Reduce Reject Painting Process Using Six Sigma Method with Dmaic Approach and Experiments on Brake Disc Products (1 Rc Hub) (Case Study in Pt. Xyz)

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Abstract:- Quality is one of the key to winning competition with the market. When the company is able to deliver quality products then it has built one of the basics to create customer satisfaction. Quality does not only have a positive impact on customers, but also for manufacturers as it can enhance their corporate image as well as a company's sustainability guarantee in the future. Every company needs to be systematically and continuously improving the quality of existing products and processes. Six sigma is a comprehensive and flexible system for achieving, maintaining, and maximizing the quality of the product produced for the success of the business. Six Sigma methods are often used by companies to control product quality by minimizing the number of defects or disabilities. One tool in implementing six sigma is the DMAIC approach, Define, Measure, Analyze, Improve and Control. PT XYZ as one of the companies engaged in the manufacture of two-wheeled automotive spare part is certainly paying attention to quality improvement as one of the efforts to enhance the competitiveness and customer satisfaction. This research focuses on enhancing the drawing process especially on the RC-Hub 1 product which is one of the high quality products as it includes export products to Japan. Initially, the painting process of 1 RC Hub was performed in the subconts, but due to quality considerations (Defect 16.8%) and losses arising, eventually after analyzing using six sigma method with DMAIC approach using various tools such as Figure Pareto, map control p, DPMO and sigma level are decided to generate within PT. XYZ. It can be seen that the biggest problem that was raised as the object of the study was the thin depot painting (40.1%), dirty (10.9%.), Lime skin (2.1%), bruntus (1.9%).

***Keywords**:- Six Sigma, DMAIC, Pareto Diagram, p-Chart, FMEA, Experiment*

I. INTRODUCTION

PT. XYZ understands that the community's perspective in choosing a product has changed, not only in terms of cost, but has grown to quality. Therefore, the company understands that quality is important because quality is the fulfillment of service to consumers. In improving product quality one of the important factors is quality control which is part of the production process.

Six Sigma is the application of rigorous, focused, and very effective quality principles and techniques. Combining elements from the work of many quality pioneers, Six Sigma aims for truly error-free business performance.

Six Sigma methods are often used by companies to control product quality by minimizing the number of defects or defects. The Six Sigma method will focus on defects and variations, starting with the stage of identifying critical elements of quality (critical to quality) from a process to determining proposals for improvement of defects or defects that occur.

The steps to reduce defects or defects are carried out systematically by defining, measuring, analyzing, improving, and controlling. This systematic step is known as the 5-phase DMAIC. DMAIC is carried out systematically based on science and facts towards the six sigma target of 3.4 DPMO (Defect per Million Opportunity) and certainly increases the profitability of the company (Vanany et al., 2007).

PT. XYZ as one of the companies that produces two-wheeled automotive parts, in the process of taking over one of its products (1RC Hub) from the painting subcont process to the inernal there are still many defects in production. This production relocation decision is because this product has the highest defect compared to other products (16.8%) so that it disrupts the next internal process. Other considerations that 1

RC-Hub is an export product (Japan), then PT. XYZ needs to make continuous improvements so that the production process can run with the lancark by using the Six Sigma Method through the DMAIC approach and Experiments.

II. LITERATURE REVIEW

A. Quality / Quality

According to Goetsch and Davis (1994) cited by Tjiptono (2012: 152), quality can be interpreted as "dynamic conditions related to products, services, human resources, processes, and environments that meet or exceed. hope". Based on this definition, quality is the relationship between products and services or services provided to consumers can meet customer expectations and satisfaction.

According to Schiffman and Kanuk (2007), product quality is the ability of a company to give identity or characteristics to each product so that consumers can recognize the product. According to Kotler and Armstrong, (2008), product quality is a potential weapon of strategy to defeat competitors. The ability of product quality to show a variety of functions including durability, reliability, accuracy and ease of use.

B. Six Sigma

Six Sigma methodology was first introduced by Motorola in 1987 by an engineer named Bill Smith and received full support by Bob Galvin as CEO of Motorola at that time as a strategy to improve and improve the process and quality control (Process Improvement and Quality Control) in his company . Six Sigma became famous and became popular throughout the world after Jack Welch used it as a Strategic Business at General Electric (GE) in 1995 [1]. In general, Six Sigma is a methodology used to make continuous or continuous improvement and improvement processes. (Budi Kho, 2017).

The strategies undertaken by Six Sigma are:

- Focus on Customer Satisfaction and Needs (Customer Focused)
- Reducing the level of disability (Reduce Defect)
- Ranges around the Target Center (Center around Target)
- Reducing Variations (Reduce Variation)

Six sigma is a comprehensive and flexible system to achieve, maintain and maximize business success. Six Sigma is uniquely controlled by a strong understanding of customer needs, disciplined use of facts, data and statistical analysis, and careful attention to managing, repairing, and reinvesting business processes. Broadly defined as 3.4 DPMO (Gasperz, 2002).

C. Six Sigma Improvement Models

In Six Sigma there are 5 phases of DMAIC (Define, Measure, Analyze, Improve, Control) which is a continuous improvement process towards the Six Sigma target. DMAIC is carried out systematically based on knowledge and facts. DMAIC is a closed-loop process that eliminates unproductive process steps, often focusing on new measurements and applying technology to improve quality towards the Six Sigma target.

➢ *Define*

Define is the phase of determining the problem, setting customer requirements, and building a team. This phase does not use a lot of statistics, statistical tools that are often used in this phase are determining CTQ, creating SIPOC diagrams, and Pareto Diagrams (Pareto Chart). These tools are used to identify problems and determine priority issues.

- *Critical to Quality (CTQ)*

The quality characteristics (CTQ) of the key are determined to be directly related to the specific needs of customers that are derived directly from output and service requirements (Gaspersz, 2002).

- *SIPOC diagram*

The SIPOC diagram is a map used to determine project boundaries by identifying the process being studied, the input and output of the process and its suppliers and customers. Understanding of the course of the process from beginning to end can be done through obtaining sufficient information about the functions involved in the company. SIPOC can help see the relationship between the process and its inputs and outputs.

➢ *Measure*

Measurement is a measurement stage of problems that have been defined to be resolved. In this stage there is data collection which then measures its characteristics and capabilities of the current process to determine what steps must be taken to make further improvements and improvements. Tools commonly used at this stage are:

- *Map Control (Control Chart)*

The control map is basically an analysis tool that is made following the statistical method, where data related to the quality of the product or process will be plotted in a map.

- *Pareto diagram*

The relationship between 20% of causes and 80% of results can be described in a diagram called pareto diagrams. This pareto diagram was first discovered by Vifredo Pareto, namely the concept of 20-80 or 20% of the population controlling 80% of wealth in Italy, the name M. Juran emerged as a doctor who dissected further the discovery of Pareto.

➢ *Analyze*

The Analysis Phase is a stage to find a solution to solve a problem based on the Root Cause that has been identified. In this stage, we must be able to analyze and validate the Root Causes or Solutions through Hypothesis statements. Tools that can be used at this stage are:

- *Causal Diagram (Fishbone Diagram)*

Fishbone diagram (diagram of a fish bone - because of its shape like a fish bone) is often also called the Cause-and-Effect Diagram or Ishikawa Diagram introduced by Dr. Kaoru Ishikawa, a quality control expert from Japan, as one of seven basic quality tools (7 basic quality tools). Fishbone diagrams are used when we want to identify possible causes of problems and especially when a team tends to fall into thinking about routines.

An action and improvement step will be easier to do if the problem and root cause of the problem have been found. The benefits of fishbone diagrams can help us to find the root causes of problems in a user friendly manner, user friendly tools favored by people in the manufacturing industry where the process there is known to have a wide variety of variables that could potentially cause problems.

- *Why-Why Analysis*

Why-Why Analysis or 5 Why's Analysis is commonly used in conjunction with the Fishbone Diagram and uses an iteration technique by asking WHY (Why) and repeated several times to find the root of the problem. Why-Why Analysis is a method that is used in root cause analysis in order to multiply the causes of problems or the causes of defects that are more systematically systematic to find deeper ways of coping.

This technique was originally developed by Sakichi Toyoda and used in Toyota Motor Corporation during the evolution of the manufacturing methodology. This is an important component of problem solving training, delivered as part of induction into the Toyota Production System. The architect of the Toyota Production System, Taiichi Ohno, describes the 5 Why method which is "the basis of Toyota's scientific approach. by repeating why five times, the nature of the problem and the solution becomes clear. "This tool has seen widespread use outside Toyota, and is now used in Kaizen, lean manufacturing, and Six Sigma. (Rudy Sugiono, 2014).

➢ *Improve*

After knowing the root of the problem and solution and validating it, the next step is to take corrective action to the problem by repeatedly testing and experimenting to optimize the solution so that it is truly useful to solve the problems we experience.

- *Failure Mode Effect and Analyze (FMEA)*

FMEA is a technique used to find, identify, and eliminate potential failures, errors, and known problems from the system, design, process, or service before it reaches the consumer. FMEA here is FMEA Process to detect risks identified during the process.

FMEA is a systematics of activities that identify and evaluate potential failure levels that exist in the system, product or process, especially in the parts of the product or process function roots on factors that affect the product or process. The purpose of FMEA is to develop, improve, and control the probability values of detected failures from the source (input) and also reduce the effects caused by the occurrence of the "failure" (Hidayat, 2007). Each type of failure has 1 (one) RPN (Risk Priority Number), which is the result of multiplication between severity, detection, and occurrence ranks. Then the RPN is sorted from the largest to the smallest, so that the most critical types of failures that are the priority for corrective action can be known (Vanany, et al., 2007).

- *Experiment*

The purpose of the experimental study was revealed by Isaac and Michael (1977: 24), which is to examine the possible cause and effect by wearing one or more treatment conditions in one or more experimental groups and comparing the results with one or more control groups that were not treated.

Based on the opinions of some experts stated earlier, it can be concluded that experimental research is research that aims to identify the causal relationship of one or more dependent variables by manipulating independent variables in a controlled condition (control variable). (Fikrotur Rofiah, 2015).

➢ *Control*

The purpose of the Control phase is to establish standardization and control and maintain the improved and improved process in the long term and prevent potential problems that will occur later or when there is a change in processes, labor and management changes.

The control stage is the most important step because repairs to unwanted processes and the benefits of continuous improvement must be obtained (Dewi, 2012).

D. Relationship of Process Capability, DPMO, and Level Sigma

Process capability is a calculation through the comparison between product output and design specifications. If the equipment has the ability to consistently meet the expected quality range, then the quality and production costs can be optimal. If the machine is unable to consistently meet the expected quality level, then the cost will be high due to reject and rework.

Capability indexes and performance indexes in functional are widely measured based on general benchmarks of process capability or performance in relation to specific requirements. Three capability indexes for the stability of process activities in normal distribution can be calculated by the formula:

$$Cp = \frac{\text{Specific Tolerance}}{\text{6 Standard Deviation}} = \frac{USL - LSL}{6s} \quad \ldots\ldots\ldots\ldots\ (1)$$

➢ *Information*

- USL = Upper Specification limit
- LSL = Lower Specification limit
- s = Standard deviation

The Quality Target expected in implementing Six Sigma Methodology in Production is to improve Process Capability by reaching 3.4 DPMO in the production process. The abbreviation of DPMO is Defects Per Million Opportunities namely Disability per One Million opportunities. 3.4 DPMO means 3.4 Defects in 1 (one) Million opportunities. DPMO is one of the Process Capability assessments to measure how well a production process [4]. Defects Per Million Opportunities (DPMO) is one of the measurements of process performance other than Cpk, PPM, Ppk, and COPQ. In the business context to make improvements in a process, DPMO is a performance measurement of a process that is calculated by the following formula:

DPMO = (D / (U x O)) x 1,000,000 …………………….. (2)

➢ *Information*

- DPMO = Defects Per Million Opportunities
- D = Defect Amount
- U = Number of Units
- = Number of Opportunities that will result in Opportunities

Conversion between% defects (Yield), DPMO and sigma values can be seen in table 1 below:

Six Sigma Conversion Table

Yield	DPMO	Sigma	Yield	DPMO	Sigma	Yield	DPMO	Sigma
6.6%	**934,000**	**0**	**69.2%**	**308,000**	**2**	**99.4%**	**6,210**	**4**
8.0%	920,000	0.1	72.6%	274,000	2.1	99.5%	4,660	4.1
10.0%	900,000	0.2	75.8%	242,000	2.2	99.7%	3,460	4.2
12.0%	880,000	0.3	78.8%	212,000	2.3	99.75%	2,550	4.3
14.0%	860,000	0.4	81.6%	184,000	2.4	99.81%	1,860	4.4
16.0%	840,000	0.5	84.2%	158,000	2.5	99.87%	1,350	4.5
19.0%	810,000	0.6	86.5%	135,000	2.6	99.90%	960	4.6
22.0%	780,000	0.7	88.5%	115,000	2.7	99.93%	680	4.7
25.0%	750,000	0.8	90.3%	96,800	2.8	99.95%	480	4.8
28.0%	720,000	0.9	91.9%	80,800	2.9	99.97%	330	4.9
31.0%	**690,000**	**1**	**93.3%**	**66,800**	**3**	**99.977%**	**230**	**5**
35.0%	650,000	1.1	94.5%	54,800	3.1	99.985%	150	5.1
39.0%	610,000	1.2	95.5%	44,600	3.2	99.990%	100	5.2
43.0%	570,000	1.3	96.4%	35,900	3.3	99.993%	70	5.3
46.0%	540,000	1.4	97.1%	28,700	3.4	99.996%	40	5.4
50.0%	500,000	1.5	97.7%	22,700	3.5	99.997%	30	5.5
54.0%	460,000	1.6	98.2%	17,800	3.6	99.9980%	20	5.6
58.0%	420,000	1.7	98.6%	13,900	3.7	99.9990%	10	5.7
61.8%	382,000	1.8	98.9%	10,700	3.8	99.9992%	8	5.8
65.6%	344,000	1.9	99.2%	8,190	3.9	99.9995%	5	5.9
						99.99966%	**3.4**	**6**

Table 1. Conversion of DPMO values and sigma levels

Cp	DPMO
0,33	317500
0,5	133600
0,67	45500
1	2700
1,1	967
1,2	318
1,3	96
1,4	27
1,5	6,8
1,6	1,6
1,67	0,6
1,7	0,34
1,8	0,06
2	0,0018

Table 2. Relationship between Process Capability Index (Cp) and DPMO (Defect Per Million Opportunities)

III. RESEARCH METHODS

This research focuses on Painted 1 RC Hub. Figure 1 shows the research flow diagram.

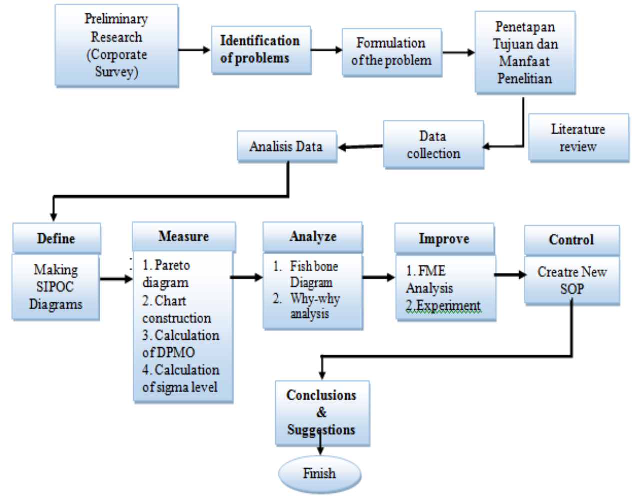


Fig 2:- Flowchart of Research Methodology

Production data and production defects that will be used are divided into two:

- Defect data during the painting process is still done in subcont (period Jan-April 2017), where this is used as a basis for making decisions to move production to the internal company and as a comparison of quality problems between the two companies.
- Data defect the internal process for the period of October - November 2017 as a basis for determining the problems that will be used as a basis for research to improve the quality of painting

➢ *Application of DMAIC Stages in this study*

Step	Activity
Define	At this stage the target will be determined and identification of the total number of product defects. At this stage CTQ is also defined based on customer input on product quality.
Measure	Some things that are done in this stage are: determining the dominant defect which is the CTQ by using the pareto diagram, p-chart, measuring the total value of the DPMO and the sigma level.
Analyze	Search and find the root cause of a problem. This can be done by using a fishbone diagram and why-why analysis
Improve	FMEA (Failure Mode and Effect Analysis) is used as a basis for analyzing potential causes of problems and determining the priority of improvement plans, then experimenting to determine optimal process parameters
Control	Stage to control the repaired process. This control can be done by using tools such as SOPs, Work Instructions, Check Sheet, etc.

Tebel 3. DMAIC Stages Application

IV. RESULTS AND DISCUSSION

A. Define (Critical to Quality)

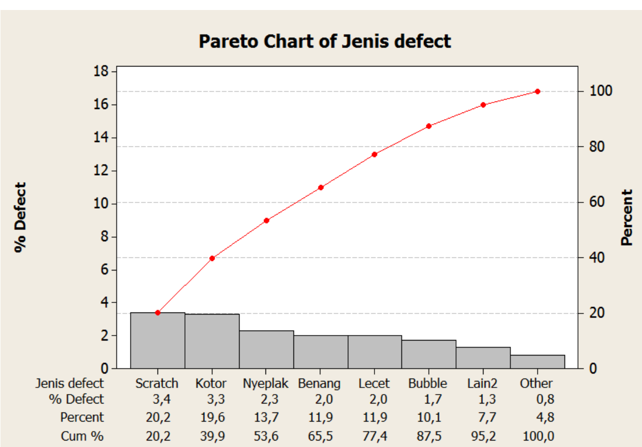
The initial stage in the DMAIC approach is the identification of matters related to quality that is prioritized (critical to quality)

The initial data on production defects was taken when the production of 1RC-Hub was still carried out at PT. XYZ for Jan-Apr 2017, see the following Tables and Graphs:

Jenis Produk	% Defect
Cover Comp Muffler	5,7%
Cover Exhaust Pipe	9,6%
Hub-1RC	16,8%
Hub-1TP	15,2%
Rear Stay Comp BG7	9,8%
Rotor 1 TP	11,0%
Rotor 1WD	1,6%
Stay 12PV	1,7%
Sprocket Gear K18	0,4%
Brace Comp LH XE631	4,1%
Brace Comp RH XE631	6,5%
Brace Comp LH XE631	5,6%
Brace Comp RH XE631	5,3%
Lain-lain	6,7%
Total	100,0%

Tabel 4. (Defect Type on Subcont)

➢ *Grafik 1 (Pareto Defect Type 1RC-Hub at Subcont)*



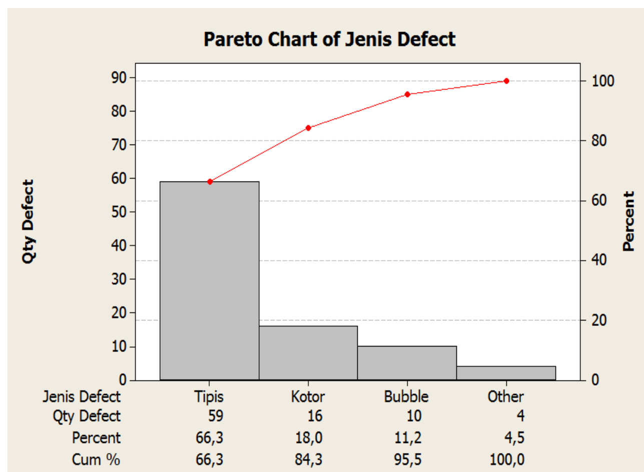
From the table and graph 1 shows that 1RC-Hub is the product with the most defects during work on the Subcont. The most types of Defect are:

- Scratch (surface defect conditions due to handling in and out of the box) 3.4%
- Dirty (dirty condition of painting surface due to dust sticking during the painting process)
- Nyeplak (thinner condition that is lifted to the surface of the product repair, after the paint dries)

Based on the data above the management of PT. XYZ decided to withdraw the production of 1RC-Hub and several other products carried out in the company's internal. Furthermore, some initial adjustments are made to the conditions and parameters of the 1RC-Hub painting process so that the problems that occur in the Subcont do not occur in the internal process. The next stage is the identification of matters related to quality that are prioritized (critical to quality), based on the initial conditions in the internal PT. XYZ production (October - November 2017 period) obtained the following defect conditions:

Qty Trial	Qty Defect	% Defect
147	89	60,5%

Internal defect details are as follows:



Graph 2. Pareto Chart Defect 1RC - Internal Relations

From graph 2 it can be seen that the most internal 1RC-Hub process defects are:

- Tiptis (condition of thin / transparent surface defects due to parameter settings that are not optimal) as much as 59 pcs (40.1%)
- Dirty (dirty condition of painting surface due to dust / dirt sticking during the painting process) as much as 16 pcs (10.9%)
- Bubble (the condition of trapping air under the paint, when the paint dries) as much as 10 pcs (6.8%)

There are differences in the types of defects that occur in the subcontract and internal processes of PT. XYZ. This is of course due to differences in conditions, parameter settings, operator competence, and others

➢ *SIPOC diagram*

Supplier	Input	Proses	Output	Customer
PT. Puji (Pickling) Washing Process	1 RC-Hub 1 RC-Rotor	Painting : Under Coat Top Coat	RC-Hub painted 1RC Rotor painted	Rivetting Process Packing Ekspor Japan

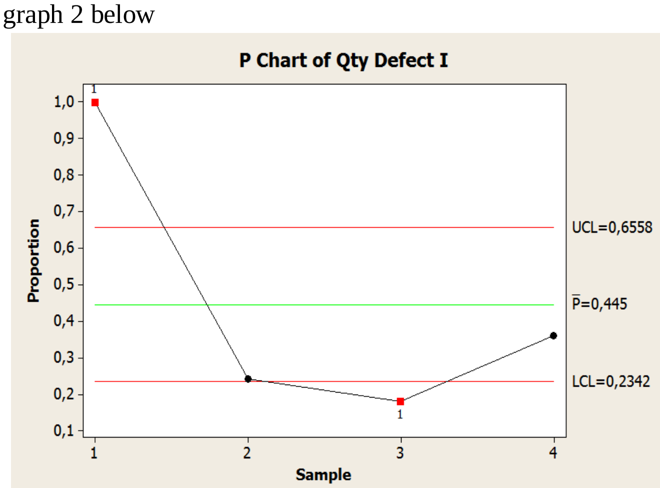
Table 5. SIPOC table

From the diagram it can be said that the RC-Hub painting process 1 relates to the pickling process in the supplier and the customer is finally Yamaha Japan, so the improvement of the problem in the painting process becomes important because it relates to two things:

- The painting process will not work if the pickling process in the supplier does not go well. This requires PT. XYZ must really control the quality of the pickup process at the supplier
- If the painting process fails, then automatically sending to the customer (Yamaha Japan) will also fail, which results in additional costs (export by air) if the export is late from the time specified by PPIC and the company's image will decrease in the eyes of the customer. Besides potential customer complaints will also occur

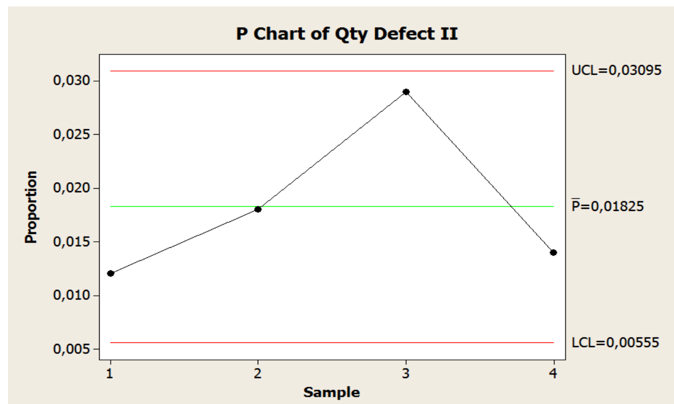
B. Measure (p-Chart, Pareto Diagram, DPMO and Sigma Level)

Petra Control P, used in attribute data with different sample sizes for each experiment (trial). , where the function is to see if the product defects are still deep required limit. See graph 2 below



Graph 3. P-Chart for initial internal processes

From the control p map, it can be seen that experiments 1 and 3 are outside the control limits, therefore, it is necessary to revise the data, by doing the next experiment.



Graph 4. Internal process P-Chart (revision of control limits)

After the next experiment, it can be seen that no points are out of control, where the control limit that can be used is

- Upper limit (UCL = 0.03095)
- Lower limit (LCL = 0.00555)

After making sure the handling process is within control limits, then the DPMO calculation and sigma level are carried out. DPMO is the number of defects per one million possibilities, obtained by multiplying the number of defects by one million possibilities, so that the DPMO value is 36,496. After obtaining the DPMO value, the sigma level can be calculated using the help of a sigma calculator. The sigma level obtained is 3.3

The actual formula is:

DPMO = (Number of Defects X 1,000,000) / ((Number of Defect Opportunities/Unit) x Number of Units)

Example:

A manufacturer of computer hard drives wants to measure their Six Sigma level.
Over a given period of time, the manufacturer creates 83,934 hard drives.
The manufacturer performs 8 individual checks to test quality of the drives.
During testing 3,432 are rejected.

Defects	200
Opportunities	4
Defect Opportunities per unit	1370

DPMO	36496,35
Sigma Level	3,3

Six Sigma Table:

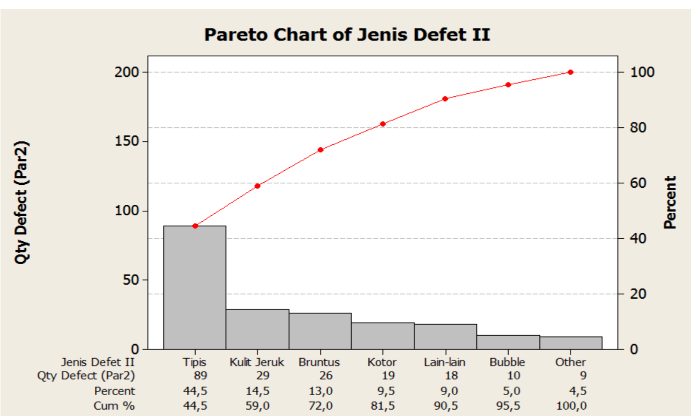
1	690.000
2	308.000
3	66.800
4	6.210
5	320
6	3,4

Source for this file:
http://home.xtra.co.nz/hosts/smtconz/Quality/Simple%20Six%20Sigma%20Calculator.xls

From the above calculation shows that improvement is still needed to reduce the defects that arise, so that the level of sigma can increase at least close to 5 or 6).

C. Analyze (Pareto Diagram, Fish Bone Diagram)

Determination of the type of dominant defect is done using a Pareto diagram. Pareto diagrams are created using a cumulative percentage of the types of defects that occur. Figure 3 shows a diagram of the pareto type of defect that occurred.



Graph 5. Pareto CTQ graph

From the graph there are 4 dominant types of defects namely, Thin (44.5%), Orange skin (14.5%), Bruntus (13.0%), and Dirty (9.5%). Determination of the type of defect follows the 80/20 rule on the principle of the Pareto diagram.

➢ *Fishone Diagram*

Of the 4 dominant types of defects that have been identified, the identification of the causes of the defect problem is then carried out using a fishbone diagram. Identified 3 categories of factors from the causes of disability, including human factors, method factors, and material factors, machine factors, and environmental factors.

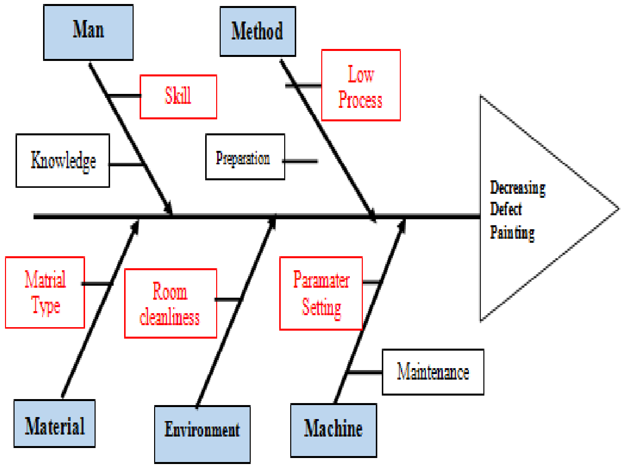


Fig 3:- Fishbone diagram

Explanation of the three influencing factors is as follows:

➢ *Humans*

- Lack of knowledge about setting parameters
- Inadvertently during the painting preparation process
- Use of gloves that are not fit and dirty

➢ *Method*

- The order of the process starts from preparation to finishing
- The process of suctioning that has not received optimal conditions (such as the mxing paint / viscosity process, the size of the paint filter, the cleanliness of the material to be placed on the hanger, etc.)

➢ *Machine (Pre heat, Paint Booth and Oven)*

- Machine parameter settings that have not found optimal parameters (such as auto air, auto air fan, paint pump, conveyor speed, open temperature,
- Machine maintenance, related to hygiene hanger, spray gun, open room cleanliness from dust)

➢ *Material*

- Use of origin or repair material

➢ *Environment*

Dusty work environment (work station), such as paint booth, and oven room

➢ *Why-Why Analysis*

Problem	Why 1	Why 2	Why 3	Why 4	Why 5	Perbaikan
Decreasing Defect Painting						
Thin Paint	A maximum of paint bursts	Less air pressure	Parameter settings are not optimal	There are no previous standards		Perform repeated experiments
Orange peel	Paint is less spread well	Viscosity paint is not standard	The paint mixing process is not yet optimal	Mixing machines are still used together		Buy a special mixing machine 1RC-Hub
Bruntus	Paint accumulates on the surface There is a lump of paint	The process of under coat and top coat is not one way Water trapped during the painting process	The production process is interrupted by other parts Splash water from the paint booth into the part during the painting process	Strict Production Planning Design uneven paint booth backgrounds		1RC-Hub production process should not be interrupted by other part no Background paint booth design improvements
Dirty	There is dirt / dust sticking	Dirt falls on the oven process / during painting	Dirty paint booth / oven room conditions	Schedule / Frequency of oven room cleaning that is too long (once a year)	There has never been a total over haul of paint booths in oven rooms	Overhaul the paint booth fan oven room

Table 5. Table of Why-Why Analysis

D. Improve (Failure Mode & Effect Analysis)

Step improve using techniques:

- FMEA table
- Repeated experiments / experiments to find conditions for optimal parameter settings

CTQ	Failure Mode	Potential Mode of Failure Mode	Potential Causes of Failure Mode	Score			RPN	Control
				S	O	D		
Thin, Orange, Bruntus, Dirty	Paint mixture (Viscosity) does not match spec	Defect (Thin) Products, Repair, Loss Cost, and Loss Time	Paint mixing process that is not optimal	7	5	5	175	Mixing machines for 1 RC-Hub should not be mixed with other part no
	Material not clean	Defect Products (Lines, orange peels), Repair, Loss Cost, and Loss Time	The initial cleaning process is not optimal	6	4	3	72	Routine lap replacement and use of special gloves (non-fibrous)
	The hanger distance is too close	Defect Products (Spots) Repair, Loss Cost and Loss Time	Operator negligence (rush)	4	3	3	36	Socialization and making special Check Points

	The parameter setting of the spray gun set is not optimal	Defect (Thin) Products, Repair, Loss Cost, and Loss Time	There are no specific standards	6	8	7	336	Conduct repeated experiments / experiments to determine optimal parameters
	Percikan air pada paint booth saat pengecekan	Defect (Bruntus), Repair, Lose Cost, and Lose Time Products	Paint booth ground back design that allows spark to occur	5	5	6	150	Changes in background paint booth design
	The oven room is dirty	Defect (dirty) Repair, Lose Cost and Lose Time products	There is dust / dirt that falls during the oven process	7	8	8	448	Periodically clean the oven room / overhaul

Table 6. FMEA table

At this stage, the root of the problems that have been described using a fish bone diagram, will be analyzed by identifying failure modes, effects and causes of failure mode and calculating the priority value of problem solving (RPN) using FMEA tools. Figure 5 shows FMEA images for handling process defects. From the FMEA, it is found that the failure mode of dirty oven room is at the top of the priority of problem solving (RPN) of 448. In this section, the proposed improvement is by cleaning the oven room periodically (overhaul) so that the oven process no longer causes a dirty defect on the product.

Even though the RPN is the biggest, but because to do repairs, it takes a small amount of money so that the realization is delayed, so only the local (not comprehensive) cleaning is carried out. This has resulted in a gross defect not being able to be maximized.

➢ *Experiment*

Experiment Stages are carried out 8 times by doing 3 actions

- Parameter settings, which include
- Parameters during preparation are paint viscosity
- Parameters in the paint booth, which includes the auto air setting, Fan air, Paint pump (good for under coat and top coat processes)
- parameters during the process, namely conveyor speed and oven temperature
- Process sequence, starting from washing palfos, the process of painting. Then touch up hole drilling
- Replacement of supporting equipment, such as paint filters

➢ *Repair Results*

Data Defect (the beginning of the internal experiment)

Defect Type	Qty defect	% Defect
Dirty	16	10,9%
Orange peel	0	0,0%
Bruntus	0	0,0%
Thin	59	40,1%
Paint contamination	0	0,0%
Bubble	10	6,8%
Gompal	3	2,0%
Translucent	0	0,0%
Etc	1	0,7%
Total	89	60,5%
Production	147	
DPMO	151.361	
Sigma Level	2,5	
Cp	0,83	

Defect data is within the control limit

Defect Type	Qty defect	% Defect
Dirty	19	1,4%
Orange peel	29	2,1%
Bruntus	26	1,9%
Thin	89	6,5%
Paint contamination	0	0,0%
Bubble	10	0,7%
Gompal	9	0,7%
Translucent	0	0,0%
Etc	18	1,3%
Total	200	14,6%
Production	1370	
DPMO	36.496	
Sigma Level	3,3	
Cp	1,10	

Defect Data After Repair

Defect Type	Qty defect	% Defect
Dirty	440	1,7%
Orange peel	72	0,3%
Bruntus	168	0,7%
Thin	193	0,8%
Paint contamination	0	0,0%
Bubble	41	0,2%
Gompal	145	0,6%
Translucent	213	0,8%
Etc	278	1,1%
Total	1550	6,1%
Production	25512	
DPMO	15.431	
Sigma Level	3,7	
Cp	1,23	

➢ *Control*

The final stage of the DMAIC approach is control. This stage is carried out standardization (standardization) of the parameters that have been proven results ranging from preparation to the final process. SOPs, Work Instruction and Check sheets are made for the consistent implementation of these parameters. Furthermore, continued continual improvement to reach the level of sigma approaching 5 or 6.

V. CONCLUSION

Some conclusions obtained include:

- PT. XYZ to draw the painting process 1 RC-Hub from subcont to internal process is the right decision. This is evident in terms of better quality internal processes and at the same time can save process costs (cost saving)
- By analyzing via fishbone diagram control maps, why-why analysis and continuing FMEA analysis and several experiments (repeated experiments) are proven to significantly reduce the process process defect.
- Based on NP control maps, the handling process of PT. XYZ is still within the control limit, there is no defect beyond the control limit (especially the upper control limit). There are 4 dominant types of defects in the handling process, namely flex (31.3%); chip (24.7%); contamination (18.7%); and scratch (13.3%).

VI. SUGGESTION

The proposals given to PT. XYZ is:

- Immediately set new standards for painting process parameters that have been proven to reduce product defects that are poured in SOPs, Work Instructions or in bent
- There is still an opportunity to increase the level of sigma in the painting process by continuing to implement cosntinual improvement, including remaining a total overhaul of paint booths and oven rooms.
- Carry out all the parameters that have been set and control them strictly using a clear check sheet

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