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Implementation of Six Sigma with Fmea (Failure Mode and Effect Analysis) Method for Improving Product Quality of Electronic Components of Capacitors

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Abstract: ***In an increasingly competitive global competitive situation, the issue of product quality becomes a central issue for every company. The ability of the company to provide quality products will be a weapon to win the competition, because by providing products that the quality of customer satisfaction will be achieved. Therefore, attention to product quality can give a positive impact to the development and progress of the company's business; this condition requires a company to process all resources owned optimally and make continuous improvement to the existing working system effectively and efficiently. This research was conducted at PT. XYZ by implementing Six Sigma with FMEA (Failure Mode and Effect Analysis) method, which aims to identify any non conformity product available in the capacitor electronic component product, measure initial condition and analyze the cause of existing problems and can be made possible measure of improvement outstanding quality with an actual breakthrough strategy. Six Sigma step is defined, Measure, Analyze, Improve and Control (DMAIC) and one of the methods used in analysis phase is FMEA (Failure Mode and Effect Analysis). The use of FMEA is used for cause and determination analysis with a DPMO (Defect Per Million Opportunities) decrease based on priority scale on RPN (Risk Priority Number) value. Implementation of Six Sigma method successfully implemented well this is marked by the existence of improving product quality. This condition can be clearly seen from the decrease of DPMO (Defect Per Million Opportunities) of 15,410 ppm to 2,8 ppm along with a continuous improvement result from cause analysis by using FMEA (Failure Mode and Effect Analysis) where priority scale based on Value RPN (Risk Priority Number). With the decline of DPMO dramatically then in itself there is a significant decrease in failure costs, which impact on improving the company's business and brought a good reputation within the company in accordance with the vision of the company became the world's number one Capacitor and Varistor manufacturing company.***

Keywords: Six Sigma, DMAIC, FMEA, DPMO, RPN

1. Introduction

At this time, all companies are required to produce a product or service that has high quality from the results of its production activities. Product quality is an effort of company in giving satisfaction to its customer. The level of customer satisfaction is always evolving along with the increasing experience customers consumed a product positioned the company to always strive to improve the quality of its products. One of the efforts made by the company in improving the quality of its production is through quality control in the production process.

One of the important factors used to produce quality products by implementing the right quality control system, has a clear objective and stages, and able to provide breakthroughs in preventing and solving problems faced by companies through quality management.

Lots of systems / methods that manage or discuss quality management with their own characteristics. One of the new breakthroughs of quality management systems in the form of quality control that gives dramatic results is by applying the Six Sigma method. Six Sigma is a methodology, statistical analysis tool and management system designed to streamline business processes by eradicating defects. The implementation of Six Sigma aims to improve and maintain quality, eliminate waste and increase profits. This is achieved by:Reduced variation in process, Measurement, analysis, improvement and process control, and Involvement and dedication from all organizations including top management.

Measured and defective processes are recorded; the goal of Six Sigma is to operate processes with fewer than 3.4 defects per one million PT opportunities. XYZ is a company engaged in the electronic Measured and defective processes are noted, the goal of Six Sigma is to operate processes with fewer than 3.4 defects per one million occasions.

PT. XYZ is a company engaged in the electronic component industry and is a company with market share of electronics companies spread all over the world. The customers of PT. XYZ, among others, PT. A, PT. B, PT. C, and others.

PT. XYZ itself produces two types of products: DCC (disc ceramic capacitor) and DCV (disc ceramic varistor) with an average production capacity of 150,000,000 pcs per month, with DCC (disc ceramic capacitor) production capacity reaching 80%. The production of DCV (disc ceramic varistor) is only 20%. This is what makes the basic improvements to the product capacitor or DCC (disc ceramic capacitor) which has a larger production capacity as an observation / research in terms of quality improvement.

Disc Ceramic Capacitor manufactured by PT. XYZ consists of more than one hundred kinds of specifications depending on its electrical properties. But this type of Disc Ceramic Capacitor is classified into 3 main classes, according to Table 1.

Table 1. Products of PT. XYZ

Product Type			
Type	Class	Spec	Class Category
Ceramic Capacitor	C1	EC	Temperature Compensating Ceramic
	C2	EK	High Dielectric Constant Ceramic
	C2	EKR	Low Loss Ceramic Capacitor
	C2	SD / SC	AC Capacitor
Ceramic Varistor	C3	SVC	Disc Varistor

2. Literature Review

Six Sigma has 5 basics to improve, maintain quality, eliminate waste and increase profits. The foundation is DMAIC. DMAIC stands for:*Define opportunity, Measure performance, Analyse opportunity, Improve performance and Control performance.*

2.1 Define

The initial step of implementing the six sigma project is the define stage, which includes the following steps: 1. Identify the problem, 2. Determining the characteristics of quality, 3. Process mapping, 4. Determination of the project theme, 5. Determining the project team, 6. Determining the implementation schedule, 7. Determining the achievement of the target.

2.2 Measure

This stage is the stage of measurement or calculation of the data that has been measured. Calculation of process capability conditions before repair. Here are some steps in the Measure step: 1. Observation of initial conditions 2. Capability Analysis 3. Calculating Defect per million opportunities

2.3 Analyze

The next stage is Analyze which is the selection of factors that influence the critical point on quality. The problems that will arise and the potential factor x against the process will be solved

2.4 Improve

Using data from the execution of previous stages may now be able to improve the process by designing creative solutions to fix and prevent problems. This is achieved by: 1. Using discipline and technology to develop innovative solutions 2. Develop and implement plans

2.5 Control

Overseeing and sustaining improvements over time by: 1. Preventing the instinct to go back to the old ways of doing improvements. 2. Develop, document and implement a monitoring plan 3. Integrate the improvement of the entire company through the use of training and incentives. Implementation of DMAIC Roule we can use 7 QC tool for the project.

3. Methodolgy

In this enlisting, there are steps that due to be able to finish the research well. Stages of research in general are:

1. Formulation of the problem
   The formulation of this problem how to improve the quality of production with six sigma.
2. Determining Research Objectives
   It is certain that the purpose of this research in order to overcome the problems of product quality. By applying Six Sigma well we can see how big improvement of product quality.
3. Project Selection
   The selection of this project is viewed from the capacity and condition of quality that is being bad at that time in accordance with existing data.
4. Step Six Sigma Step By executing
   The five basic steps Six Sigma DMAIC (Define, Measure, Analyze, Improve and Control) can take what steps should be done during the project
5. Analysis and discussion
   Follow-up of the steps Six sigma.
6. Conclusion After analysis and discussion
   It can draw conclusions on Project Six sigma.

4. Results and Discussion

From the results of data retrieval Non Conformity during March 2016 to June 2016 in get data such as table 2:

Table 2: Process Data of PT. XYZ (Mar - Jun 2016)

Period / ype of NC	Mar'16			Apr '16			May '16			Jun '16			TOTAL		
	Qty	%	Prod Result	Qty	%	Prod Result	Qty	%	Prod Result	Qty	%	Prod Result	Qty	%	Prod Result
Coating NG	469	0.810%	57,882	605	0.895%	67,587	826	1.328%	62,189	688	1.076%	63,924	2,588	1.029%	251,582
Marking NG	78	0.135%	57,882	101	0.149%	67,587	69	0.111%	62,189	84	0.131%	63,924	332	0.132%	251,582
Mu Marking	70	0.121%	57,882	91	0.135%	67,587	57	0.092%	62,189	59	0.092%	63,924	277	0.110%	251,582
Popo	55	0.095%	57,882	71	0.105%	67,587	57	0.092%	62,189	54	0.084%	63,924	237	0.094%	251,582

Imurjel	55	0.095%	57,882	71	0.105%	67,587	34	0.055%	62,189	26	0.041%	63,924	186	0.074%	251,582
Gigong	16	0.028%	57,882	20	0.030%	67,587	23	0.037%	62,189	22	0.034%	63,924	80	0.032%	251,582
Other	16	0.028%	57,882	20	0.030%	67,587	23	0.037%	62,189	14	0.022%	63,924	72	0.029%	251,582
Gipo	8	0.014%	57,882	10	0.015%	67,587	23	0.037%	62,189	12	0.019%	63,924	53	0.021%	251,582
Mitnocul	4	0.007%	57,882	5	0.007%	67,587	11	0.018%	62,189	11	0.017%	63,924	31	0.012%	251,582
Doriogiri	4	0.007%	57,882	5	0.007%	67,587	11	0.018%	62,189	10	0.016%	63,924	30	0.012%	251,582
Thickness NG	4	0.007%	57,882	5	0.007%	67,587	11	0.018%	62,189	5	0.008%	63,924	25	0.010%	251,582
Total	**779**	**1.346%**	**57,882**	**1,004**	**1.485%**	**67,587**	**1,145**	**1.841%**	**62,189**	**985**	**1.541%**	**63,924**	**3,911**	**1.555%**	**251,582**

Coating process shows the largest Non Conformity with Non Conformity detail as shown in table 3.

Table 3: Data NCCoating of PT. XYZ (Mar - Jun 2016)

Process	Item	Unit	Before Improvement			
			Mar '16	Apr '16	May '16	Jun '16
Assembling	Prod. Result (Input)	KPcs	59,038	68,992	63,733	65,733
	Qty NC	Pcs	375	397	398	476
	Good Ratio	%	99.4	99.4	99.4	99.3
	Non Conformity	**%**	**0.6347**	**0.5750**	**0.6237**	**0.7274**
	Prod. Result (Output)	Kpcs	58,663	68,595	63,336	64,907
Coating	Qty NC	Pcs	779	1,004	1,145	985
	Good Ratio	%	98.7	98.5	98.2	98.5
	Non Conformity	**%**	**1.3458**	**1.4855**	**1.8412**	**1.5409**
	Prod. Result (Output)	Kpcs	57,882	67,587	62,189	63,924
Sorting	Qty NC	Pcs	388	378	277	392
	Good Ratio	%	99.3	99.4	99.6	99.4
	Non Conformity	**%**	**0.6696**	**0.5588**	**0.4452**	**0.6129**
	Prod. Result (Output)	Kpcs	57,494	67,210	61,912	63,532
Editing	Qty NC	Pcs	199	187	178	122
	Good Ratio	%	99.7	99.7	99.7	99.8
	Non Conformity	**%**	**0.3456**	**0.2782**	**0.2870**	**0.1919**
	Prod. Result (Output)	Kpcs	57,296	67,023	61,734	63,410
Total	Good Ratio	%	97.04	97	96.86	96.97

From the data on the numbers can be Non Conformity in June 2016, which is shown with Pareto Graph below:

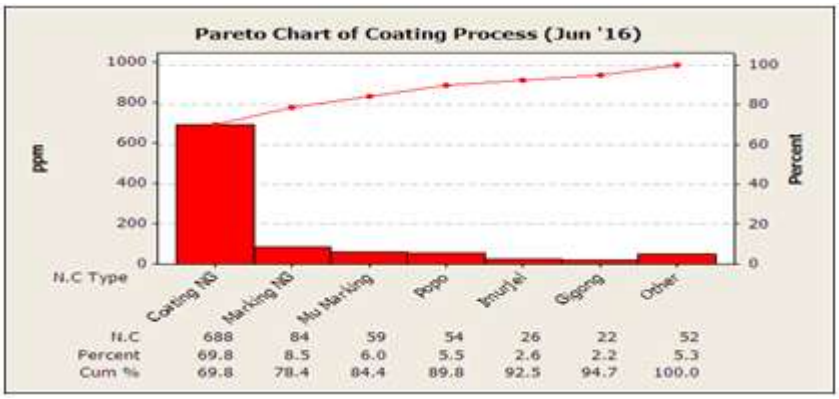

Figure 1: Pareto NC Coating Process

Furthermore, from the pareto data, we look for some of the causes of the largest non conformity in the coating process ie coating dents. Here is the cause and effect diagram of Dents Coating.

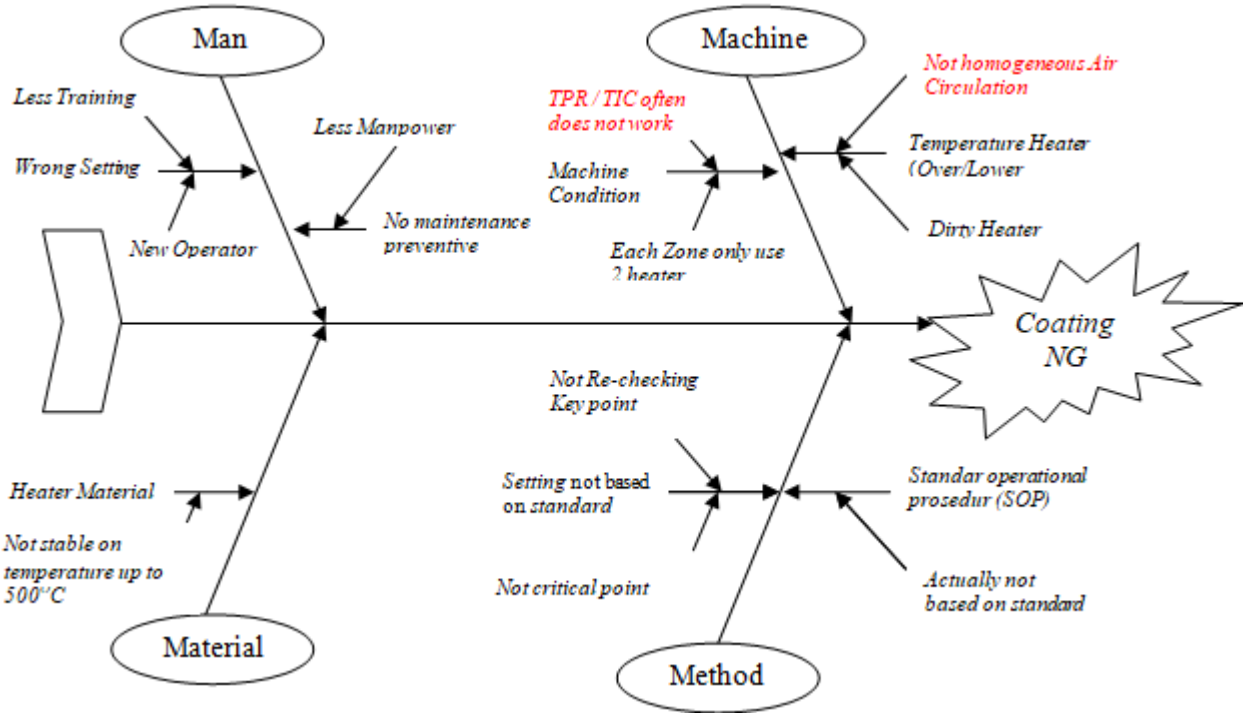

Figure 2. Causation diagram of Coating Dent

Table 4: Failure Mode and Effect Analyze

Failure Mode and Effect Analysis										
FunctionCoating Process		*Part NameDisc Ceramic Capacitor*			*Issue By* Sandi Ardian				*Date of Issue* Jun~Aug 2011	
Operation		*Characteristic of Failure*			*Rating*				*Remedial action of Current Control*	
No	*Process/Step*	*Failure Mode*	*Cause Failure*	*Effect of Failure*	*OCC*	*SVN*	*DTC*	*RPN*	*Possible Cause*	*Plan Action / Improve*
1	*Temperature Heater Setting*	Temperature unstable	Heat circulation unstable and dirty heater	*Coating* NG, Gigong	5	8	3	120	- Broken TPR/TIC - Not homogenous Heat Circulation - *Dirty Heater.*	- *Air heater installation.* - *TIC Display* in each *air heater.* - Installation air pipe to *blower.* - *cooling profile installation.*
2	Machine speed Setting	Speed Machine uncontrolled	Indicator and *Pulley* problem (broken)	*Marking NG*, Mitnocul	2	8	3	48	- There isn't *display indicator* (old model) - Not yet installation *reels inpulley* (new model).	- Installation *indicator* of new model. - Installation new pulley with *reel.*
3	*Setting Reservoir Vacuum*	*Powder* circulation not properly	*Reservoir indicator* and *air pressure* < 4 bar.	Gipo	1	3	1	3	- Reservoir Indicator *still* analog. - Leakage of compressor.	- Installation digital *indicator.* - *Compressor added.* - *Compressor* item included to *maintenance preventive.*
4	*Setting Marking*	*Marking NG*	Censor Position, Jig or fixture of *Censor* and *Time Delay*	*Mu Marking, Marking* Position *marking* not center and *unmarking.*	2	3	2	12	- *Censor condition not steady.* - *Censor* fixture unstable. - Not yet SOP for *Time Delay marking* setting.	- *Double marking installation.* - Modification of fixture *censor* to make set up easier and faster. - *Issue SOP/Keypoint* for *time delay.*
5	Movement product to wheel	*Sticky Coating*	*Broken Wheel,* broken strain yarn and Product not handle properly by operator	Popo	1	3	1	3	- *Old Wheel .* - Not *stopper* installation.	- *Wheel modification.* - *Installation stopper* to make easier and faster of operator working.

6	Movement *wheel* to rack.	*Broken rack.*	*Coatingscratch,* inserting *wheel* in a hurry.	*Coating scratch*	1	2	1	3	- *Broken Rack* - *Less operator training*	- Repair of broken rack - *Intensivetraining* for operator.

Based on data processing and through pareto diagrams, causation, FMEA and other supporting data for problem solving occurring in our Coating process can result in some continuously growing improvement to produce high-quality products.

In Figure 3 can be seen data changes that occur in the Coating process

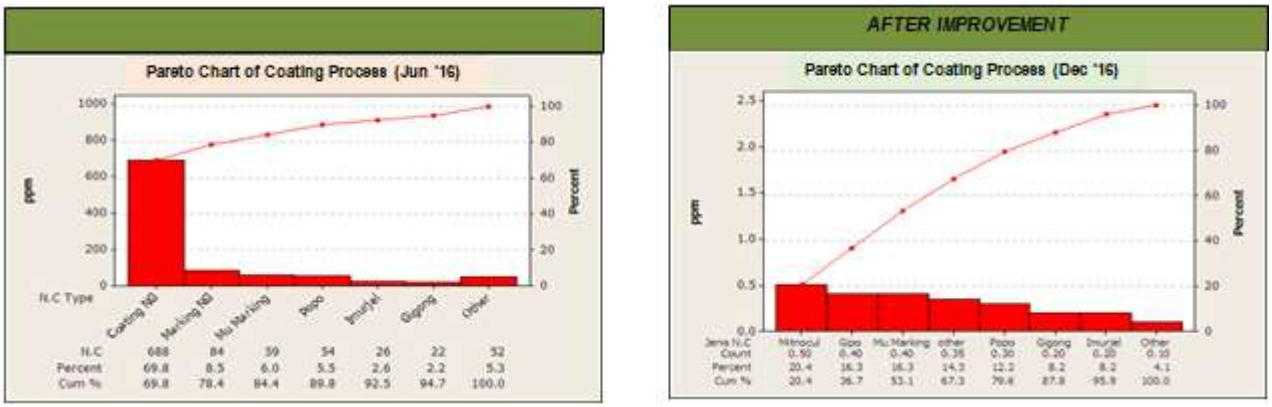

Figure 3: Pareto decrease of NC Coating Process

5. Conclusion

1) Six Sigma method to improve the quality of the product in PT. XYZ successfully implemented well
2) Improved quality with six sigma method through DMAIC (Define, Measure, Analyze, Improve, and Control) :
   a) The decrease target of Defect Per Million Opportunities from 15,410 in June 2016 to 2.8 in December 2016.
   b) The achievement of the Defect Per Million Opportunity reduction targets according to the timetable is also supported by the establishment of a good team that not only focuses on the Quality Department but together with the Production, Technical and Maintenance Departments. With the support by Top Management.
   c) To analyze the cause of the above problem is done by using QC Tools in the form of cause and effect diagram then to determine the priority of improvement is done by using Failure Mode and Effect Analysis which improvement priority seen in Risk Priority Number. Improvements are preferred based on Non Conformity Product data, which are listed in the pareto chart. Improvements will continue to be sustainable in line with the company's priority and readiness levels in terms of funding, difficulty levels and preferably at the most influential priority level in order to improve the quality efficiently and efficiently. This is intended to continue to carry out continuous improvement so that in the end Zero Defect achieves in accordance with the company's mission.
3) With the non-conformity decline dramatically as in point 2.a then there is a significant decrease in Cost, which affects the improvement of the company's business as well as bringing a good reputation in the company and becomes a manufacturing company DCC and Varistor in accordance with the company's vision to be number one in the world.

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