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Minimizing Defective Products of Motorcycle and Car Exhaust Products using Six Sigma Method in PT Berlindo Mitra Utama

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Abstract: ***The purpose of this study is to determine the level of sigma, find out what factors cause defects, and find out the right way to reduce defective products. The research methodology used is quantitative. The analysis used is the Six Sigma method. The results achieved from this research are the level of sigma produced in the motorcycle exhaust of 4.3 and in the car exhaust 4.46, the factors that cause defects are mold, material, human, method, engine, and the right way to reduce the defective product is to check the machine carefully before and after use. The conclusion obtained is to minimize defective products on motorcycle and car exhaust products at PT Berlindo Mitra Utama by using the Six Sigma method.***

Keywords: Defective Products, Quality Control, Six Sigma

I. INTRODUCTION

Business activities in the industrial sector, indirectly, can increase the country's income, increase employment opportunities, withhold foreign exchange from importing goods, and can expand economic activities. With the economic development of the Indonesian people is the 4th (fourth) largest in the world, which is one of the countries that have a world-class automotive industry base. The government predicts that growth in the national automotive market until 2020 will reach 6.8%. Where this is supported by data processed by the Indonesian Automotive Industry Association (Gaikindo), in 2017 the first quarter of car sales in Indonesia increased by 6%, which shows that the domestic market is still interested [1].

Operational management must be done carefully. Leading companies such as PT Honda Prospect Motor experienced defective products in the type of Honda Mobilio in 2014-2017, Honda Brio in 2014-2017, Honda Jazz in 2014-2017, Honda HR-V in 2014-2017, and Honda BR-V 2015-201 production year.

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An error occurred in the components of the Master Cylinder and Master Power in the braking system in the production of the car. The total number of problematic vehicle units that were defective in the system at that time reached 463,891 cars.

This results in the car owner being able to carry out checks or even replace damaged components which are carried out without any costs being charged to the customer [2]. PT Berlindo Mitra Utama is a company in the field of automotive and electronic muffler manufacturing where this company is a company that specializes in the design, construction, and also manufacturing equipment in metalworking. This company has experience in meeting the needs in terms of the tools needed. The company is located in the Integrated Industrial Area of Indonesia China Kavling 9B Kec.Serang Baru Kota Deltamas Cikarang Pusat, Bekasi 17530. The company was established on September 29, 2005. After making observations and interviews with Mr. Ian as the president director of PT Berlindo Mitra Utama, the products produced by the company are in the form of car exhausts and also motorcycle exhausts where the production process is good but there are still defective products or defects that are visible, the company's tolerance limit of 0.5% where in reality it is still above the tolerance limit.

Research conducted at PT. Berlindo Mitra Utama uses the Six Sigma method. The difference in the research that the author did with previous research is that in the 2017 journal by A. Suryadi, F Ardiansyah P. And Y. Using the Six Sigma method, this journal does not use the Effort Benefit Matrix. Whereas in our study, we used the Effort Benefit Matrix at the improve stage. From the results above, the resulting sigma level is in the motorcycle exhaust product of 4.3 and the car exhaust of 4.46. Moreover, from the results above can also be seen that the factors that cause product defects in the company are the material, people, molds, methods and machinery, and the right way to minimize the company's defective products by checking machines regularly before and after use.

From the above background, the problem can be formulated as follows: (1) What is the level of a defect in the product produced and the level of sigma produced by PT Berlindo Mitra Utama?; (2) What factors can cause defects in car exhaust and motorcycle exhaust products produced by PT. Berlindo Mitra Utama?; (3) How is the right way to reduce defective products at PT Berlindo Mitra Utama?

Based on the problem formulation above, the objectives of this study are as follows: (1) To find out what the level of defects in the products produced and the level of sigma produced by PT.

Berlindo Mitra Utama; (2) To find out what factors can cause defects in car exhaust and motorcycle exhaust products produced by PT. Berlindo Mitra Utama; (3) To find out the right way to reduce defective products at PT. Berlindo Mitra Utama.

II. RESEARCH METHOD

The research method used in this study is quantitative. Quantitative methods are based on the philosophy of positivism and have fulfilled scientific principles that are concrete/empirical, objective, measurable, rational, and systematic [3]. This type of descriptive research examines the form of activities, characteristics, changes, relationships, similarities, and differences with other phenomena. For time data collection or time horizon used by the authors in this study is cross-sectional. Data collection techniques used in this study are library research from literature study, internet media, and data from institutions or agencies related to the object of research. Field Research is research that comes directly to the place that is the object of research such as conducting interviews directly with the President Director of the company PT. Berlindo Mitra Utama, namely Mr. Ian and also the operational manager besides observing the company. The analytical method used in this study is Six Sigma. Six sigma uses a systematic approach called DMAIC (Define, Measure, Analyze, Improve, and Control). Define is the first stage that focuses on identifying problems, determining process goals and identifying customer needs The first step is the writer making a SIPOC diagram by identifying Suppliers (all suppliers), Inputs (everything that enters the process), Processes, Outputs (results of processes), Customer (recipient of the results of the process ([4]) and also in this stage the author uses the CTQ (Critical to Quality) tools, CTQ is a processing element that significantly influences the output process ([5]) In this phase which is the second stage of the DMAIC approach, namely measure the writer will measure the production process of PT Berlindo Mitra Utama in the period January 2017-December 2017. The steps taken in this stage are the authors calculate the DPMO (Defect per Million Opportunities), which is one of the capability process assessments ([6]). The next step is me calculate the percentage of defects caused by different causes to identify the main quality problems using Pareto diagrams. The next tool used in this stage is the P chart. P chart is used to track the proportion of disabilities in a series of samples. Moreover, the sample size used is less than twenty. At the analyze phase, this is the stage where the data is analyzed to determine the cause of the problem. The tools used in this stage are cause and effect diagrams (fishbone diagrams) and FMEA (Failure Mode and Analysis). Fishbone diagrams help find out the root cause of a problem that occurs in the production process while FMEA is a formal risk assessment tool that is used to identify ways that might cause failure and something that can cause failure to the owner's system. The improve phase is done by making changes during the production process. Moreover, the results are measured whether the problem has been eliminated, if not more changes might be needed ([7]). The tools used are brainstorming and Effort Benefit Matrix. Brainstorming is used to develop opportunities, problems, and ideas that come from the team itself. While the Effort Benefit Matrix is a priority tool for choosing several solutions to problems in the company. At the control stage it is expected to improve the production process, product quality and prevent the same mistakes as before applying the Six Sigma method in the company.

III. RESULT AND DISCUSSION

In conducting this research, researchers used secondary data from PT Berlindo Mitra Utama in the January 2017 to December 2017 by looking at two product models produced at the company, motorcycle exhaust, and car exhaust.

Table- I: Production Data and Data Reject PT. Berlindo Mitra Utama for the period of January 2017 - December 2017

	MOTORCYCLE			CAR		
	PRODUCTION	*REJECT*	%	PRODUCTION	*REJECT*	%
JANUARY	627,693	9,492	1.5%	121,696	472	0.4%
FEBRUARY	579,983	4,239	0.7%	13,310	387	2.8%
MARCH	669,542	5,462	0.8%	117,700	274	0.2%
APRIL	480,626	5,326	1.1%	210,803	377	0.2%
MAY	763,508	13,823	1.8%	140,196	633	0.4%
JUNE	477,555	7,041	1.5%	234,576	462	0.2%
JULY	669,802	2,966	0.4%	130,755	1,322	1.0%
AUGUST	630,330	2,087	0.3%	45,119	207	0.5%
SEPTEMBER	715,088	3,310	0.5%	140,005	989	0.7%
OCTOBER	744,295	10,602	1.4%	103,582	1,802	1.7%
NOVEMBER	676,349	7,124	1.0%	171,592	972	0.6%
DECEMBER	526,062	6,610	1.2%	160,849	1,783	1.1%
TOTAL	**7,560,833**	**78,082**	**1.0%**	**1,590,183**	**9,680**	**0.6%**

Source: PT Berlindo Mitra Utama, 2017

With the production data, the authors will continue the research using the Six Sigma DMAIC quality control methods (Define, Measure, Analyze, Improve, and Control). At the define stage, there are:

Supplier	Input	Process	Output	Customer
• PT. SSK • PT. INDOMETAL • PT. HANWA • PT. SPS • PT. PERSADA	• *Material Coil: SUS 409, SPCC SD* • *Material Sheet: SPHC PO, SPHC Black* • *Long pipe: SUS 409, STKM*	• *Stamping* • *Blanking* • *Drawing* • *Piercing* • *Bending* • *Trimming* • *Swaging* • *Expanding* • *Caulking* • *Welding* • *Assembling*	• *Part Muffler* • *Sub Assy Muffler* • *Muffler Unit* • *Part Instrument Panel* Mobil • *Part Lighting Fixture*	• PT. SAKURA • PT. SMAP • PT. PANASONIC • PT. FUKOKU • PT. MARUHACHI

Fig. 1. SIPOC Diagram of PT Berlindo Mitra Utama
Source: PT Berlindo Utama, 2018

Fig. 2 shows the CTQ Tree of company

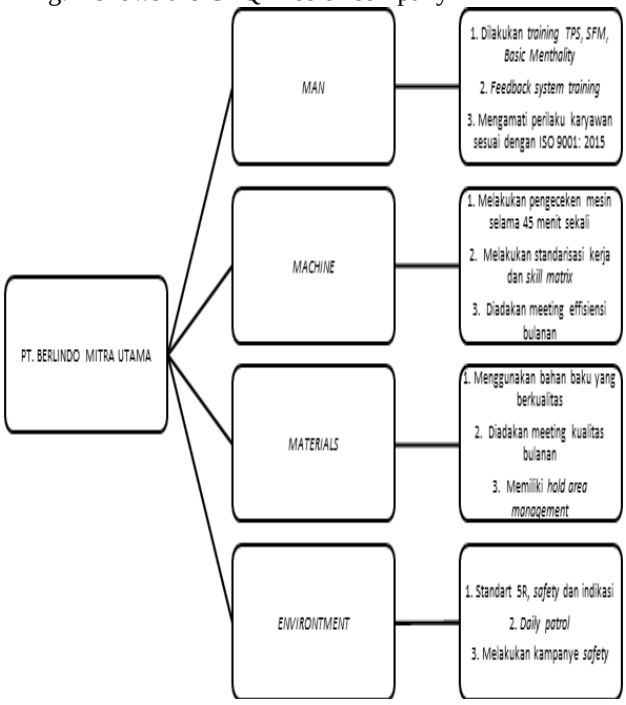

Fig. 2. CTQ Tree
Source: PT Berlindo Mitra Utama, 2017

After that, the stages of measure include DPMO and sigma level calculations, namely:

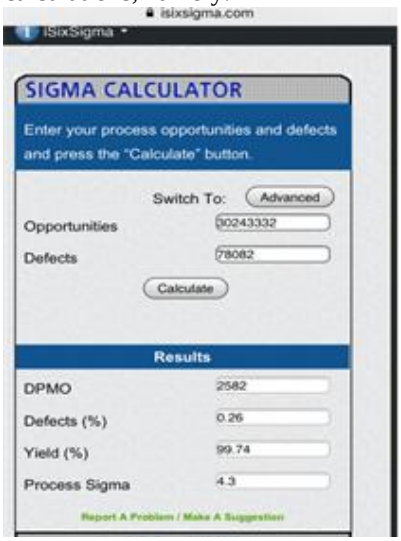

Fig. 3. Six Sigma Calculator of Motorcycle Exhaust

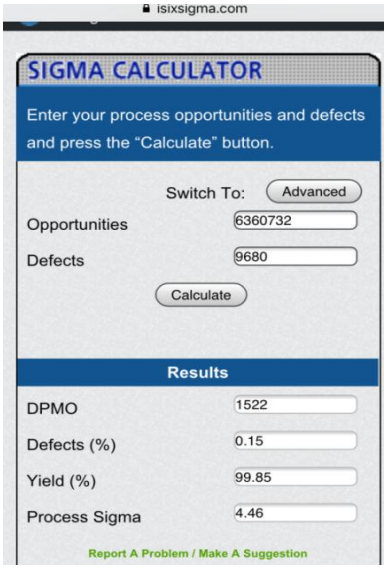

Fig. 4. Six Sigma Calculator of Car Exhaust

It can be concluded that the DPMO and the sigma level produced are 2,582 and 4.3 with a defective rate of 0.26% in the production of motorcycle exhausts. While the DPMO car exhaust production and sigma level produced were 1,522 and 4.46 with a defective rate of 0.15%.

Fig. 5 shows the Pareto diagram on the motorcycle exhaust product:

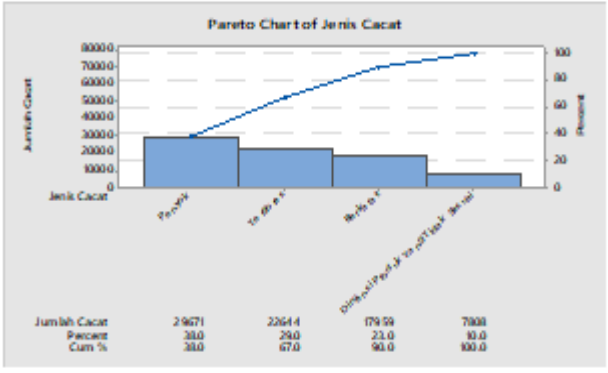

Fig. 5. Pareto Diagram of Motorcycle Exhaust

It can be concluded that the most important disability occurred in the dent defect is 38%. The following is a Pareto diagram for car exhaust:

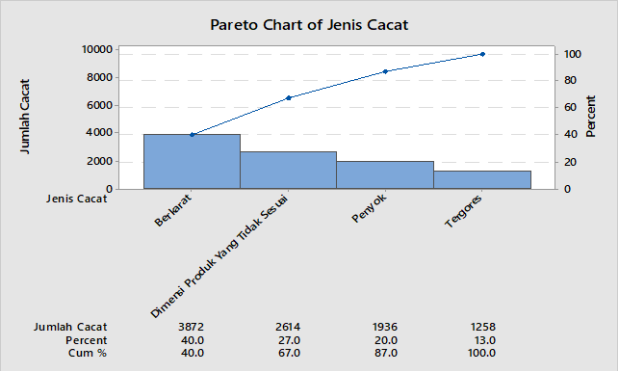

Fig. 6. Pareto Diagram of Car Exhaust

It was concluded that the main defect occurred came from rusty defect products in which 40% of the defects occurred from the production process produced.

In this analysis is a control chart used to monitor disability that occurs is to use a P-chart.

Following is the P-Chart motorcycle exhaust:

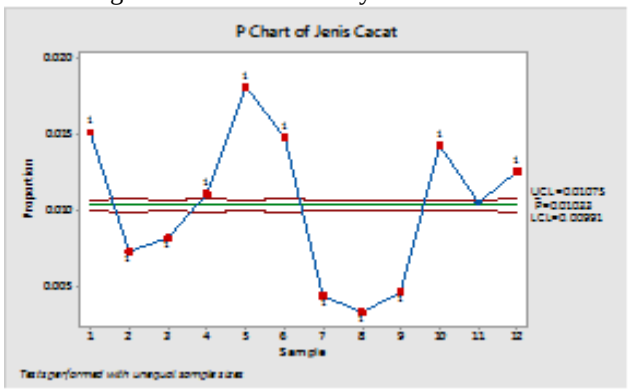

Fig. 7. P-Chart of Motorcycle Exhaust

From the results of the control chart p generated in the processing of motorcycle exhaust production data at PT. Berlindo Mitra Utama by using production data for January-December 2018 it can be concluded that there is a blue dot which is in the middle of the control line which is in sample 11 is within the limits of UCL (Upper Control Limit) and LCL (Lower Control Limit) with a value of 0.01075 and 0.00991. This shows that in the past 11 months the process of motorcycle exhaust production was still beyond the control and supervision of PT. Berlindo Mitra Utama, which causes high levels of defective products and a lack of quality products.

Here is a car exhaust P-Chart:

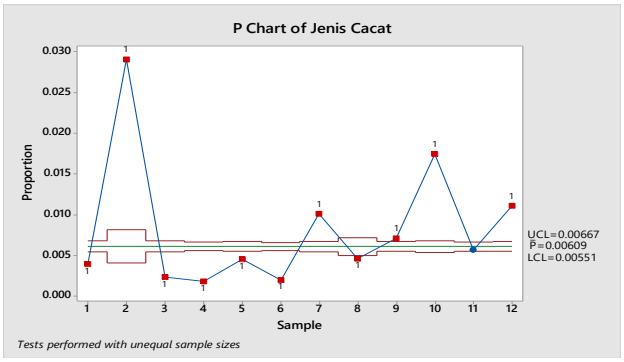

Fig. 8. P-Chart of Car Exhaust

In the car exhaust product can be seen from the results of data processing that there is one sample point that is in the control line UCL (Upper Control Limit) and LCL (Lower Control Limit), each worth 0.00667 and 0.00551, namely in sample 11. Other 11 samples are still outside the UCL and LCL boundaries.

Furthermore, in the analyze phase:

Fig. 9 shows a diagram of the Cause and Effect of motorcycle and car exhaust products at PT Berlindo Main Partners:

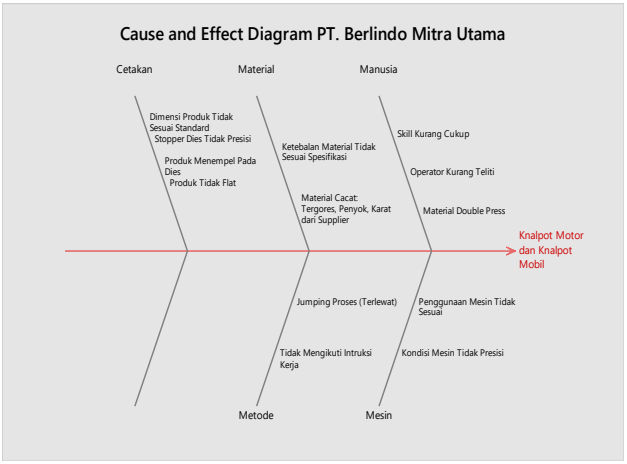

Fig. 9. Diagram of Cause and Effect of PT Berlindo Mitra Utama

Based on the picture, factors that can cause defective products which are produced as a whole come from the material is the material used in making the product to be produced, where this material is an important material from the production process of PT Berlindo Mitra Utama. Humans are one of the important factors in a production process, where humans are in control of the production process. In this mold factor as a whole there were 4 (four) errors that caused this production process is hampered, that is, the dimensions of the product to be processed were not following what had been prepared. In this factor the method is an important thing because by minimizing errors in the factors can cause good product quality. Moreover, the machine is a tool that can help the production process and can simplify and accelerate the production process itself. Furthermore, making FMEA is a formal risk assessment tool that is used to identify ways that might cause failure and something that can cause failure to the system owner, or people who work ([8]).

Table- II: FMEA

Process	Potential Failure Mode	Potential Failure Effects	S.	Potential Causes	O.	Current Controls	D	RPN
Stamping	Damage to the Mold	Causes Blockage in the Machine	8	Not checking	7	Inspection of the mold before the production process	4	224
	Improper Print Orientation	Resulting in slanted print position	6	Negligence of workers	8	Reprimand workers who do not follow the SOP	1	48
Blanking	Clearance on processes that are too small	Faults that occur beyond the specified limits	7	Workers do not follow established methods	8	Conduct training to employees following the method	1	56
	Clearance on the process is too large	Incorrect cutting results	7	Workers do not follow established methods	8	Conduct training to employees following the method	1	56
Drawing	Operates with more than three delta factors	Causes defects on the surface of the wire	6	Not checking	7	Inspection of the delta factor before drawing	8	336
Piercing	Stopper is not functioning properly	Plate shift occurs so that the plate becomes wrinkled	1	The machine is not functioning properly	10	Doing maintenance on a regular basis on the machine	4	40
Bending	Large size material is curved with a small radius	Causing distortion in the production process carried out	6	Negligence of workers	8	Reprimand workers who do not follow the SOP	1	48
Trimming	**There are parts that are not cut**	**Resulting in products that do not meet the specified criteria**	**10**	**The machine is not functioning properly**	**10**	**Doing maintenance on a regular basis on the machine**	**4**	**400**
	Work accident	Production process is hampered	10	Employee Inaccuracy	8	Provide sufficient rest time for workers and machines	4	320
Swaging	Reduction in diameter that is not appropriate	Cause there is no extension towards the axis	6	Negligence the worker	8	Reprimand workers who do not follow the SOP	1	48
Expanding	Do not do the process continuously	Cannot reach the desired dimension	1	Workers do not follow established methods	8	Conduct training to employees in accordance with the method	1	8
Caulking	Inaccurate in giving caulking point on the workpiece	The locking process is not perfect so it creates an open gap	6	Negligence of workers	8	Reprimand workers who do not follow the SOP	1	48

Welding	High temperatures that do not comply with established standards	Side joints are consumed by arcs and form pallets	6	Workers do not follow established methods	8	Conduct training to employees in accordance with the method	1	48
Assembling	Placement of oil pump that is not appropriate	The installation process cannot be carried out	7	Do not check	7	Check the oil pump before assembling	8	392

In the improve phase, the following brainstorming can be done*:*

Table- III: Brainstorming

NO.	FACTOR	*BRAINSTORMING* RESULTS
1	Human	Conduct training for all employees with 5R standards
		Supervise employees
		Hold a monthly *briefing* on the use and production process of the company
2	Material	Inspect raw materials by separating raw materials that do not meet the standards
		Check the raw materials received from suppliers according to the specified specifications
3	Print	Perform maintenance and checking regularly
		Check engine temperature
		Check the raw materials before printing
4	Method	Hold *briefings* , supervision, and direction regarding the production process
5	Machine	Give direction from superiors
		Careful checking of the machine before use and after use

After doing the brainstorming, do the effort benefit matrix as follows

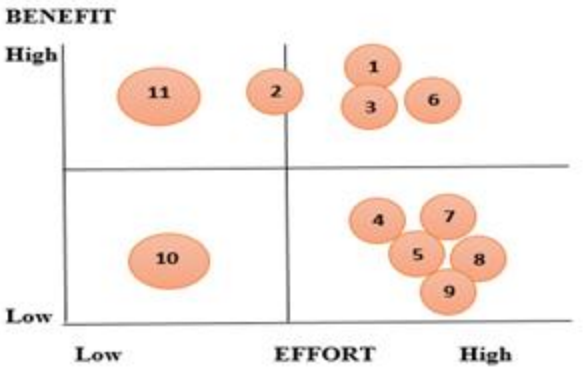

Fig. 10. Effort Benefit Matrix

IV. CONCLUSION

Based on the results of research conducted from the analysis of production data for January 2017-December 2017 it can be concluded as follows:

1) Defective rate of production at PT. Berlindo Mitra Utama uses DPMO (defect per million opportunity), it can be seen that the value of DPMO produced in motorcycle muffler production is 2,582 with a sigma level value of 4.3 while in car exhaust production produces 1.522 DPMO with sigma level of 4.46. Based on the results of the analysis conducted, the authors found what factors can cause production defects, these factors are material, human, mold, method, and machine.

Judging from the results of the Effort Benefit Matrix the way that can benefit the company is to do a careful checking of the machine before and after use.

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