control chart and capabilities in the finishing, natural drying, oiling, combustion and routine test sections.



(Source: Data processing company, 2020)
Fig 4 :control chart and capabilities in the finishing, natural drying, oiling, combustion and routine test sections.

b. Calculating the Sigma Leve

In calculating the value of DPO and DPMO using historical data for April 2020, which shows the capability of the process before repair.Measurement of the six sigma level with the help of the six sigma calculator application.Table 6.shows the results of the calculation of DPO, DPMO and six sigma level.

Table 6 :The six sigma calculation results table

Proses	DPO	DPMO	Level Sigma
Natural Drying	0,024679904	24679,904	3,47

(Source: Data processing company, 2020)

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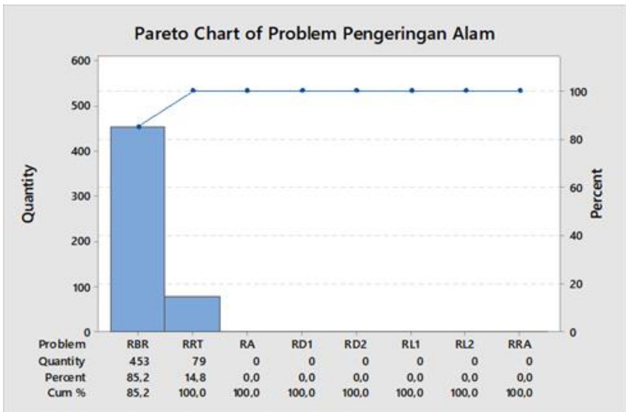
3. Analyze Phase

Analyze phase is the stage of isolating the main cause of the focused CTQ, therefore determining the root of the problem using the Pareto diagram and the source of the cause of the defect using a fishbone diagram.

a. Pareto Diagram

Figure 4: shows the Pareto diagram of the natural drying section. From the figure, it can be seen that the main failure is RBR (Cracked Skirt Lip).



(Source: Data processing company, 2020)

Fig 4 :Pareto diagram parts of natural drying section.

b. Fishbone Diagram

To find the main causes of product failure, direct interviews were conducted with sources who were considered to be experts, then a Fisbone Diagram was made. Brainstroming was conducted to determine the possible root causes from the fishbone diagram. The figure in appendix 1 shows a fishbone diagram of a natural drying section.

4. Improve Phase

Analyzing the problem and taking corrective action to reduce pin post insulators using 5W1H tools (Why, When, Who, Where, What and How). Table 6 shows the 5W1H table.

5. Control Phase

In the Control stage, the selected solution is implemented, with the aim of controlling the process whose performance has been improved and maintaining that performance.Table 7 shows the control measures to maintain the changes made in the improve phase.

a. Analysis capabilities

Comparison of process performance after repair with specified requirements and before repair can be seen in Appendix 2.

b. Calculates the six sigma level

Calculation of the six sigma level is done again to determine the achievement of the six sigma level and improvement is carried out again. Table 7 shows the results of the calculation of the six sigma level after the improve stage.

From the table, it is found that the results of the improvements that have been made can reduce the DPMO value, in the natural drying section from 24679.9 to 3800.6. Meanwhile, there was an increase in the sigma value, in the natural drying section from 3.47 to 4.17.

V. CONCLUSIONS AND SUGGESTIONS

A. *Conclusions*

Based on the results of the research that has been done, it can be concluded that:

In the finishing part, rijek occurs: RRT (middle skirt crack) and RBR (skirt lip crack), caused by: the pugmill machine is worn out, Vaccum in the finishing section is unstable and the Honggote (HG) radius in the forming section does not match the Sita radius in the finishing section. The corrective actions are as follows: cleaning the vacuum lines in the finishing section and keeping them clean from material dirt, repairing the auger by patching the worn auger and periodic maintenance and repairing Sita in the finishing section so that the radius matches the HG in the forming section.

The use of the Six Sigma method has a positive effect on the quality of the products produced. This is indicated by increasing the six sigma level from 3.47 to 4.17.

B. Suggestions

There are several suggestions that can be put forward in this research and are likely to have an impact on both the company and the industrial world, including:

- Suggestions for companies to continue research to achieve a higher level of six sigma or zero defects by increasing employee competence in implementing Six Sigma.
- The need for further research into departments other than production for continuous improvement.

Table 6.Tabel 5W1H

No	Penyebab	Why	What	Where	When	Who	How
1	Vaccum in the finishing part is not stable (too big or small)	Because the vaccum duct is clogged with residual dirt	Vacuum lines cleared and operator finishing at briefings	in the finishing section	18-May-20	Maintenace	Vaccum finishing line cleaning and routine maintenance checks
2	The auger pugmill or extruder has worn more than 5 mm	Because 45,597 km have been used, it needs maintenance	Repair of the auger and maintenance standards were established	in the extruder	08-Jun-20	Maintenace	Repair of the auger by patching worn augers and making a pugmill wear checkset that converts from pcs to m for periodic maintenance
3	Operators in entering the feeder into the mold forming as long as it is not perpendicular.	Because the going in forming is not perpendicular because the pugmill operator is in a hurry to put the going into the lorry.	Pugmill operators are trained to put the going so as not to tilt.	on the pugmill section	08-Jun-20	Operator pugmill	Pugmill operator training for laying down and consistent monitoring of work by the Head of Formation.
4	Between the HG in the forming section and the seized part in the finishing section, the dimensions don't match	By checking the results of the forming form are placed in seized, the result is that the lip of the skirt does not reach the confiscated stoper.	Repairs are carried out for confiscation and standards are made for maintenance.	in the finishing section	25-Jun-20	Finishing and maintenanc e operators	Use the checksheet for use of HG and confiscated molds and check the similarity of dimensions of confiscated and HG after each use of 20,000 pcs for maintenance
5	There is no torsional measurement for YG mold results	Because the most recent measurement is sufficient as a reference for checking the measured measurements.	Dilakukan pengecekan untuk puntiran YG dan operator diberi training.	in the forming section	23-Jun-20	Forming operator, Head of forming and QC	Making a check sheet for YG measurement and setting the rotation standard for YG, namely 90 degrees.

(Source: Data processing company, 2020)

Table 7 : Table control after improvement

No	Control	Tool	How to often	Checking	Who
1	Vaccum	Maintenance checklist	Monthly	Vaccum duct	Maintenance
		Production checklist	Daily	Work consistency	Head of Forming Section
2	Auger	Extruder usage checksheet	Monthly	Length x production pcs	Maintenance
3	Consistent insertion of going into mold forming	Production checklist	Daily	Work consistency	Head of Forming Section
4	HG compatibility with sita	Production checklist	Weekly	Number of production	Forming operators, finishing and forming technicians.
5	YG twist	YG checking checksheet	Daily	Degree of twisting	Forming operator, Head of forming and QC

(Source: Data processing company, 2020)

Table 8 :The table is the calculation result of DPO, DPMO and six sigma level after the upgrade stage.

Proses	DPO	DPMO	Level Sigma
Natural Drying	0,003800601	3800,601	4,17

(Source: Data processing company, 2020)

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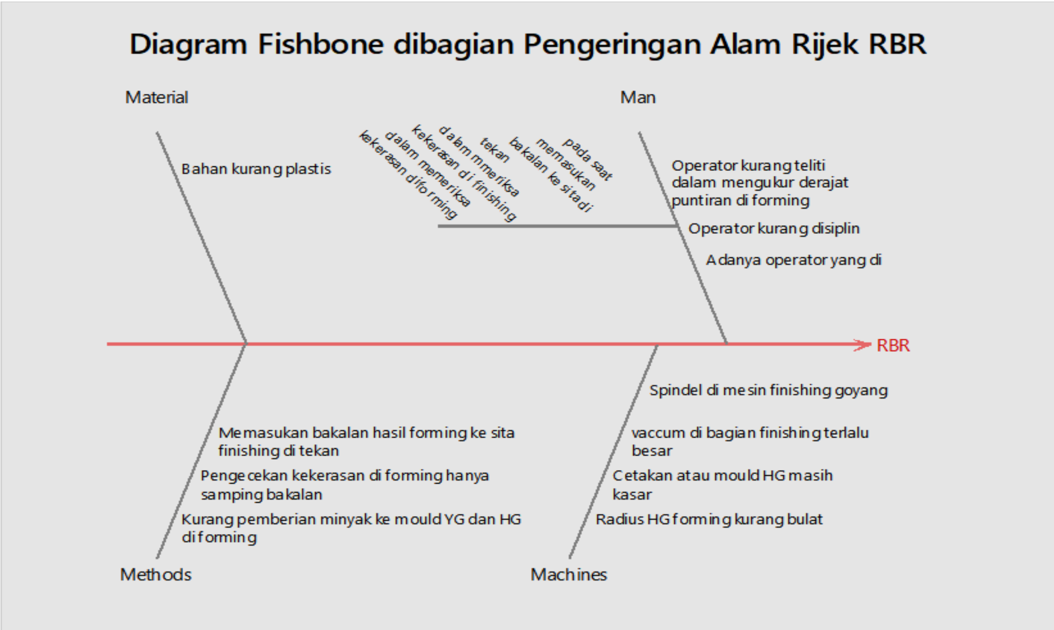
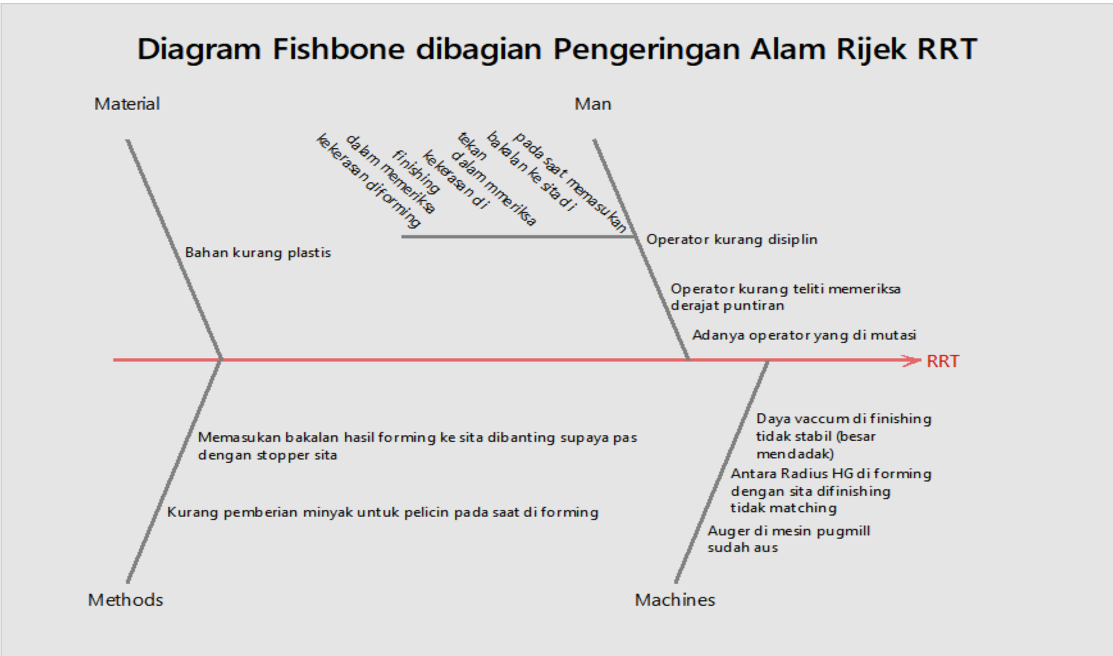
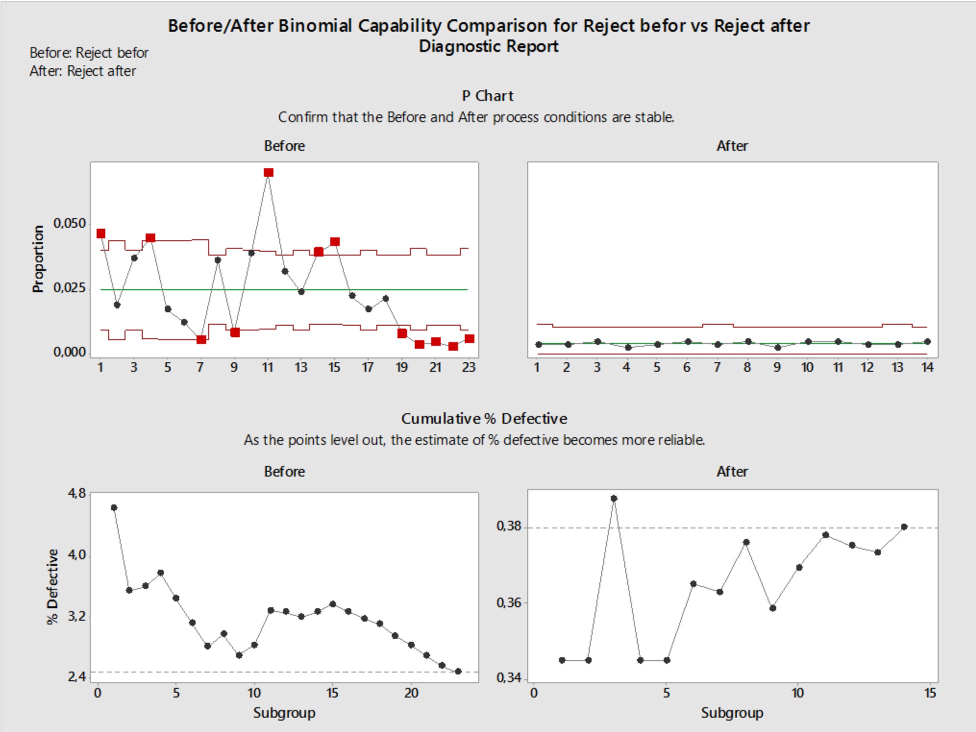
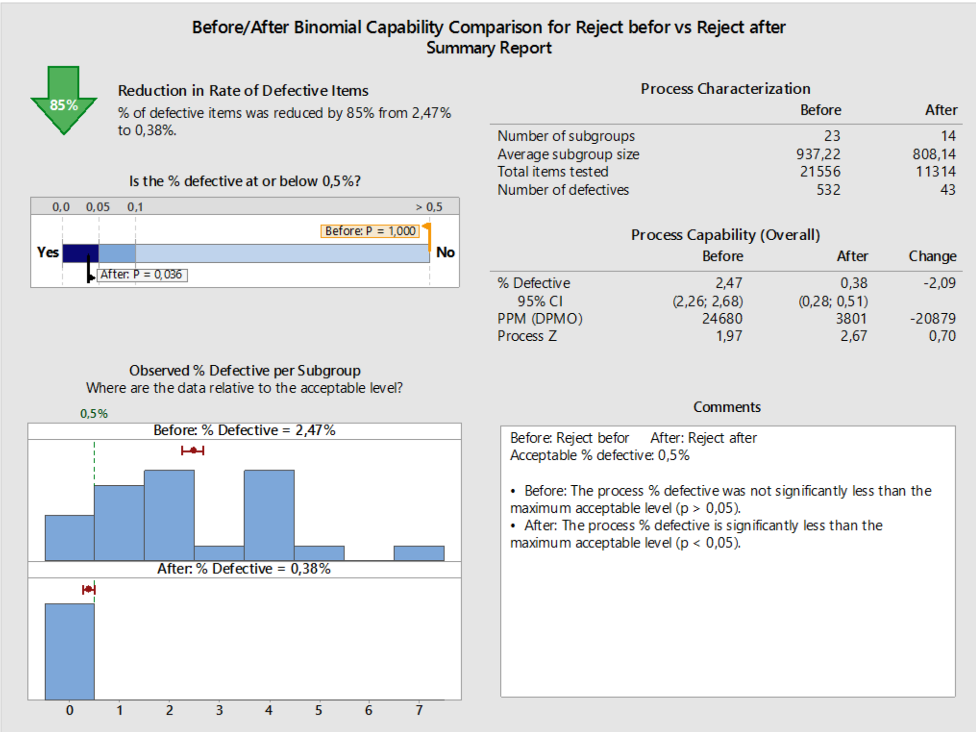
APPENDIX 1





APPENDIX 2


Before/After Binomial Capability Comparison for Reject befor vs Reject after
Diagnostic Report
Before: Reject befor
After: Reject after
P Chart
Confirm that the Before and After process conditions are stable.
Before
After
Proportion
Cumulative % Defective
As the points level out, the estimate of % defective becomes more reliable.
Before
After
% Defective
Subgroup
Subgroup


Before/After Binomial Capability Comparison for Reject befor vs Reject after
Summary Report
85%
Reduction in Rate of Defective Items
% of defective items was reduced by 85% from 2,47% to 0,38%.
Is the % defective at or below 0,5%?
Yes
No
Before: P = 1,000
After: P = 0,036
Process Characterization
Before After
Number of subgroups 23 14
Average subgroup size 937,22 808,14
Total items tested 21556 11314
Number of defectives 532 43
Process Capability (Overall)
Before After Change
% Defective 2,47 0,38 -2,09
95% CI (2,26; 2,68) (0,28; 0,51)
PPM (DPMO) 24680 3801 -20879
Process Z 1,97 2,67 0,70
Observed % Defective per Subgroup
Where are the data relative to the acceptable level?
Before: % Defective = 2,47%
After: % Defective = 0,38%
Comments
Before: Reject befor After: Reject after
Acceptable % defective: 0,5%
• Before: The process % defective was not significantly less than the maximum acceptable level (p > 0,05).
• After: The process % defective is significantly less than the maximum acceptable level (p < 0,05).