ISSN No:-2456-2165

Decreasing Analysis of Reject Claim Plate Levels of Shocking on Insert to Cassette Process for Battery YTZ4V Type Using Dmaic and Benchmarking Approachmethod
Case Study in Process Battery Manufacturing Industry

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Abstract:- Strict industrial competition in particular Battery manufacturing is always competing to improve the quality of a product and reduce as much as possible reject claim market. So this research will focus on this key action improvement by using DMAIC approach method which has been known as the most effective problem solving method and has been widely used by many previous research. The research design used is explorative quantitative type focusing on 4M analysis to find the cause of the problem and find the solution. Starting with step 1: Define, through the collection of data sampling month of Jan-Dec 2016 known that reject claim of Plate bent is 41 PPM Step 2: Measure, Processing data reject and the amount of claim reject and set the target that will do the improvement 3: Analyze , benchmarking against type cassette A and Cassette B from FTA analysis Step 4: Improve, define and standardize Cassette Type cassette B dimensional changes by changing the partition edge L and edge R from C3mm to R4mm from Cp = 1.58, Cpk = 0.63 to Cp 2.32 and Cpk 2.23. Step 5: Control, After getting the dimension set value 29.5 PPM down to 4 PPM with target standard 18 PPM and decrease to company cost savings of 455.5 KUSD / Year.

Keywords:- *Battery Manufacturing, Plate bent, Six sigma, Benchmarking, FTA, Cost Saving,Reject.*

I. INTRODUCTION

In the process of making the battery there are parts - parts that consists of the terminal, plate group, container, water acid, lid cover of the component is very important role in the quality and performance of a battery is in the Plate group with this company is very focused to reduce and make continuous improvements to lower reject claim market caused by bent plates. The result of the reject type YTZSeries battery has a reject rate of 41.7 PPM in 2016 compared to the Type YTX series of 35 PPM. Here reject example of bent palte.

Type	Total Amount of Production	Internal reject 2016 (PPM)	Eksternal reject (claim) 2016/ (PPM)
YTZ Series	6662075	6300	41.7
YTX Series	3394517	7100	35

Table 1
Source: Production data

Since the customer claim is far from the specified target and can affect the customer's trust then this research focuses on the decrease of Claim costumer. From the data if battery claims for type YTZ have a reject value of 41.7 ppm so that researchers focus to reduce reject claim type YTZ battery Series

This research will use DMAIC approach method with benchmarking process in step analysis. According to Guangyu Mu et. al. (2013) using the DMAIC six sigma methodology approach to decrease the defect in the welding exhaust system process in the automotive company and the result of defect rate biting edge and stomata decreased 20000 ppm to 1280 ppm and the sigma level can be increased from 3.55 to 4.52. And Gupta (2016) implements the DMAIC six sigma model to evaluate and improve the quality of the chassis preparation process in the amplifier production process. From the study conducted to increase the sigma level of 3.35 to 3.58 from the process preparation chassis.

Fig 1:- Reject Plate bent
Source: Production Data 2017

➢ *Formulation of the Problem*

Based on the background described above, then the formulation of the issues to be discussed in this study are:

- Looking for factors that cause reject plate bent?
- What actions should be taken to reject the bent plate down?
- What is the decrease in cost saving to reject claim customer after the repair?

➢ *Purpose and benefits of research*

The purpose of this study is expected to:

- Determining factors causing reject plate bent
- Determine the action to be taken to lower the bent reject plate
- Knowing the value of cost saving from decreasing reject claim reject plate bent.

➢ *Benefit Researchers*

- *Scientific Contribution*

Based on the review of the literature, this research provides suggestions to the effort to gain knowledge of the implementation of quality improvement to reduce the Reject on Battery industry by considering all the criteria of quality improvement process from previous research.

- *Applicative Contributions*

This research is expected to make the input on the company as the object of case study and as a model for quality improvement for other companies in terms of decreasing the number of Rejects to the bent plate and decreasing the reject claim caused by bent plates.

➢ *Assumptions and Problem Restrictions*

In doing this research that focuses on the reduction of bent reject plate because it can cause short between cells and not included in the specification of the number of voltages and amperes on the battery that is :

- Plate group in the process of assy, the process of entering plate group is done with tools insert to container that has been specified by the standard process in the company and the process does not move the machine / station at the time of its production
- Limit tolerance The bent plate did not change during the study mass.
- The machine in the Assembly has not changed or modified on the pusher system.
- Type of battery type in meticulous has not changed the design during the research

II. LITERATUR REVIEW

(Burhan 2015). Defect is a condition in which a product declared failed in achieving the requirements set by the company or customer. Defect itself is grouped into several categories among them :

❖ *Defect Minor*

This minor defect is a defect category with a low level of seriousness. Product with this minor defect category can still be done again (reworks) to achieve the specified requirements

❖ *Defect Major*

Defect major is a defect category with a high degree of seriousness or commonly called the term scrap. Products with this major category can not be done anymore in the sense that the product must be discarded / can not be sold.

According Feigenbaum (Jha& Kumar, 2010), quality is full customer satisfaction (full customer satisfaction). A product is said to be qualified if it can give full satisfaction to the consumer, that is in accordance with what is expected by consumers of a product.

(Muis, 2014). In the application of quality control by using DMAIC or Define method, Measure, Analyze, Improve, Control.

(Rimawan, 2010) Six Sigma is a business process that can make companies drastically increase their profits by increasing and monitoring daily business activities by minimizing waste and resources along with increasing customer satisfaction.
The goal of Six Sigma itself is not to improve quality to a level even though increasing quality and efficiency is the result of the Six Sigma itself.

(Rimawan, 2009) Improving business performance requires a structured approach, disciplined thinking, and the involvement of all employees in the company. These factors have been the basis of various methods of increasing productivity and quality over the years. The implementation of Six Sigma methods is carried out at the DMAIC (Define, Measure, Analysis, Improve, Control) and Cost of Poor Quality at the calculate from product print defects.

➢ *Define*

This phase is divided into 3 parts:

- *Prepare and initialize project charter*

The background of the project charter consists of a business case, problem statement, statement of purpose, scope, schedule, list of advantages, list of rules of conduct and responsibility, and outline of the project objectives.

- *Conducting SIPOC analisas (Suplier, Input, Process, Output, Customer)*

It is a simple way to identify suppliers and their inputs to the process, process sequence, process output, and supplier importance to output.

- *Analyzing VoC (Voice of customer)*

VoC analysis aims to identify issues related to Critical to Quality (CTQ) for market segments. There are 2 types of VoC data that is reactive and proactive. Reactive data types ignore data sources while proactive data are sourced from within organizations that specialize to collect such data through wawacara, surveys, market research, customer research, benchmarking and focus on groups or segments. Quality tools used in the define phase include:
CE-Matrix, Pareto chart, SIPOC.

➢ *Measure*

The phase measure is divided into 4 main parts, namely:

- Making operational definitions for each CTQ (Critical to Quality)
- Designing measurement system validation for each CTQ
- Designing capability limits for each CTQ
- Check phase checklist

Quality equipment used in this phase:

- R & R Gauge
- Graph (Control chart, run chart, histogram, etc.)
- Process capability analysis (Cp, Cpk)

➢ *Analyze*

Kulaitas equipment used in this phase:

- Test the hypothesis
- Graphic technique (control chart, histogram, runchart, etc)
- Correlation and regression
- Cause effect matrix

➢ *Improve*

The purpose of phase up is:

- Make and make sure the solution choices
- Focus KPIV to optimize output
- Generate and ensure Y = f (x)

The equipment used in this phase is:

- DOE (Design of Experiment)
- ANOVA
- Hypothesis testing
- Correlation and regression

➢ *Control*

It is the last operational stage in an effort to improve quality based on Six Sigma. At this stage the quality improvement results are documented and disseminated, the best practices that are successful in improving the process are standardized and disseminated, the procedures are documented and made as standard guidelines, and ownership or responsibility transferred from the team to the owner or person in charge of the process.

A. FTA Method(fault tree Analysis)

Rachman, (2016) Techniques to identify failures of a system using FT (fault tree) perform analysis by utilizing FT either qualitatively or quantitatively. FTA (Fault Tree Analysis) is function-oriented or better known as the "top down" approach because this analysis starts from the system level (top) and passes it down. The starting point of this analysis is to identify the functional failure mode at the top level of a system or subsystem. FTA is a widely used technique for studies dealing with the risks and reliability of a system engineering. Potential events that cause failure from an engineering system and the probability of occurrence of the event can be determined by FTA. A TOP event which is the definition of a system failure, must be determined first in the FTA.

➢ Define the problem and boundary condition of the system
➢ Reconstruction of the fault tree
➢ Identify minimum cut set or minimum path set
➢ Qualitative analysis of the fault tree
➢ Quantitative analysis of fault tree

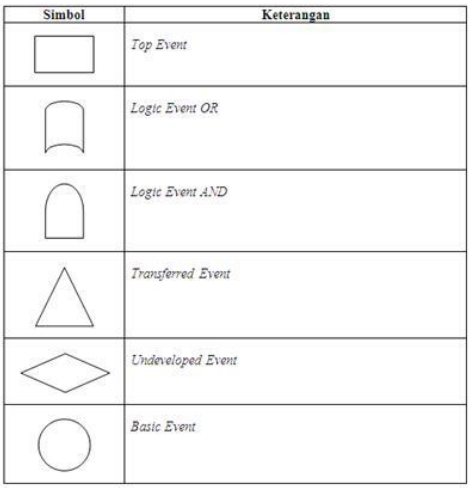

Fig 2:- Symbol - symbol FTA
Source: Rachman 2016

B. Metode Benchmarking

(Budi Kho, 2016) The Benchmarking process is an outward looking process (other products, other organizations, other systems) to find out how others reach their level of performance and understand the work processes they use. Thus, Benchmarking can explain what is going on behind the performance of either process or the product being compared. If properly implemented, Benchmarking can assist an organization in improving its organizational performance or production process.There are 4 important stages in implementing Benchmarking

➢ Understand in detail the current production process or product.
➢ Analyze production processes or other products that perform well.
➢ Compare the production process or the product itself with a production process or a product that performs well.
➢ Apply the necessary corrective steps to approach the production process or the product performing well.

In his explanation, Robert Camp in his book published in 1989 put forward a Benchmarking Methodology consisting of 12 Stages, namely:

➢ Selecting Subject
➢ Determining the Process
➢ Identify potential Partners to compare
➢ Identify data sources
➢ Collect data and select partners to compare
➢ Determine the gap
➢ Establish process differences
➢ The expected performance targets
➢ Communicating

ISSN No:-2456-2165

- Goal Adjustment
- Apply
- Review and re-adjust

C. Type of Benchmarking

Benchmarking can be done Internally comparing the performance of several groups or teams within the Organization or Externally comparing the performance of an organization with other organizations or between Industries. Benchmarking can be divided into several types, such as:

- **Strategic Benchmarking**,namely Benchmarking which observes how other people or organizations outperform their competition.
- ***Process Benchmarking***,namely benchmarking that compares work processes.
- ***Functional Benchmarking***,namely Benchmarking that performs a comparison on certain Functional work to improve the operational on the functional.
- ***Performance Benchmarking***, namely benchmarking that compares performance on a product or service.
- ***Product Benchmarking***,namely Benchmarking that compares the product competitors with their own products to determine the location of strength (Strength) and weakness (Weakness) products.
- ***Financial Benchmarking***, namely Benchmarking that compares the financial strength to determine its competitiveness.

III. METHODOLOGY

DMAIC Stages	Analisis data	Quality Tools
Define	1. Identify the flow of production processes. 2. Identify for the problem to be analyzed	Pareto
Measure	1. Create a control chart to control the number of defects that occur. 2. Creating the dominant type of defect category in the insert to cassette process improvement	Pareto, U chart, FTA
DMAIC Stages	**Analisis data**	**Quality Tools**
Analyze	1. More in-depth analysis of factors causing defects in the insert to casstte process and minimizing the risk of failure	FTA, 5W +1 H
Improve	Use the design factorial 1. Design standard cassette tools 2. Modified cassette design	Banchmark
Control	Controlling the process and standardizing the cassette design against bent defect plat	Drawing, SOP

Table 2

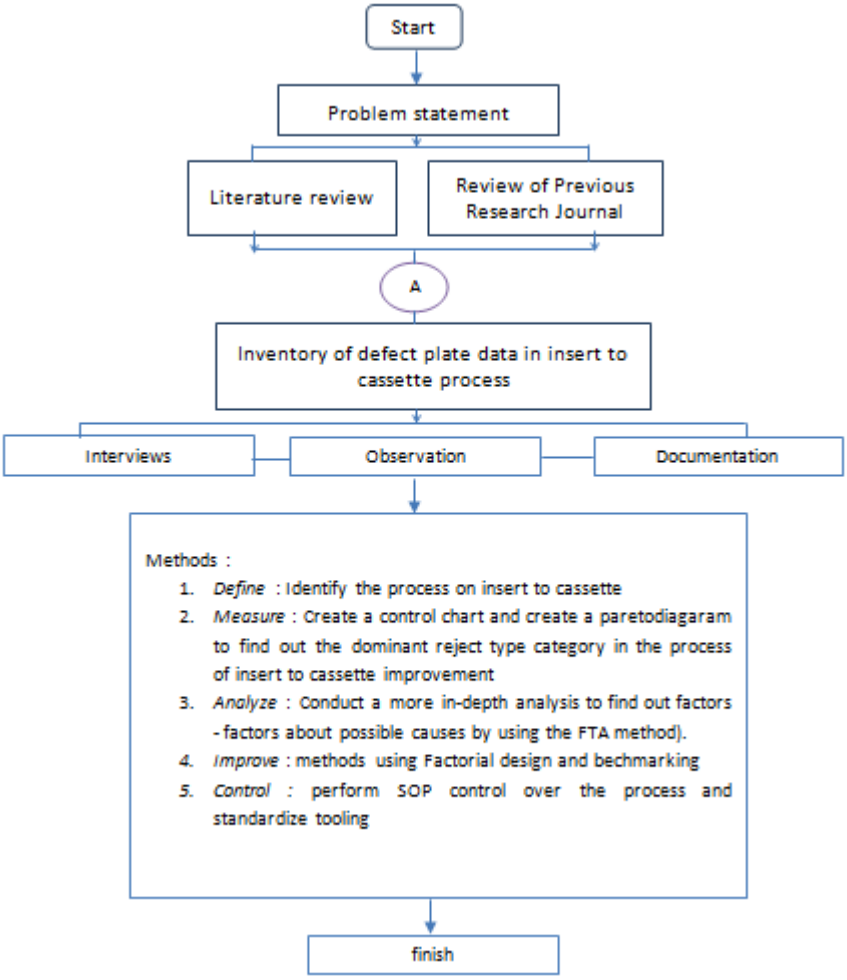

Fig 3:- Flow Chart of research methods

IV. CONCLUSION

➢ *Define Stage (Defined)*

At the stage of data collection, the data - data collected include everything associated with data processing. Data obtained by collecting claim market data

	QTY CLAIM	QTY SALES	PPM	Target (PPM)
Jan-16	10	278031	35.96721	18
Feb-16	11	295864	37.17924	18
Mar-16	12	222006	54.05259	18
Apr-16	10	324887	30.77993	18
May-16	13	295422	44.00485	18
Jun-16	13	331947	39.16288	18
Jul-16	12	290723	41.2764	18
Aug-16	8	226670	35.2936	18
Sep-16	11	212337	51.80444	18
Oct-16	12	230728	52.00929	18
Nov-16	11	263327	41.77316	18
Dec-16	11	238297	46.16088	18
FY2016	134	3210239	41.74144	18

Table 3
Source : Company data

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Based on the Type YTZ product seriesnya following contributors largest reject claim according to the following pareto diagram:

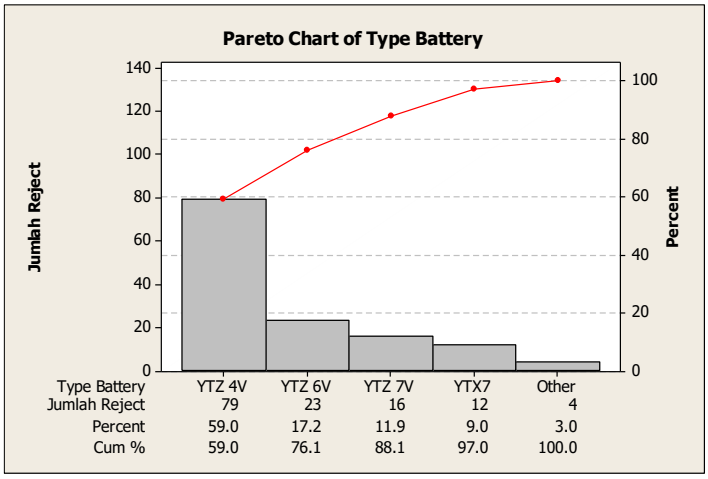

Fig 4
Source : Data though 2017

➢ *Measure*

From the results Data processing on the number of claim market and target production limit of 18 PPM.

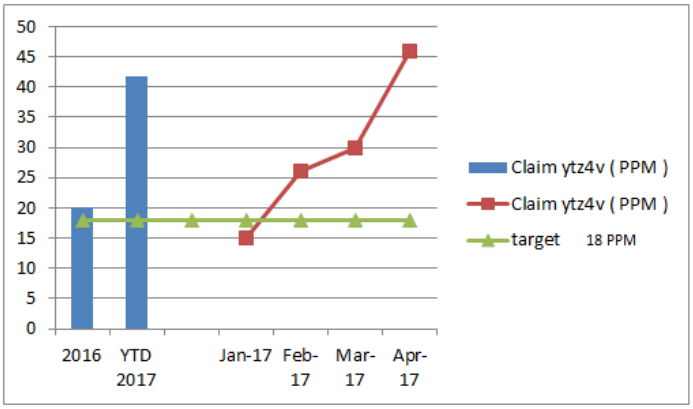

Fig 5
Source : Data though 2017

The data shows the number of rejects in 2016 in January to December 2017 (YTD) of 41.74 PPM (Part per million). In early January to April 2017 a very significant increase of 46 PPM. That caused by several types of rejects are as follows:

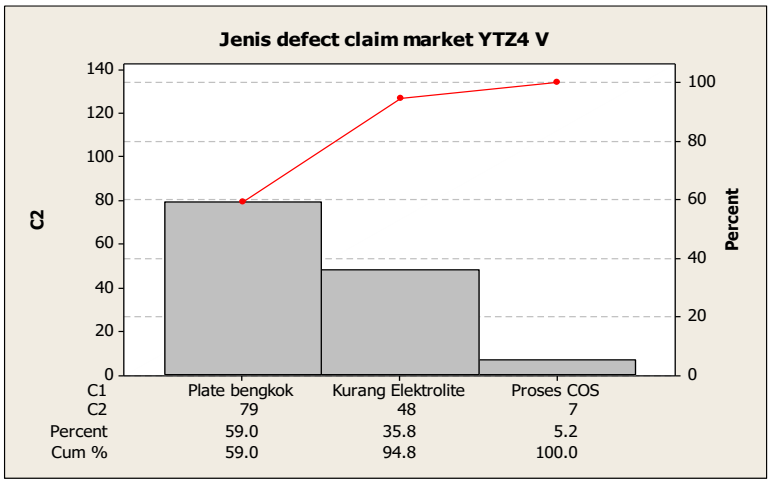

Fig 6
Source : Data though 2017

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Of the three types of damage, the largest reject contributor is bent plate sebnayak 59% compared with less electrolyte as much as 48% and COS process 5.2%. The results of these researchers continue the analysis of the causes of the reject plate bent

➢ *Analyze(Analys)*

- *Benchmarking type Defect Plate bent from Customer*

FTA (Fault tree Analysis) Insert To Cassette

From the results of the analysis using FTA to determine the improvement and the root of the problem against the bent plate is makadi described as follows :

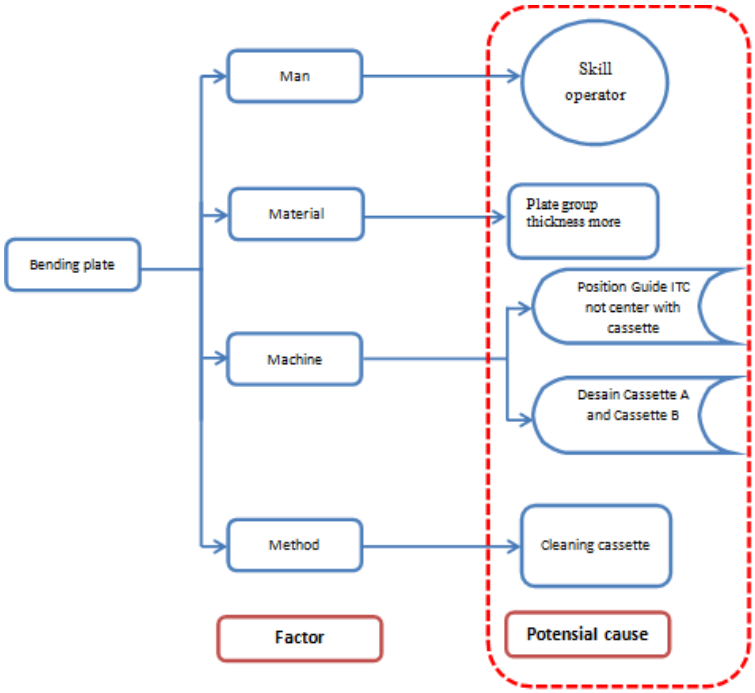

Fig 7:- FTA Diagram The insert to cassette process
Source: Data 2017

A. Benchmak Operator expertise (Skill Operator)

From the test results skil operator researchers make benchmarking against 2 people or operators who have been accustomed or devoted to the station process insert to cassette for 5 working days between the shift 1 and shift 2.

No	Operators	Shift	Standard SOP	Test Benchmarking					Result
				H1	H2	H3	H4	H5	
1	A	Shift 1	1. Plate group positions are neatly arranged	√	√	●	√	√	**OK**
			2. Plate group is not blocked	√	√	√	√	√	No effect
			3. There should be no crooked earplugs	√	√	√	√	√	to the process
			4. There should be no plate folding	√	√	√	√	√	
2	B	Shift 2	1. Plate group position is arranged neatly	√	●	√	√	√	**OK**
			2. Plate group is not blocked	√	√	√	√	√	No effect
			3. There should be no crooked earplugs	√	√	√	√	√	to the process
			4. There should be no plate folding	√	√	√	√	√	
3	B	Shift 1	1. Plate group position is arranged neatly	√	√	√	√	√	**OK**
			2. Plate group is not blocked	√	√	√	√	√	No effect
			3. There should be no crooked earplugs	√	√	√	√	√	to the process
			4. There should be no plate folding	√	√	√	√	√	
4	A	Shift 2	1. Plate group position is arranged neatly	√	√	√	√	●	**OK**
			2. Plate group is not blocked	√	√	√	√	√	No effect
			3. There should be no crooked earplugs	√	√	√	√	√	to the process
			4. There should be no plate folding	√	√	√	√	√	

Table 4
Source : Company data

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From the data for the thickness of plate group measured in accordance with the standard dimensions set by the company, the position of the curve is at the target limit. Dimensionally shows that there is no deviation dimension. Next look and gemba to the production to meninjaui and verify the state of the engine insert to cassete following data on the results of gembaproduction :

B. Position Guide insert to cassette against cassette

NO	ITEM	Standar	HASIL	STATUS
1.	Position the Lug plate parallel in the guide	Paralel	Paralel	OK
2.	Positive and negative plate arrangement is composed of Series	arranged series	arranged series	OK
3.	Man power used is according to competence	corresponding	Already appropriate	OK
4.	The distance between Lug (+) and Lug (-) corresponds to JIG	according to the jig	Already appropriate	OK
5.	Setting parameters Engine insert to cassette	according to Mcct PE	Already appropriate	OK

Table 5
Source: Gemba March 2017 data

From the results of production to the insert to cassette positioning of the cassette machine in the centering position did not change, including the pressure on the water cylinder pusher of 0.5 Mpa according to 2017 production standard.

Standard	Actual
Centre	Centre

Fig 8:- Machine Insert to cassette against cassette
Source : Picture 2017

C. Test of Palte Group Capability

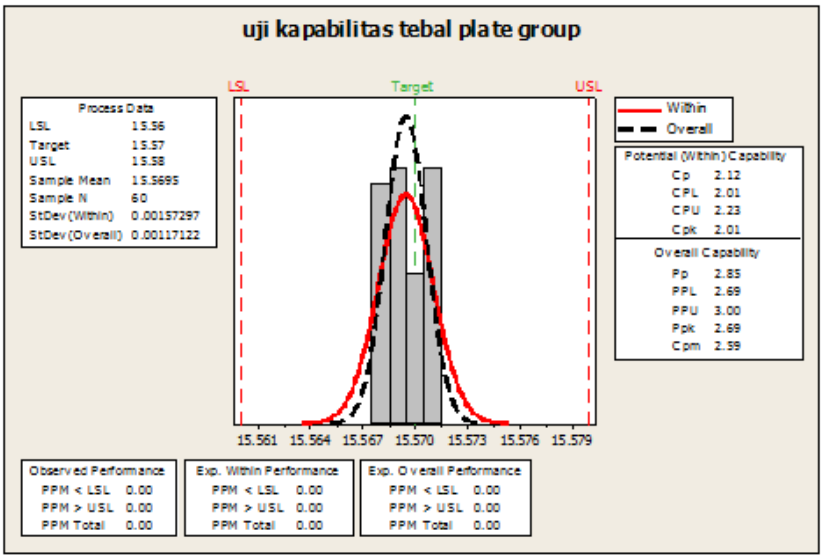

Fig 9
Source : Data though 2017

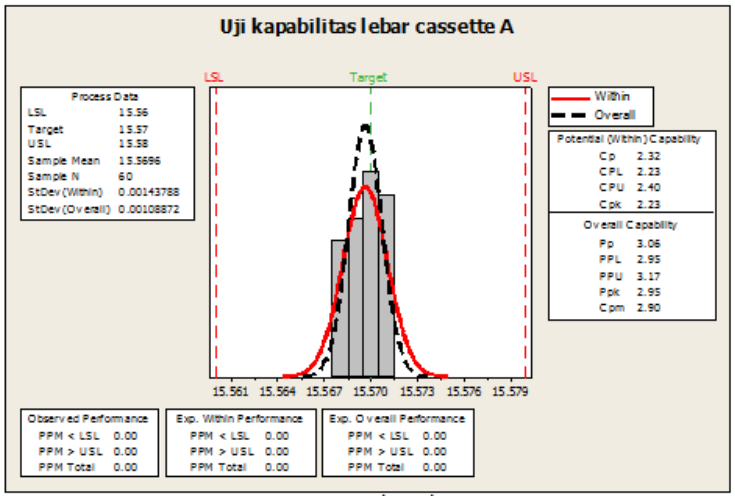

Fig 10
Source : Data though 2017

From the measurements to the dimensions of the cassette width indicates type A the value of Cp 2.32 for Cpk 2.23 is very good for the width dimension almost closer to the target. However type A type cassette can be categorized in suaian pas

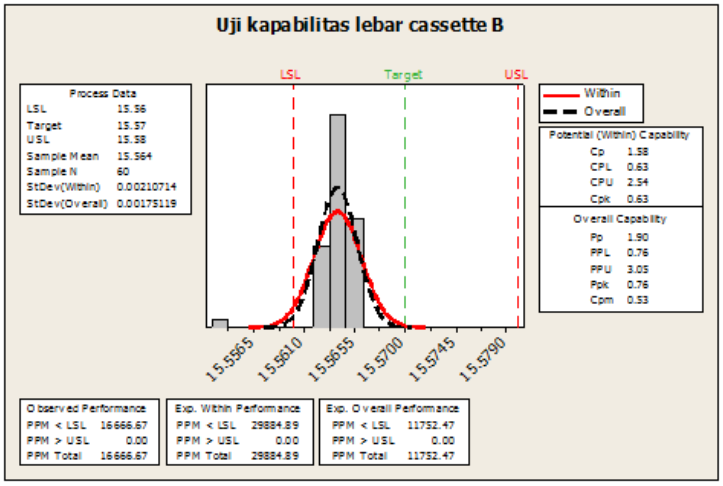

Fig 11
Source : Data though 2017

From the measurements to the dimensions of the cassette width indicates the B type of the nilaCp is nice but Cpk<1.33 denotes there is a shift towards the minimum size (LSL) or tendency even though Cassette type B dimension enters but the tendency towards the forced force. From the results of both types of cassettes for type B suaian forced category so that given the same pressure type cassette B hard to enter and potentially bent Plate because it is not strong to resist the impetus of the pressure

D. Condition Cleaning Cassette

Jumlah (Units)	Waktu Pelaksanaan	Januari'16		Pebruari'16		Maret'16		April'16		Mei'16		Juni'16		KETERANGAN
		M II	M IV	M II	M IV	M II	M IV	M II	M IV	M II	M IV	M II	M IV	
60	Pada saat produksi off (Sabtu/Minggu) Jam 08.00 s/d 16.00 WIB	→	→	→	→	→	→	→	→	→	→	→	→	
60		→	→	→	→	→	→	→	→	→	→	→	→	
60		→	→	→	→	→	→	→	→	→	→	→	→	
Jumlah (Units)	Waktu Pelaksanaan	Juli'16		Agustus'16		September'16		Oktober'16		November'16		Desember'16		KETERANGAN
		M II	M IV	M II	M IV	M II	M IV	M II	M IV	M II	M IV	M II	M IV	
60	Pada saat produksi off (Sabtu/Minggu) Jam 08.00 s/d 16.00 WIB	→	→	→	→	→	→	→	→	→	→	→	→	
60		→	→	→	→	→	→	→	→	→	→	→	→	
60		→	→	→	→	→	→	→	→	→	→	→	→	

Fig 12:- Cleaning Schedule Cassette (Blasting tools)
Source: 2016 production report

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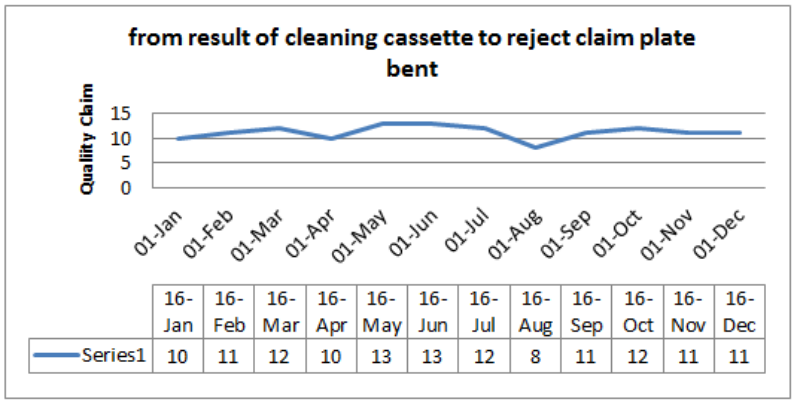
From production report data that cleaning cassette already done in 1 month done every 2 weeks but reject trend during january month - April 2017 still found reject on plate bent .



	16-Jan	16-Feb	16-Mar	16-Apr	16-May	16-Jun	16-Jul	16-Aug	16-Sep	16-Oct	16-Nov	16-Dec
Series1	10	11	12	10	13	13	12	8	11	12	11	11

Fig 13:- Data Cleaning cassette against reject claim
Source: 2017 processed data

- *Improve (Repair)*

- *Determine the Alternative repair steps*

From the results of data analysis following alternatife improvement on cassette design

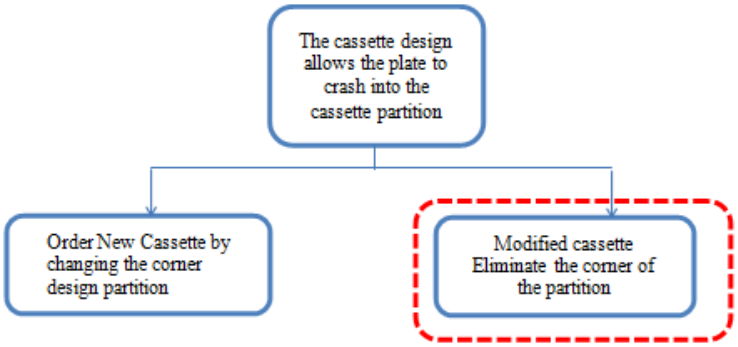


Fig 14:- Alternative Solution
Source: Data 2017

Alternative solution taken from 5w + 1H is to modify the cassette in this way the work more time and cost efficiency that dikerluarkan by the company because fewer compared with having to buy new cassette

No	What	Why	How	Where	When	Who
1.	Make new Cassette	Dimensi cassette of presisi	Order ke Tools maker Need Line 8 = 60 pcs Price 1 Cassette: Rp. 8000.000 Total cost = 60 x 8000.000 = **Rp. 480.000.00**	OUTHOUSE	Estimation 3 month	Tools maker
2.	Modification Cassette	Faster job time	Need Line 8 = 60 pcs 1. Employee overtime costs : - Nedd operation Man Power = 4 MP - Employee overtime costs 1 Hari : 4 x 400.000 = Rp 1.600.000 - Employee overtime costs : 4 x 1600.000 Total = Rp 6.400.000 2. Procurement Costs for a Cassette Modification Tool in 1 Month : - grinding eyes : need 16 Pcs price Rp. 27.500/pcs Total : 16 x 27.500 = Rp 440.000 - sandpaper : Need 180 sheet price Rp 5.000/ sheet Total: 180 x 5.000 = Rp 900.000 Total : 440.000 + 900.000 = Rp. 1.340.000 Grand Total price (1 + 2) = **Rp. 7.740.000**	INHOUSE	1 month	PE

Table 6
Source : Company data

➢ *Control*

- *Control by Cassette Design Standard*

Having obtained the results of the analysis test, Alternative cassette design that needs to be done is standardization tools, especially on the cassette in the following partition.

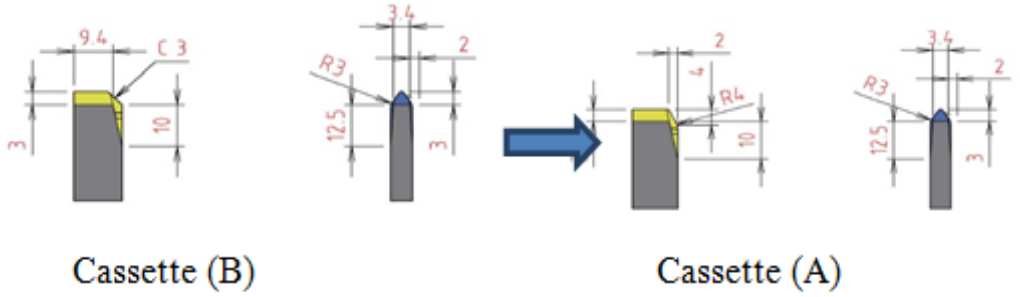


Fig 15

No	Partition Cassette	DesainStandar (mm)	Desain Improve (mm)
1	Edge L and Edge R Cassette B	C3	R4
2	Partition between cells	R3	R3

Table 7
Source : Data though 2017

From these data needs to be made design changes and in standarkan. In order to make the new cassette tool or spare not use the old design with C3mm suduh that can cause the occurrence of plate bent

- *Make standard SOP steps*

To prevent the Production Dept. make standard checks at the beginning of each production to ensure that the cassette in the production line uses the latest R4mm dimensional design that has been preserved by the company. After the design changes on the Edge R and edge L in the cassette and determined the results of improvements to the bent plate can be seen from May 2017 to 2014 des decreased significantly from the total 41.7 PPM and in januari 2017 - April 2017 of 29.5 PPM Became 4 PPM target claim is reached. Under 18 PPM.

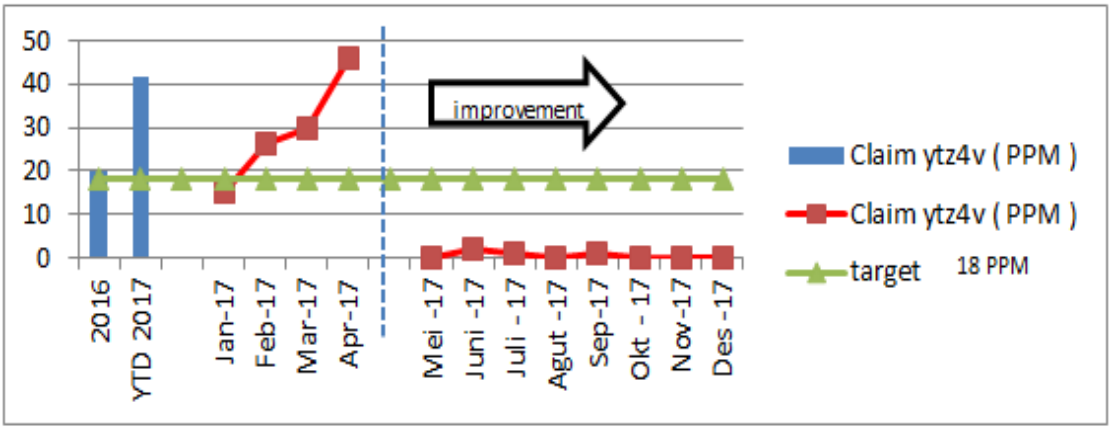


Fig 16:- Graph of the result of improvement
Source: 2017 production data

After the design changes on the Edge R and edge L in the cassette and determined the results of improvements to the bent plate can be seen from May 2017 to 2014 des decreased significantly from the total 41.7 PPM and in januari 2017 - April 2017 of 29.5 PPM Became 4 PPM target claim is reached. Under 18 PPM.

V. CONCLUSION

It can be concluded that this study which takes time from data collection jan 2016 until april 2017 for analysis and see data amount of reject plate bent. From this result we can see the improvement of the design of the R and L edge partition changes on cassette B from the original C3 mm to R 4mm to produce the capability index of dimension Cp 2.32 and the value of Cpk 2.23. in accordance with the

index capability plate group that has Cp 2.12 and the value of Cpk 2.01. So when the process of insert plate to the cassette occurssuaian pas so that the plate is able to withstand the pressure of the water cylinder process of 0.5Mpa.

After the design changes on the Edge R and edge L in the cassette and determined the results of improvements to the bent plate can be seen from May 2017 to 2014 des decreased significantly from the total 41.7 PPM and in januari 2017 - April 2017 of 29.5 PPM Became 4 PPM so the target drops to 25.5 PPM Target claim is reached. under 18 PPM. with this decreasing condition resulting in cost savings of 455.4 KUSD / year. Obviously this financial impact will greatly help the financial condition of companies that are experiencing a decline in sales turnover in 2017.

REFERENCES

[1]. Anonim .(2016) Annual report product year 2016.
[2]. Anonim.(2017). Annual reportproduct year 2016.
[3]. Antony, J. Kumar, M. &Tiwari, M.K. (2005).An application of Six Sigma methodology to reduce the engine-overheating problem in an automotive company.*Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*. 219: 633.
[4]. Banuelas, R., Antony, J. & Brace, M. (2005).An Application of Six Sigma to Reduce Waste. *Quality and Reliability Engineering International*. 21:553–570.
[5]. Bloomberg (2018).*USDISR Spot Exchange rate 27/4/2018.* Retrieved from http://www.Bloomberg.com
[6]. Elwyn, C.D. (2001).The quality gurus.*Engineering Management Journal*., PO BOX 17,3300 AA Dordrecht, The Netherlang
[7]. Frankel. Ernst G.,(1988), Systems reliabilility And Risk Analsis,2nd edition, Kluwer Academic Publisher
[8]. Gasperz, V. (2011).*Lean Six Sigma for Manufacturing and Service Industries*. Bogor: Vinchristo publication
[9]. Gijo, E.V., Scaria, J. & Antony, J. (2011).Application of Six Sigma Methodology to Reduce Defects of a Grinding Process.*Quality and Reliability Engineering International journal.*
[10]. Gupta, A., Sharma, P., Malik, S.C., Agarwal, N. &Jha, P. C. (2016).Productivity Improvement in the Chassis Preparation Stage of the Amplifier Production Process: A DMAIC Six Sigma Methodology. *International Journal of Reliability, Quality and Safety Engineering Vol. 23,* No. 6
[11]. Hamza, S.E.A (2008).Design process improvement through the DMAIC Six Sigma approach: a case study from the Middle East. *International Journal Six Sigma and Competitive Advantage,* Vol. 4, No. 1.
[12]. Jirasukprasert, P., Reyes, J.A.G., Kumar, V. & Lim, M.K. (2013).A Six Sigma and DMAIC application for the reduction of defects in a rubber gloves manufacturing process. *International Journal of Lean Six Sigma, Vol. 5 Issue.1,* pp. 2 – 21.
[13]. Jha, U. C., & Kumar, S. (2010). Critical Success Factor (CSFs) of TQM : A Literature Review and Analysis. *Oxford Business and Economics Conference Program.*
[14]. Kaushik, P. &Khanduja, D. (2009).Application of Six Sigma DMAIC methodology in thermal power plants: A case study. *Total Quality Management & Business Excellence, 20:2,* 197-207.
[15]. Kumar, A. & Sharma, N. (2015).Six Sigma DMAIC Methodology: A Powerful Tool for Improving Business Operations.*Advanced Materials Research Vols 488-489*, pp. 1147-1150.
[16]. Kwak, Y. H. &Anbari, F.T. (2006).Benefits, Obstacles and Future of Six Sigma Approach.*Technovation Vol.26* ,pp 708-715.
[17]. McCormick.N J., (1981), Reliability and risk Analysis : Methods and Nuclear power Applications, Academic Press, Inc.
[18]. Muis, S (2016). *Metode Six Sigma* :TeoridanAplikasidilingkunganPabrik.
[19]. Ruxton.T,(1997)."Formal Safety Assessment " TransactionIMarE, part 4
[20]. Ramakurmar. R., (1998), Engineering Reliability : Fundamentals and Application, Premtice hall, Inc. Englewood Cliffs, New Jersey 07632
[21]. Rimawan.Erry, (2009), improvement of print quality by Six Sigma method at the new printing department of PT United Can. Journal of Synergy 13: 1
[22]. Rimawan.Erry (2010) Lowering Claim Rate Cap Deco 'Scratch Service with Six Sigma method at PT. LG Inonesia Electronics. Scientific Journal of Synergy. 15; 1