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Quality Control to Minimize Defective Products in the Outer Part Production Process

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***Abstract*— Quality control (QC) is an activity to measure the quality of an item by comparing it according to the specifications and requirements needed by the company, or it can be said also as an effort to maintain the quality of the goods produced in accordance with predetermined specifications based on company regulation. The method used to reduce various types of defects, produced by PT. XYZ was analyzed using the Pareto diagram to indicate the type of defect and the most of the control chart that produced defects were still within the control limits, using the six sigma method in calculating DPMO which resulted in a DPMO value of 49,613.04 with a sigma value of 3,125, and a fishbone diagram describe various disabilities, causes and consequences of events.**

Keywords: control chart, six sigma, DPMO, fishbone diagrams

I. INTRODUCTION

Many companies are involved in the automotive industry, the automotive industry in Indonesia is currently experiencing an increase. One of the products on the automotive industry that is constantly evolving and increasingly sophisticated car is produced by a manufacturing plant. One of the company's automotive industry is PT. XYZ.

PT. XYZ is the casting of components engine and vehicle body presses at once producing a jig and die which are exported abroad. PT. XYZ certainly produces in large quantities with markedly. However, the total production of course experience problems in disability products, one of which is the part of the vehicle body press.

In this report, the authors will discuss the topic of QC in the press production process at PT. XYZ by analysing problems, causes, and solutions to problems that occur, which will be elaborated in general discussion, the discussion of the method using a control chart method has a purpose to reduce the variation of defects in the production process, six sigma with the calculation of the DPMO to measure how much defects occur, as well as Fishbone diagram to determine the accuracy of the causes. Fishbone diagram is one of the tools of 7 QC tools that is used to identify and show the relationship between the causal in order to find the root cause of a problem. Fishbone diagram is used to identify and regulate causes that may appear from certain effects and then isolate the root cause. Having known the cause of the problem can provide conclusions and solutions to reduce or correct defects in the resulting production (Source: PT.XYZ).

PT. XYZ's Quality Management has characteristics that focus to customers, have high quality obsession, using a scientific approach in decision making and problem solving to have a long-term commitment. Requires teamwork, improve processes on an ongoing basis, conducting education and training, giving a controlled freedom, have unity of purpose and the involvement and empowerment of employees.

PT. XYZ implement the concept of "work smart" instead of "working hard", to minimize waste in the various sectors. The incoming waste in waste management that is part of the base the problem in a company, then do Kaizen in PT. XYZ's "Customer First & Respect for People". Kaizen philosophy of a Japan that focuses on the development and consummation continually. Kaizen methods in a PT. XYZ is determine potential repairs, analysing the methods used, giving ideas, developing implementation plans, implementing and evaluating new methods (Source: PT. XYZ). The objective of this research are finding out the quality control process and calculate the quality control data to have a conclusion.

II. LITERATURE STUDY

Quality control or quality control (QC) is an activities to measure the quality of an item by comparing the terms and according to the specifications required by the company, or it can be said also as an effort to maintain the quality from the resulting goods to conform to predetermined specifications based on company regulation. Quality Control as a profession has the task of checking, testing, and separate using statistics as an analysis of the figures (data), as an answer to the comparison and estimation results good and not good split to find which ones are acceptable and which are rejected. Medium and large

companies should need to have a sections specifically quality control.

A. Control Chart

The control chart is a graph used to study how a process changes over time. Data are plotted in time order. A control chart always has a central line for the average, an upper line for the upper control limit and a lower line for the lower control limit. These lines are determined from historical data. By comparing current data to these lines, you can draw conclusions about whether the process variation is consistent (in control) or is unpredictable (out of control, affected by special causes of variation). This versatile data collection and analysis tool can be used by a variety of industries and is considered one of the seven basic quality tools.

Control charts for variable data are used in pairs. The top chart monitors the average, or the centring of the distribution of data from the process. The bottom chart monitors the range, or the width of the distribution. If your data were shots in target practice, the average is where the shots are clustering, and the range is how tightly they are clustered. Control charts for attribute data are used singly [1].

B. Six Sigma (DPMO)

In many quality management methodologies such as Six Sigma, several metrics for quality control are used. One of the most important metrics is the DPMO which is also known as the defects per million opportunities metric. This metric is used to measure the performance of a specific process. To better understand DPMO, it is important to define the term defect within the context of quality management. A defect is defined as a non- conformance of a specific quality characteristic to its planned specification. The quality characteristic can be the width of a finished product, the response time of a particular service or the durability of a finished product. While considering DPMO, processes are seen to be of high quality if the defect per a million units produced or services provided are few [2].

Calculating DPMO in a process, it is important for organizations to identify and define the quality characteristics. Quality characteristics can be obtained through the following ways:

a. Having a very clear understanding of all the requirements needed for a particular process to take place
b. Through industry standards and specifications
c. Prioritizing different types of defects from the least to the mostcritical

DPMO has been defined as the ratio of the number of defects (based on the quality characteristic defined for the process) in 1 million opportunities when a finished item can have one or more defects. To calculate DPMO, it is critical to know the total number of defect opportunities [2].

Defect opportunities, in this case, are defined as the total number of possible defects that can be identified within a given process. The formula for DPMO is as below (as depicted in Figure 1):

DPMO = (Total number of defects found in a sample/Sample size * number of defect opportunities per unit in the sample) * 1.000.000

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**

Figure 1. Process Sigma Level Conversion Table

C. Fishbone Diagram

A fishbone diagram is a tool that can help you perform a cause and effect analysis for a problem you are trying to solve. This type of analysis enables you to discover the root cause of a problem.

This tool is also called a cause and effect diagram or an Ishikawa diagram. These names can be used interchangeably

III. RESEARCH METHODOLOGY

Research methodology is the process or scientific way to get the data that will be used for the purposes of researchers. The following are the steps in

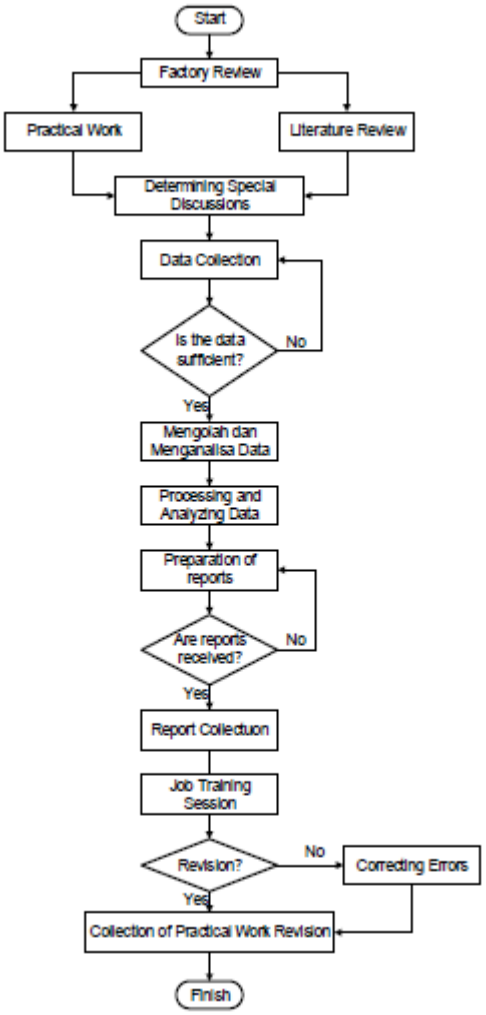

Figure 2. Flowchart of Research Methodology

IV. ANALYSIS METHODS

Here are some of the methods used to minimize the disability on the outer part of the car that was in production by PT. XYZ.

A. Control Chart

Control charts for variable data are used in pairs. The top chart monitors the average, or the centring of the distribution of data from the process. The bottom chart monitors the range, or the width of the distribution. If your data were shots in target practice, the average is where the shots are clustering, and the range is how tightly they are clustered. Control charts for attribute data are used singly. Calculation table CL, UCL, LCL can be seen Table 1 to Table 4.

Table 1. Part Side Member (Right)

Periode	Produksi (pcs)	Cacat (pcs)	CL	UCL	LCL
Sept'18	1513	1003	891	3017,273	0
Okt'18	1604	1604	891	3017,273	0
Nov'18	1531	1531	891	3017,273	0
Des'18	1230	212	891	3017,273	0
Jan'19	1693	105	891	3017,273	0
Mean	891				
STD	708,757716				

Table 2. Part Side Member (Left)

Periode	Produksi (pcs)	Cacat (pcs)	CL	UCL	LCL
Sept'18	1422	538	715,4	2746,027	0
Okt'18	1546	1546	715,4	2746,027	0
Nov'18	1300	1300	715,4	2746,027	0
Des'18	1340	55	715,4	2746,027	0
Jan'19	1750	138	715,4	2746,027	0
Mean	715,4				
STD	676,8757641				

Table 3. Part Panel Roof

Periode	Produksi (pcs)	Cacat (pcs)	CL	UCL	LCL
Sept'18	1490	262	310,2	703,9859	0
Okt'18	1670	351	310,2	703,9859	0
Nov'18	1390	497	310,2	703,9859	0
Des'18	1490	137	310,2	703,9859	0
Jan'19	1603	304	310,2	703,9859	0
Mean	310,2				
STD	131,2619518				

Table 4. Part Panel Back

Periode	Produksi (pcs)	Cacat (pcs)	CL	UCL	LCL
Sept'18	1457	360	150,2	517,2093	0
Okt'18	1500	142	150,2	517,2093	0
Nov'18	1587	120	150,2	517,2093	0
Des'18	1080	74	150,2	517,2093	0
Jan'19	1560	55	150,2	517,2093	0
Mean	150,2				
STD	122,3364214				

control chart can be seen in Figure 3 to Figure 6.

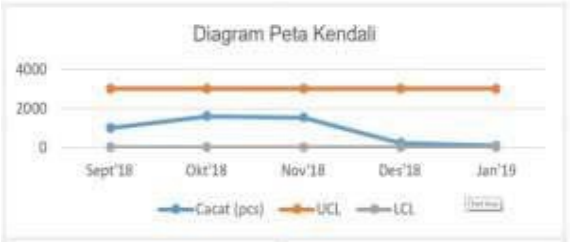

Figure 3. Part Side Member (Right)

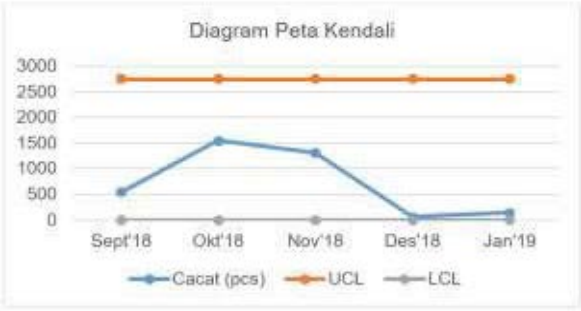

Figure 4. Part Side Member (Left)

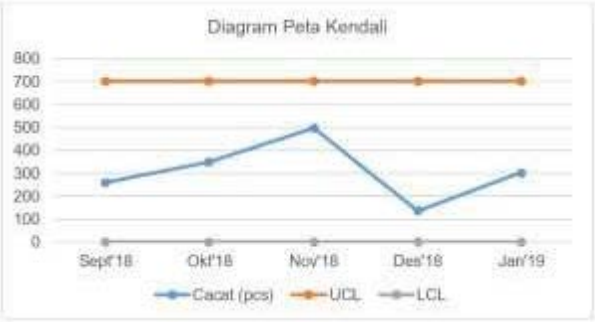

Figure 5. Part Panel Roof

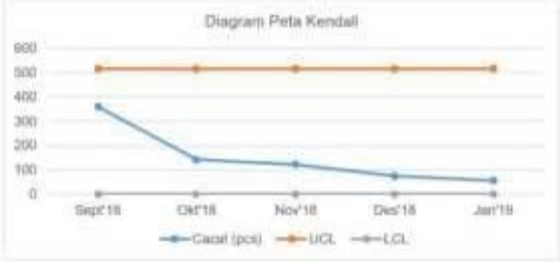

Figure 6. Part Panel Back

The above control chart shows good results, for five months (December 2018 – January 2019) flaw that occurs does not exceed the limits of control.

B. Six Sigma (DPMO)

Following is the calculation of DPMO at PT. XYZ:

a. Unit (U)
The number of four types of parts produced by PT. TXYZ period September 2018 - January 2019, which is 29,756 pcs.

b. Opportunities (OP)
There are seven types of defects in this outer part, namely nobi / ware, ding / dent, shiwa, makure, kaziri, bari, scratch.

c. Defect (D)
The number of defects in parts produced by PT. XYZ period September 2018 - January 2019, as many as 10,334 pcs.

d. Defect per Unit (DPU)
DPU = D / U
= 10.334 / 29.756
= 0.3472913

e. Total Opportunities (TOP)
TOP = U x OP
= 29,756 x 7
= 208,292

f. Defect per Opportunities (DPO)
DPO = D / TOP
= 10.334 / 208.292
= 0.04961304

g. Defect per Million Opportunities (DPMO)
DPMO = DPO x 1,000,000
= 0.04961304 x 1,000,000
= 49,613.04

h. Sigma level
The Six Sigma level can be seen in the Six Sigma table, the DPMO value is conserved into a sigma value. The result of the score is 3.125.

In the calculation that has been done, the DPMO value is 49,613.04 with a sigma level of 3.125. Improvements in various sectors continue to be carried out to reach the level of negligence, namely Zero Defect.

C. Fisbone Diagrams

The fishbone show the root of the problem [3]. Example fishbone diagram can be seen in Figure 7.

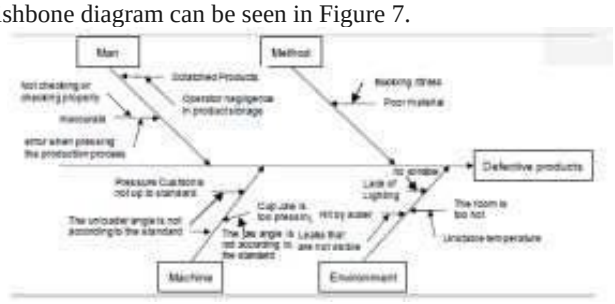

Figure 7. Fishbone Diagram [4]

Based on the causal diagram above, basically the cause of occurrence of defective packing is leaking is the conflict/friction.

The cause due to several factors, namely:

a. the human factor, because of the negligence of the operator product in storage as a result of the product scratched with other objects. Operators are less scrupulous, that an error occurred in the press of a button when the production process is in proagress and is not or less checks/checking that produce a product that is defective.
b. Material Factors, because the materials used are less nice so it eases product became disabled (rust).
c. environmental factors, because the temperature is unstable as a result of the room too hot, the lack of lighting so that the operator is insufficient in his work. The product is exposed to air due to leaking not seen will produce a product that is defective.
d. Factor machines, pressure cushion does not comply with the standard, the unloader does not fit standard Angle, as well as the cup of the jaw is too pressing to result in defective product, e.g. ding, dent, etc.

V. DISCUSSION

In the manufacture of a product, there are several factors that affect the quality of a production that is, human, machinery, and raw materials. Quality is one of the main things that must be maintained by every company, because it will affect consumers who will buy the product. Quality is referred to as the totality of form and characteristics of a product the Products ability to meet market needs and also consumers. To keep the quality remained guaranteed, quality control is carried out. In addition to the benefits of the application of the pest is quality can increase the productivity of a company.

Quality is an important part of product creation or core business. In ISO 8402, quality is defined as the totality of the characteristics of a product that supports its ability to satisfy needs that are specified or specified. Quality is often interpreted as customer satisfaction or conformance to needs or requirements because it requires measurement of customer satisfaction.

Companies that provide superior service quality as measured by customer satisfaction also experience higher economic benefits than less service-oriented competitors. Satisfied customers is central to the long-term success of the business, and the relationship between customer satisfaction from customer behaviour have been well documented in the marketing literature.

PT. XYZ is a manufacturing company engaged in the automotive sector that applies standards so that the quality of products produced is maintained. However, although has done a wide range of process control from the start to the end of the initial phase of production, still found a defect in the product. Disability on the diverse types of products. Therefore be conducted data analysis of disability that occurs in the resulting products in PT. Toyota Motor Manufacturing Indonesia on a discussion of this case.

VI. CONCLUSION AND RECOMMENDATIONS

A. Conclusion

The method used to reduce various types of defects, produced by PT. XYZ was analysed using the Pareto diagram to indicate the type of defect, data feasibility test which resulted in insufficient data, and data normality test which resulted that from the four variables didn't have normal data distribution, most of the control chart that produced defects were still within the control limits, using the six sigma method in calculating DPMO which resulted in a DPMO value of 49,613.04 with a sigma value of 3,125, and a fishbone diagram describe various disabilities, causes and consequences of events.

B. Recommendations

Based on the results of the analysis of the quality control regarding the defective product at PT. XYZ, the author tried to give recommendations using Bayes- Fishbone. The Fishbone Diagram has the advantage of being visually clear in its diagram and being able to explore ideas from several people's thoughts in detail based on a set of categories, namely 5M1E (man, machine, method, material, measurement, environment). Even so, it is unfortunate that the tool has its drawbacks, namely fishbone diagrams cannot describe the relationships or interrelationships between variables in it and are unable to clearly correlate the correlation between the sources of the identified problems In addition, the causative factors are still in the form of hypotheses so that their existence has not been proven. With these weaknesses, it is believed that the reason behind the failure of fishbone diagrams in identifying common cause variations.

On the other hand, bayesian networks can be used to present the relationship between the uncertain variable and to predict the probability of the effect that will occur and also be able to represent a causal correlation Improvement in a diagram between variables from a structure of the Bayes belief network. This will complement fishbone diagram's weaknesses.

After a comparison analysis from the literature review of the characteristics of both, a gap was found between the bayesian network and fishbone diagrams so that the two would be complementary or complementary. The advantages of the bayesian network can fill or overcome the shortcomings of fishbone diagrams, and vice versa. Can be seen in Table 1, the differences in the fishbone and bayesian network methodology diagrams to later be complementary.

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