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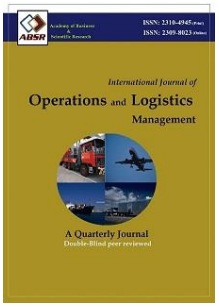

Product Quality Control in Plastics Industry PT Megah Plastik

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Quality control should be integratedly aimed at multiple objectives so as to best satisfy consumers' needs. The problems in quality control lies in the fact of how to maintain and direct the products and services produced by the company in order to meet the quality standard. The problems in this research are formulated in the following questions: 1) What factors might potentially cause product defect in the production process at PT Megah Plastik?; 2) How to apply quality control system in order to minimize product damage? The population of this research are plastic products manufactured by the company during the period of January to November 2015. The data were collected by random sampling and systematic sampling methods wherein the total of observed data amounted to 345 data which were then divided into 20 subgroups.

The analysis results discovered that there are 3 (three) types of defects in the production of PT Megah Plastik including crumpled, ripped and cracked plastics. The ripped defect was in the second dominant (33%) due to an error in the cutting process of plastic products. From the cause and effect of the diagram, several factors that cause the production defects at PT Megah Plastik were revealed such as human, machine and material. The crumpled and ripped defects are caused by a) Human factors/Operator had fatigue that he became negligent; b) the quality of raw material is poor that the mixture of material turns out uneven; c) No machinery maintenance provided that the plastic rolling is not as it should be.

Keywords: Control,Quality,Products,Industry

INTRODUCTION

Background

A company should be consistently monitoring its production activities in order to be able to compete with its competitors. The factor of a quality is the main point that should be of a company's concern so that its products able to be consistently absorbed by the market. This aspect is what drives companies to improve the quality of products produced complying with the product specifications set out by previous company. In a

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production process, failure sometimes occur despite the production process has been well planned and executed. There are 5 main causing factors of deviation of works quality : Man; Work Method; Machine/Equipment; Raw Material and Work environment. To mitigate products failure/defective products, the company is expected to make continuous improvement. One of its ways is to perform quality control.

Quality Control is performed starting from the process of information/raw materials input by marketing and purchasing division to the process of raw materials entering and processed in the factory (transformation phase) that finally are delivered to customers. Even quality control can also be performed after sales. Quality control must be performed under the process of continuous and sustainable development. The process of quality control can be peformed through the process of PDCA (Plan, Do, Check, Action) which was introduced by dr. W. Edwards Deming, an American renown expert on quality, that this cycle is coined as the Deming Cycle. PDCA cycle is commonly used as the main statistical tools, including 1). Check Sheet or inspection sheet is the tool to collect and analyze data presented in a table which contains names and number of goods produced and type of incompatibility with the amount of production; 2). Histogram is used to provide ease of access to reading or explaining the data efficiently, in the form of bar graph that shows distribution of values obtained in numbers; 3) Control Chart is a graphical method used to evaluate whether a process is in quality control statistically or not, so that it can solve problems and generate quality improvement; 4) Pareto Diagram is used to identify major problems to minor problem; 5) Cause and Effect Diagram is used to show main factors that affect the quality and has consequences on the main problem; 6) Scatter Diagram is used to test the strength of the correlation between the two variables and to determine correlation type of the two variables: positive, negative, or no relationship; 7) Stratification is an effort to classify data into groups with similar characteristic. These tools are beneficial in the collection of objective information for the basis of decision-making (Haning, 2007).

Quality control should be integratedly aimed at multiple objectives so as to satisfy consumers. The problems in quality control lies in the fact of how to maintain and direct the products and services produced by the company in order to meet the quality standard. Therefore, the role of product quality control is deemed crucial and beneficial for the company.

Several studies related to quality control are elaborated below.

1. A research conducted by Ni Luh Putu Hariastuti entitled: "Product Quality Control in an effort to reduce the level of finished products failure at CV Percetakan X. The research results discovered that the most dominant type of failure is the less bright mold color (16,67%). This failure is caused by operator or human error

2. Sutrisno Badri, Romadhon conducted a research entitled: "Controlling Product Quality with SQC Model approach (Statistical Quality Control) Model Application on a Furniture Company. The control chart in analysis results discovered that an average product damage is 0,026 (2.6%). The supervisory limit of UCL is 0,031 (3.1%) and LCL is 0,021 (2.1%).

3. Suardilutan, Melynda (2008) conducted a research entitled: "The Role of Quality Control to minimize the number of defective product at PT Surya Millenia. According to cause and effect diagram, it was discovered that the factors of human/labors, raw materials and equipment are the causes of defective products to be cracked/broken and deformed in shape.

PT. Megah Plastik is a company which is engaged in the manufacturing of opaque white plastic bags often used for sugar packaging, etc. The company products are circulated around Medan city and its vicinity. To manufacture its products, the company uses raw material of HDPE and LLDPE plastic ores imported from Kuwait. Plastic quality is one of the requirements that a company has to meet in order not to disappoint consumers for the products that have been purchased. The types of defect found on the plastic production process are: Cracked, Ripped, and Crumpled The attributes of cracked, ripped and crumpled were selected since the three attributes

indicate the condition of a plastic cannot be used or rejected. Based on the data illustrated in table 1.1, it was discovered that the average total defects in the products produced by PT Megah Plastik monthly during the year 2015 is of 3.56 %.

TABLE 1 HERE

Research Questions

1. What factors that might potentially cause the defects in the production process at PT Megah Plastik Medan?

2. How to apply quality control system in order to reduce the number of product damages?

Conceptual Framework.

Quality control is an activity that must be performed by a company. This is aimed at reducing the level of product damages, despite it leads the company to expend additional production cost on quality supervision. On the contrary, if the company fails to pay attention to quality control, in the long term, the company will find it hard to market its products.

Statistical quality control using SPC (Statistical Process Control) and SQC (Statistical Quality Control) has seven main statistical tools that can be used to control quality. These include check sheet, histogram, control chart, pareto diagram, cause-effect diagram, scatter diagram and process diagram (Heizer and Render, 2006, 263 - 268). The process of problem solving and quality improvement using the Seven Tools can help troubleshooting process faster and more systematic. The concept of the Seven Tools was founded by Yosano Ishikawa, a reputable expert on quality from Japan. According to Ishikawa, 95% of quality-related problems can be resolved with these basic tools. The function of the seven quality control tools is to improve the ability to repair the process, thus obtaining: a) increased ability to compete; b) reduced cost of quality and increased flexibility price.; c) increased resources productivity. These Seven tools can be used professionally in an attempt to facilitate the process of quality improvement.

RESEARCH METHODOLOGY

Population and Sample of Research

The population of this research are plastic products manufactured by the company during the period of January to November 2015. The data were collected by random sampling and systematic sampling methods wherein the total of observed data amounted to 345 data which were then divided into 20 subgroups.

Models of Analysis

This nature of this research is descriptive with the following analysis tools:

1. Data Stratification/Grouping .

Stratification is a technique of grouping data into specific categories, allowing the data to describe problems clearly so that conclusions can be more easily be drawn. The categories formed include relative data on the machinery resources environments used in the process, raw materials and others.

2. Check Sheet

A check sheet or an inspection sheet is the tool to collect and analyze data presented in a table which contains names and number of goods produced and type of incompatibility with the amount of production.

3. Pareto Diagram

This diagram is used to identify and evaluate types of defect found in the plastic. This diagram reveals the type of damage frequently occurs, which will allow the main cause of the damage to be detected.

4. Fishbone/Cause-Effect Diagram

Fishbone/Cause-Effect Diagram is used to investigate the cause of uncontrolled situation or to analyze the extent of specification deviation, which will allow the causes of product damage be resolved.

5. Histogram

Histogram is used to provide ease of access to reading or explaining the data rapidly, in the form of bar graph that shows distribution of values obtained in numbers.

6. Scatter Diagram

Scatter Diagram is used to observe correlation among the three factors that affect the defect of the product.

To calculate the value of the correlation (r), the following formula is used

$$r = \frac{n\sum XiYi-(\sum Xi)(\sum Yi)}{\sqrt{[(n\sum Xi^2)-(\sum Xi)^2][(n\sum Yi^2)-(\sum Yi)^2]}}$$

7.Control Chart

P Chart

Upper Class Limit (UCL) and Lower Class Limit (LCL) can be calculated

with the formula:

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

$$\text{LCL} = \bar{\text{p}} - 3\sqrt{\frac{\bar{\text{p}}(1-\bar{\text{p}})}{\text{n}}}$$

U chart

Upper Class Limit (UCL) and Lower Class Limit (LCL) can be calculated

with the formula

$$UCL = \bar{u} + 3\sqrt{\frac{\bar{u}}{n}} \qquad LCL = \bar{u} - 3\sqrt{\frac{\bar{u}}{n}}$$

RESULTS AND DISCUSSION

4.1. Product quality control system of PT Megah Plastik

PT. Megah Plastik manufactures 3 types of plastic products including opaque white, flash plastic bags and plastic ropes. This research mainly touches on opaque white plastic often used for sugar packaging, flour packaging, etc. PT Megah Plastik manufactures plastic products as many as 150 units per hour. Company's production capacity is 1200 units per day. The types of defect found on the plastic production process are: Cracked, ripped, and crumpled Cracked defect is caused by molding machine error. Ripped defect is caused by an error in cutting process. While the crumpled defect is caused by an error of plastic rolling. The attributes of cracked, ripped and crumpled were selected since the three attributes indicate the condition of a plastic cannot be used or rejected. To discover the comparison percentage of defects with the total defects that occur, then the type of defects must be ordered according to the largest percentage, and its cumulative percentage is subsequently calculated . The percentage of the comparison can be seen in table 2 below.

TABLE 2,3 & 4 HERE

Histogram for total defective products can be seen in figure 1

FIGURE 1 HERE

The types of defective plastic products produced by PT Majestic Plastics is recapitulated as follows: Ripped 29; crumpled 33 and cracked 26.

FIGURE 2 HERE

From the histogram diagram, it can be concluded that the defects in the products of PT Megah Plastik are dominantly crumpled (33), ripped (29) and cracked (26).

FIGURE 3 HERE

From the Pareto Diagram, it can be concluded that the error in the production process is the cause of defective products manufactured by PT Majestic plastic. One of the most common errors is in plastic Rolls, which leaves the plastic being crumpled (37.5%). Then followed by an error in the product cutting process that cause ripped defect by 33% and cracked defect by 29.6%.

To observe correlation among the three factors that affect the defective products, a Scatter Diagram is used.

Based on the calculation results of the correlation between crumpled defects with Non Conformities, it was discovered that the value

$$r = \frac{20(217) - (33)(88)}{\sqrt{\left[20(85) - (33)^2\right]\left[20(590) - (88)^2\right]}} = 0.9122$$

The correlation value obtained was strongly positive, which means that the higher the defect on the crumpled plastic, the higher the number of Non Conformities.

FIGURE 4 HERE

Based on calculation results of correlation between ripped defects with Non Conformities, it was discovered that the value

$$r = \frac{20(187) - (29)(88)}{\sqrt{\left[20(63) - (29)^2\right]\left[20(590) - (88)^2\right]}} = 0.9113$$

The correlation value obtained was strongly positive, which means that the higher the defect on the ripped plastic, the higher the number of Non Conformities.

FIGURE 5 HERE

Attribute Data Control Chart

P Chart

TABLE 5 HERE

$$\bar{p} = \frac{\sum X}{\sum n} = \frac{23}{140} = 0.164$$

$$UCL = 0.1643 + 3\sqrt{\frac{0.1643(1-0.1643)}{20}} = 0.4128$$

$$LCL = 0.1643 - 3\sqrt{\frac{0.1643(1-0.1643)}{20}} = -0.0843$$

→ 0 minimum total defects per unit is 0 so that a minus number is replaced with 0.

FIGURE 6 HERE

From the P Chart, it was discovered that all the data are within control limit.

TABLE 6 HERE

Source : Data Processed

$$\bar{p} = \frac{\sum X}{\sum n} = \frac{26}{165} = 0.1576$$

$$UCL = 0.1576 + 3\sqrt{\frac{0.1576(1-0.1576)}{15}} = 0.4398$$

$$LCL = 0.1576 - 3\sqrt{\frac{0.1576(1-0.1576)}{15}} = -0.1246$$

→ 0 minimum total defects per unit is 0 so that minus number is replaced with 0.

FIGURE 7 HERE

From the P Chart above, it was discovered that all the data are in control limit.

TABLE 7 HERE

$$u = \frac{\sum c}{\sum n} = \frac{44}{140} = 0.3143$$

$$UCL = 0.3143 + 3\sqrt{\frac{0.3143}{20}} = 0.6904$$

$$LCL = 0.3143 - 3\sqrt{\frac{0.3143}{20}} = -0.618 \rightarrow 0$$

minimum total defects per unit is 0 so that minus number is replaced with 0.

FIGURE 8 HERE

From the P Chart, it was discovered that all the data are in control limit.

TABLE 8 HERE

$$u = \frac{\sum c}{\sum n} = \frac{26}{165} = 0.2667$$

$$UCL = 0.2667 + 3\sqrt{\frac{0.2667}{15}} \quad 06667$$

$$LCL = 0.2667 - 3\sqrt{\frac{0.2667}{15}} = -0.0.1333$$

→ 0 minimum total defects per unit is 0 so that a minus number is replaced with 0.

FIGURE 9 HERE

From the P Chart above, it was discovered that all the data are within control limit.

Consumer's demand for plastic needs generally requires no defects-free plastics. Consumers allow defects in the products, however, the defects shall not affect the main function of the product. Consumers realize how difficult it is to produce undefective products in plastic industry considering the many factors that play a role in the production process, in addition to the high level of human error.

Based on the observations results on table Why-Why. it was discovered that the main factor causing defects in plastic products are classified into human, engine, and material errros. Furthermore, an Fault Tree Analysis (FTA) was made in order to help analyze and predict the fact-based failures. FTA was made based on table Why-Why and Cause-Effect Diagrams.

TABLE 9 HERE

FIGURE 10 HERE

FIGURE 11 HERE

TABLE 10 HERE

CONCLUSION AND DISCUSSION

Conclusions

1. Types of Plastic Defects under the production of PT Megah Plastik include Crumpled, Ripped and Cracked From Histogram and Pareto Diagram, it was discovered that the crumpled defect is the most dominant defect with 37,5%. This is caused by an error in plastics rolling. The ripped defect was in the second dominant defect, due to an error in the cutting process of plastic products.

2. From the cause and effect diagram, it was discovered that the factors cause

the defects in production results at PT Megah Plastik is human, machine and materials. The crumpled and ripped defects are caused by : a) Human factors/Operator experieced fatigue that he became negligent; b) the quality of raw material is poor that the mixture of material turns out uneven; c) No machinery maintenance provided that the plastic rolling is not as it should be.

3. Repairing measures need to be taken in order to minimize product damages.

With 5W + 1H method, it was discovered that there are 3 repairing actions that should be taken by PT Megah Plastik, namely :

a. To get production results is in accordance with the specification, Head

of production must fix working method by supervising stations that are less productive. This activity is done in the production floor or two weeks.

b. To reduce the number of defective products, Head of Production needs to fix the production process by performing inspection on Production Process. This activity is done in production floor, just once in one period.

c. To reduce errors committed by operators, Head of Production should monitor operators at work. This is done on production floor during the production process.

Suggestions

1. To reduce production defects due to human factor, it is suggested that PT Megah Plastik perform supervision on operators at work, fixing working methods and providing trainings to workers.

2. To reduce the level of defective products due to machinery errors, it is suggested that PT Megah Plastik perform regular check and machinery maintenance.

3. To reduce the defects in the product caused by materials, it is suggested that PT Plastic Splendid set the standard for the composition of raw materials.

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APPENDIX

Table 1. The number of defective products at PT Megah Plastik in 2015

No	Month	Total Working Days	Total Production (Unit)	Total Defects (Unit)	%
1	January	24	107,800	4.000	3,71
2	February	24	108,000	3.800	3,52
3	March	25	112,500	4.200	3,73
4	April	25	112,300	4.000	3,56
5	May	23	103,500	3.000	2,90
6	June	25	112,350	4.000	3,56
7	July	25	112,370	4.000	3,56
8	August	26	117,000	4.200	3,59
9	September	26	117,100	4.300	3,67
10	October	26	116,950	4.500	3,85
11	November	25	112,450	3.900	3,47
Total		**274**	**12,323,200**	**43,900**	

Source : PT Megah Plastik Medan

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Table 2. Stratification of Total Defective Products

Sub Group	*Number of Inspection*	Total Defects			Cause of Defect				Product
		Ripped (So)	Crumpled (K)	Cracked (S)	Human	Machine	Material	Methods	
1	20	3	5	3	So,S	K	S	-	8KS,10KSo,13SoS,14K,15S,16SoK,20K
2	15	3	2	3	K	So,K	-	-	4SoK,5SoS,6S,14SoK,15S
3	20	2	2	1	-	S	So	-	9So,10K,17SoSK
4	15	1	1	0	-	S	K	-	2K,5So
5	15	1	1	1	K,S	-	So,K	-	5S,4So,14K
6	15	1	2	0	S	So	-	-	8SoK,14K
7	20	1	0	1	So	-	K,S	-	15SoS
8	15	2	2	1	So,S	S	-	-	5SoSK,16SoK
9	20	0	0	0	-	So,K	K	-	-
10	15	0	0	1	So	-	S	-	14S
11	15	0	1	0	-	So	S	-	1K
12	20	0	0	0	K,S	K	-	-	-
13	15	1	1	0	So	-	S	-	11SoK
14	15	3	3	4	So	-	S	-	5SoSK,8SK,19SoSK,20SoS
15	20	2	3	3	S	K,S	-	-	2SoSK,5SoSK,7KS
16	20	3	2	2	So,K	-	S	-	8SoK,18SoS,19SoSK
17	15	1	1	1	S	So	K	-	8SoSK
18	20	2	3	2	-	So,S	K	-	6K,7SoSK,20SoSK
19	15	1	2	3	K,S	-	-	-	1S,7SK,8K,15SoS
20	20	2	2	-	-	S	K	-	3SoK,4K,18So

Source : PT Megah Plastik

Table 3. *Check Sheet* of Total Defective Products

Sub Group	Time Intervals	*Number of Inspection*	*Frequency*	*Number of Nonconforming*	*Number of Nonconformittes*	Remarks
1	08:00:00 – 08:01:00	20	IIIIIII	7	11	8,10,13,14,15,16,20
2	8:21:00 AM – 8:22:00 AM	15	IIIII	5	8	4,5,6,14,15
3	8:42:00 AM – 8:43:00 AM	20	III	3	5	9,10,17
4	9:03:00 AM – 9:04:00 AM	15	II	2	2	2.5
5	9:24:00 AM – 9:25:00 AM	15	III	3	3	3,4,14
6	9:45:00 AM – 9:46:00 AM	15	II	2	3	8.14
7	10:06:00 AM – 10:07:00 AM	20	I	1	2	15
8	10:27:00 AM – 10:28:00 AM	15	II	2	5	5.16
9	10:48:00 AM – 10:49:00 AM	20	-	-	-	-
10	11:09:00 AM – 11:10:00 AM	15	I	1	1	14
11	11:30:00 AM – 11:31:00 AM	15	I	1	1	1
12	11:51:00 AM – 11:52:00 AM	20	-	-	-	-
13	1:00:00 PM – 1:01:00 PM	15	I	1	2	11
14	1:21:00 PM – 1:22:00 PM	15	IIII	4	10	5,8,19.20
15	1:42:00 PM – 1:43:00 PM	20	III	3	8	2,5,7
16	2:03:00 PM – 2:04:00 PM	20	III	3	7	8,18,19
17	14:24:00 - 14:25:00	15	I	1	3	8

18	2:45:00 PM – 2:46:00 PM	20	III	3	7	6,7,20
19	3:06:00 PM – 3:07:00 PM	15	IIII	4	6	1,7,8.15
20	3:27:00 PM – 3:28:00 PM	20	III	3	4	3,4,18

Source : PT Megah Plastik

Table 4. Calculation of total defective plastics

Sub Group	*Number of Inspection*	Total Defects			*Number of Nonconformittes*
		Cracked (So)	Crumpled (K)	Ripped (S)	
1	20	3	5	3	11
2	15	3	2	3	8
3	20	2	2	1	5
4	15	1	1	0	2
5	15	1	1	1	3
6	15	1	2	0	3
7	20	1	0	1	2
8	15	2	2	1	5
9	20	0	0	0	0
10	15	0	0	1	1
11	15	0	1	0	1
12	20	0	0	0	0
13	15	1	1	0	2
14	15	3	3	4	10
15	20	2	3	3	8
16	20	3	2	2	7
17	15	1	1	1	3
18	20	2	3	2	7
19	15	1	2	3	6
20	20	2	2	0	4
Total		**29**	**33**	**26**	**75**
Defects Percentage		**32.95%**	**37.50%**	**29.55%**	**100%**
Cumulative Percentage		**32.95%**	**70.45%**	**100%**	**-**

Source : PT Megah Plastik

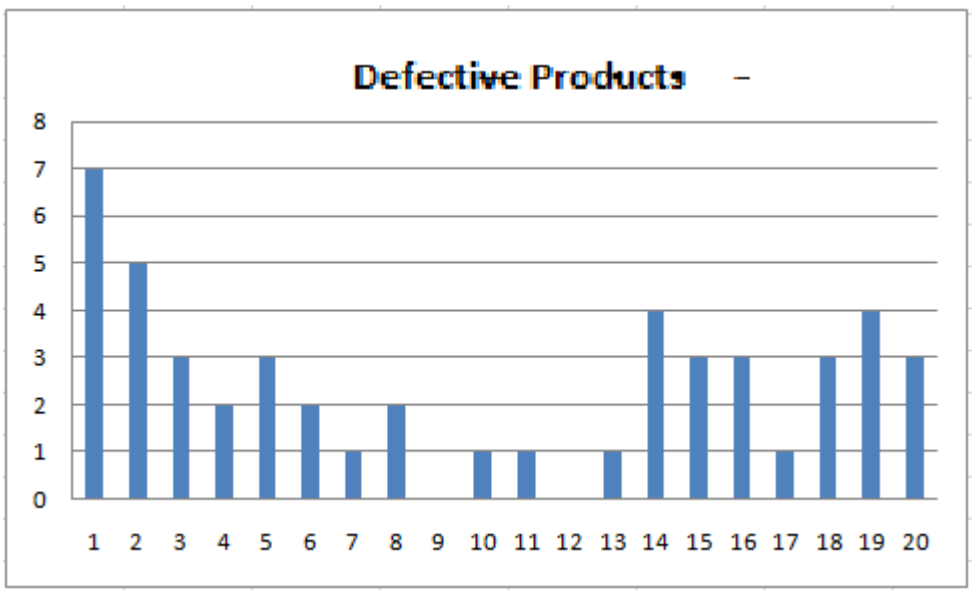


Figure 1. Histogram of Total defective Plastic products

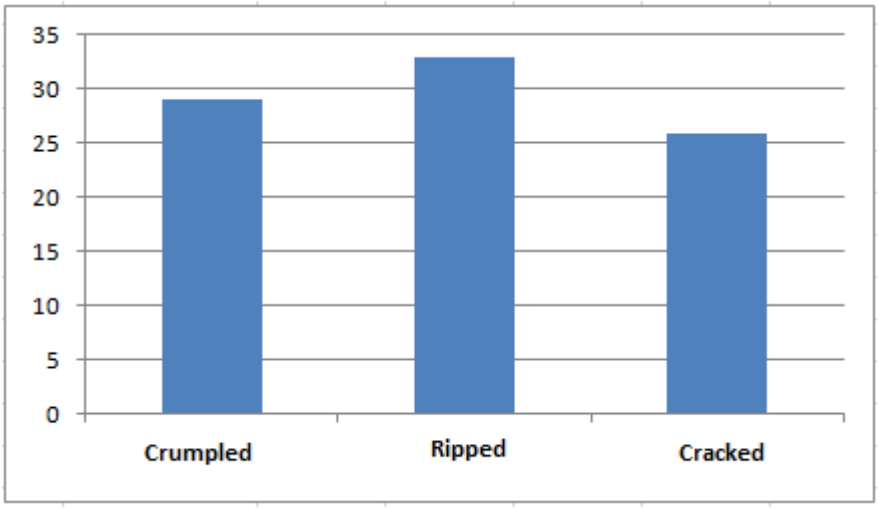


Figure 2. Histogram of Plastic Defects Stratification

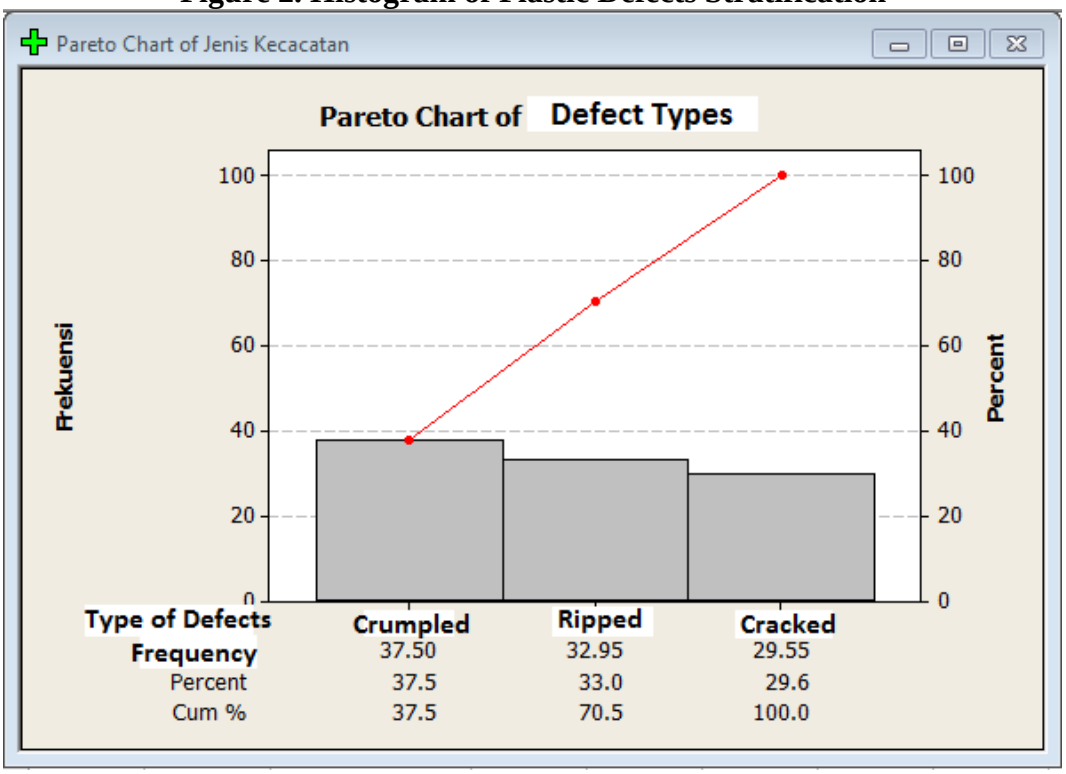


Figure 3. Pareto Diagram

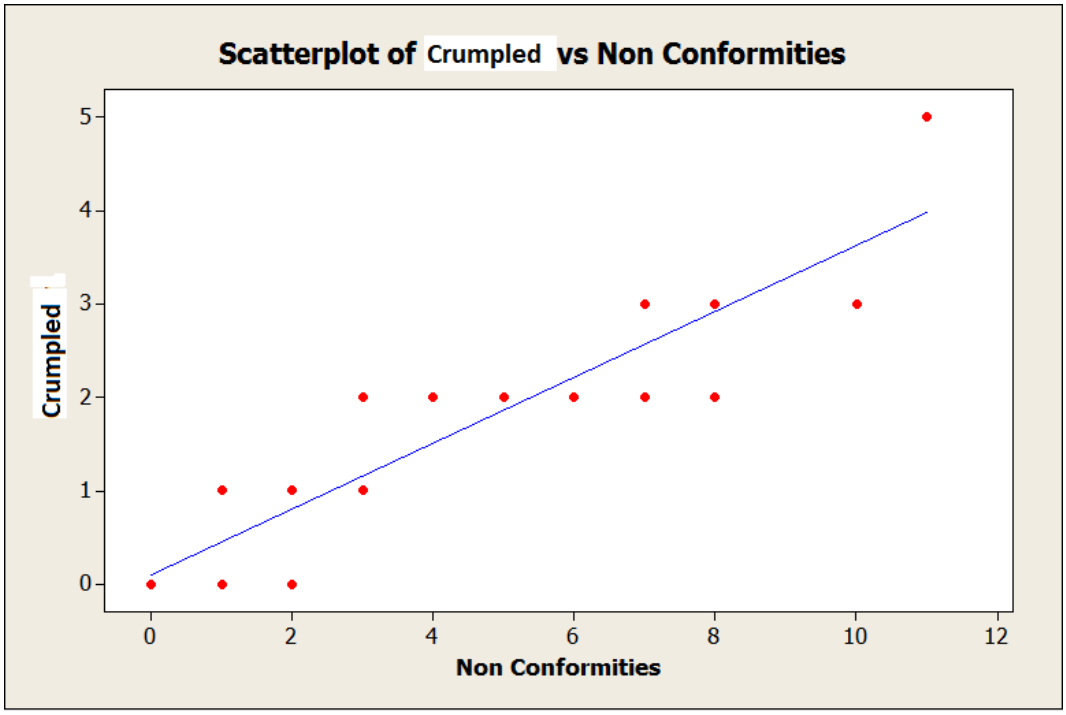


Figure 4. ***Scatter Diagram*** **between Crumpled Plastics with Non Conformities**

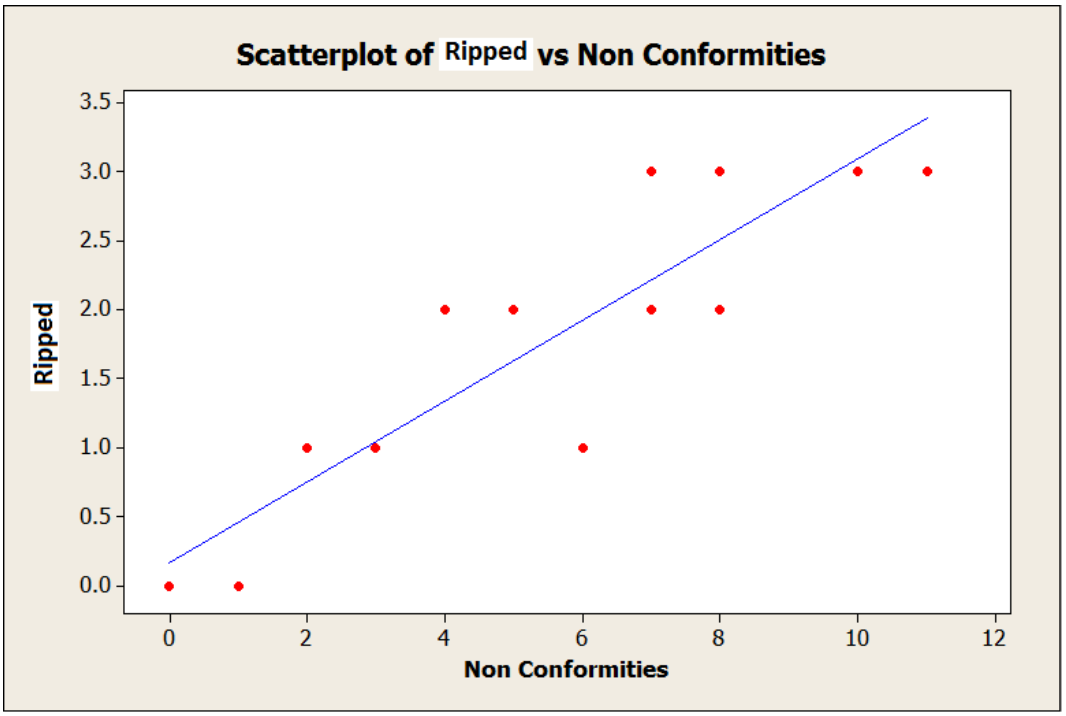


Figure 5. ***Scatter Diagram*** **between ripped plastics with Non Conformitties**

Table 5. Total Number of Inspection 20

No	Sub Group	*Number of Inspection*	*Number of Nonconformittes*
1	1	20	7
2	3	20	3
3	7	20	1
4	15	20	3
5	16	20	3
6	18	20	3
7	20	20	3
	Total	**140**	**23**

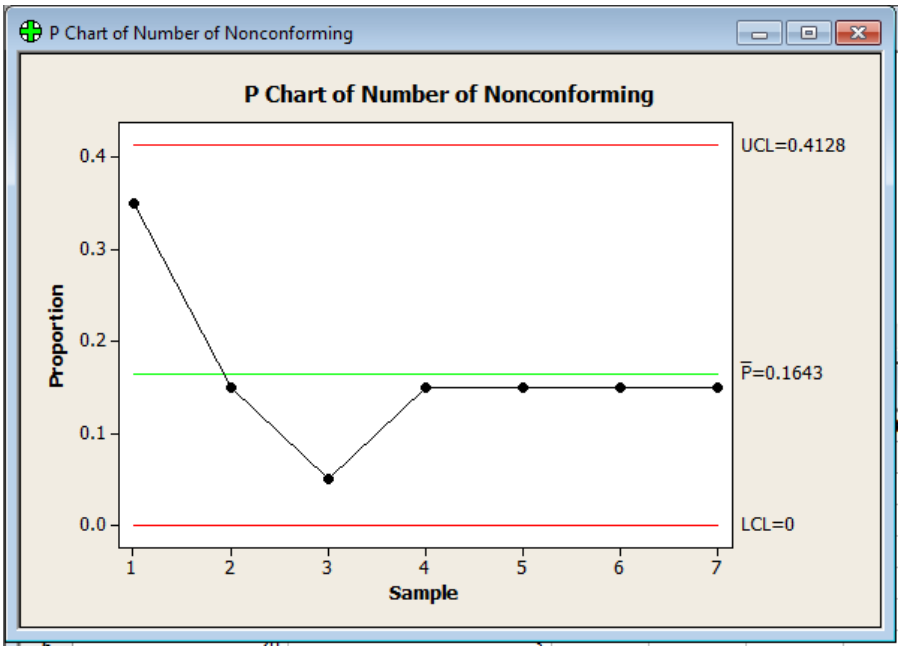


Figure 6. P Chart

Table 6. Total Number of Inspection 15

No	Sub Group	*Number of Inspection*	*Number of Nonconformittes*
1	2	15	5
2	4	15	2
3	5	15	3
4	6	15	2
5	8	15	2
6	10	15	1
7	11	15	1
8	13	15	1
9	14	15	4
10	17	15	1
11	19	15	4
	Total	**165**	**26**

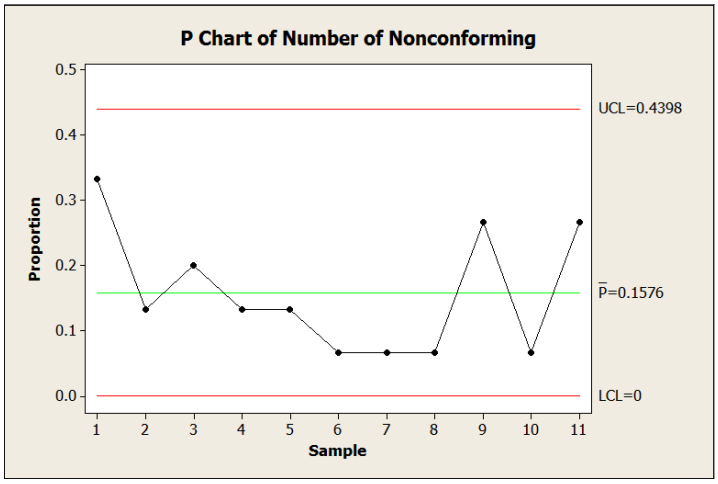


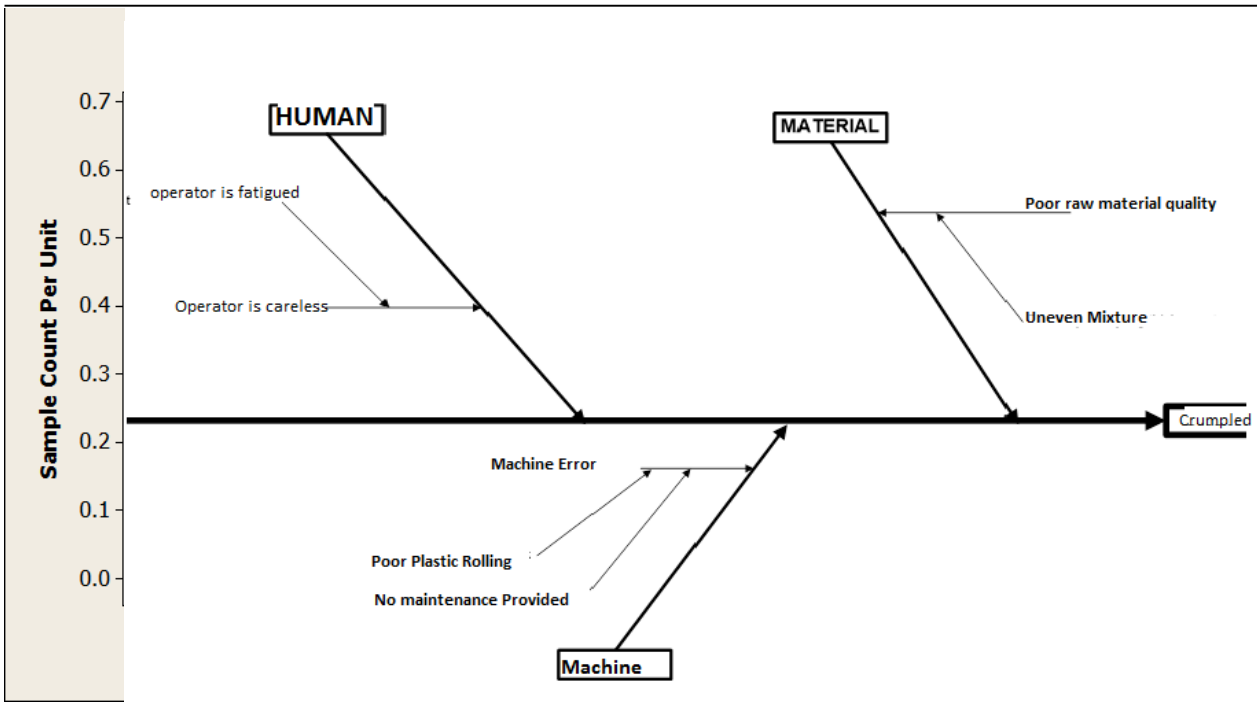
Figure 7. P Chart

Table 7. Total Number of Inspection 20

No	Sub Group	*Number of Inspection*	*Number of Nonconformittes*
1	1	20	11
2	3	20	5
3	7	20	2
4	15	20	8
5	16	20	7
6	18	20	7
7	20	20	4
Total		**140**	**44**

Table 8. Total Number of Inspection 15

No	Sub Group	*Number of Inspection*	*Number of Nonconforming*
1	2	15	5
2	4	15	2
3	5	15	3
4	6	15	2
5	8	15	2
6	10	15	1
7	11	15	1
8	13	15	1
9	14	15	4
10	17	15	1
11	19	15	4
Total		**165**	**26**



Figure

9. U chart

Table 9. Tabel *Why-Why*

Why	*Why*	*Why*	*Why*	*Why*
Defects	**Crumpled**	**Human**	Operator is careless	Operator experience Fatigue
		Material	Raw Material in poor quality	Uneven Mixture
		Machine	Machine error	No maintenance provided and Poor Plastic Rolls
Defects	**Ripped**	**Human**	Operator is careless	The operator is fatigued and error in cutting process
		Material	Poor Material Mixture	Uneven Mixture
		Machine	Machine error	No

Figure 10. *Fish Bone Diagram* of crumpled

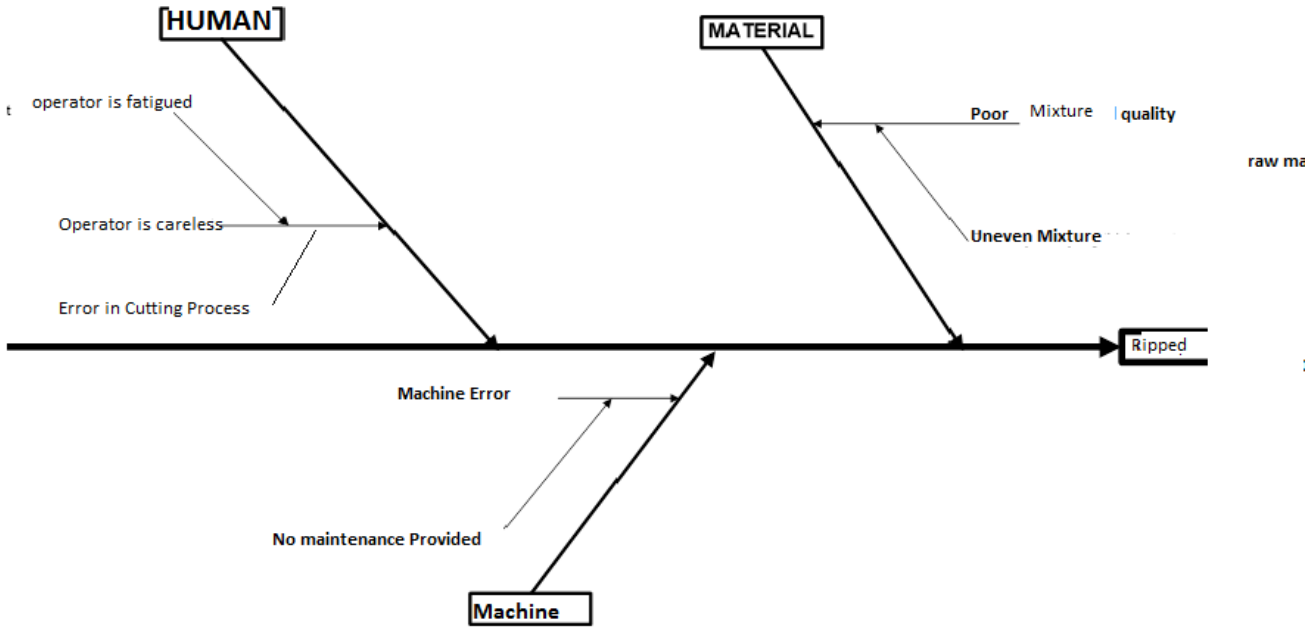


Figure 11. ***Fish Bone Diagram of ripped***

Table 10. Repairing with 5W+1H method

What	*Where*	*Why*	*Who*	*When*	*How*
Fixing working methods	is performed in production floor	To get the production results in accordance with the specifications	Head of Producti on	Performed in two weeks	Supervising less productive stations
Fixing Production Process	Performed in production floor	To reduce the number of defective products	Head of Producti on	Once in one period	Performing inspection on Production Process
Supervisin g Operator	Performed on production floor	To reduce errors committed by operator	Head of Producti on	During Production Process	Performing supervision on operator at work