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Analysis of Quality Control of 800ml Lubricant Bottle Leaks with Seven Tools Method at PT. EFG

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Abstrak

Abstract

PT EFG is a lubricant company that maintains customer satisfaction by producing quality products, starting from supply of raw materials, production process until final product. Company tries to minimize damage, but there are still many leaking products and not according to standards. This study aims to control quality using seven tools method to reduce leaking bottles of 800ml size, from January-October 2022, the biggest is fish eyes. The highest amount of damage occurred in June at 0.0039%, exceeding the maximum damage limit of 0.003%. Improvements are divided by external and internal. External, from the supplier are cleaning the mold cavity, cleaning remaining material on the mold, and maintaining the cleanliness of plastic seeds. Suppliers ensure the leak tester are detected and not sent to PT EFG. Internal, are carried out by improving the leak detection of the led light table machine and changing the random sampling method when material incoming from suppliers.

Kata kunci:
Pengendalian Kualitas;
Seven Tools;
Produksi;
Kebocoran

Abstrak

PT. EFG merupakan perusahan pelumas yang menjaga kepuasan pelanggan dengan menghasilkan produk berkualitas, dimulai dari penyediaan bahan baku, proses produksi sampai produk akhir. Perusahaan berusaha meminimalisir kerusakan, tetapi aktualnya masih banyak ditemukan produk bocor dan tidak sesuai standar. Penelitian ini bertujuan mengendalikan kualitas menggunakan metode seven tools untuk mengurangi botol bocor ukuran 800ml. Data bulan Januari-Oktober 2022, penyebab botol bocor terbesar adalah bocor mata ikan. Jumlah kerusakan tertinggi terjadi pada bulan Juni sebesar 0,0039%, melebihi batas maksimal kerusakan 0,003%. Perbaikan terdiri dari perbaikan eksternal dan internal. Perbaikan eksternal dari pemasok yaitu cleaning mold cavity, membersihkan sisa material pada mold, dan menjaga kebersihan biji plastik. Pemasok memastikan kerja mesin leak tester agar botol bocor terdeteksi dan tidak terkirim ke PT. EFG. Perbaikan internal yaitu perbaikan alat deteksi kebocoran mesin led light table berupa penambahan cahaya dan perubahan metode sampling saat material masuk dari pemasok.

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1. INTRODUCTION

The rapid development of the industry has an impact on increasingly fierce business competition as well. Various efforts are made by business actors or companies to be the best. Rational consumers always see the quality and specifications of the product according to their needs and desires, with advances in information technology, consumers very easily find comparisons of similar products to be purchased (Yovita et al., 2019). This competition occurs in almost all fields of business, including companies that produce lubricants.

Indonesia is a developing country that requires a large volume of lubricants. Based on 2020 data from the Ministry of Industry, domestic lubricant demand is 1.14 million kilo litres per year. Domestically produced lubricants amounted to 908,360 kilo litres, for automotive needs of nearly 781 thousand kilo litres more while for industrial lubricants of 127,000 kilo litres per year. The Ministry of Industry continues to suppress lubricant imports by spurring investment in the country, this encourages the growth of lubricant producers(Kementerian Perindustrian Republik Indonesia, 2020).

The increasingly fierce competition for lubricant producers encourages PT EFG to always carry out quality control from raw materials to finished goods. Based on defect data in 2022, the highest number of leaking products occurred in June as many as 81 bottles or 0.0039% compared to the total production, and has exceeded the established leakage tolerance limit of a maximum of 0.003%. This research will focus on the quality control process with the seven tools quality tool method to analyse the causes of leakage of 800 ml bottles. In various previous studies, the seven tools quality tool method has proven to be able to find the root cause of the problem and reduce the amount of bottle damage by an average of 0.001 per cent each month.

2. METHODS

Data collection techniques are divided into two, namely field research and literature study. Field research is carried out by means of interviews, observation and documentation. Literature study is conducting research by reading and studying literature that has to do with quality control (Dartawan, 2023). The next method is data analysis, which is part of the data testing process whose results are used as sufficient evidence to draw research conclusions. To assist in conducting data analysis, statistical tools are needed that support the PDCA method and one of them is the Quality seven tools or better known as the seven quality tools (Dahda, 2023).

A. Definition of Quality

According to (Eriandani, Pudjolaksono, 2018) "The quality of goods and services is defined as the overall combination of characteristics of goods and services according to marketing, engineering, production, and maintenance which makes the goods and services used meet the expectations of customers or consumers. Quality is something that is decided by the customer. This means that quality is based on the actual experience of customers or consumers of goods or services measured against certain requirements or attributes. Meanwhile, quality is one of the important indicators for companies to be able to exist in the midst of intense competition in the industry. Quality is defined as the totality of the characteristics of a product that support the ability to satisfy specified or specified needs (Apriliana & Sukaris, 2022). In the vocabulary of ISO 8402 and of the Indonesian National Standard (SNI 19-8402-1991), quality is the overall characteristics of a product or service whose ability to satisfy needs, whether explicitly or obliquely stated. The term requirement is interpreted as a specification stated in the contract or criteria that must be defined in advance (Syarifah Nazia et al., 2023).

B. Definition of Quality Control

Controlling the level of product damage can be done by implementing good quality control where this technique is one of the techniques that need to be carried out starting from before the production process runs, during the production process, until the production process ends by producing the final product (Laili & Kurniawan, 2023). For this reason, it is necessary to prevent products that do not meet predetermined quality standards and not to improve the quality of products that have been completed in production. Thus, quality control activities in addition to finding errors, damage and non-conformity of a product or process, can also find the causes of errors which then provide solutions or alternative solutions to problems that arise. And also serves to inspect finished goods that are adjusted to the specifications and quality that has been set (Sari et al., 2022). The purpose of quality control is so that the goods produced can achieve the quality standards that have been set (Mulyono & Jefva Septio, 2022). In addition, it is used to maintain and direct product quality so that quality can be maintained as planned or in other words so that product quality can reach predetermined standards, so that action can be taken to prevent and make improvements with the aim of avoiding the same mistakes from

recurring. The ultimate goal of quality control is to provide satisfaction to consumers or customers according to their needs (Syarifah Nazia et al., 2023).

C. Seven Tools of Quality

Seven Tools are 7 (seven) basic tools used to solve problems faced by production, especially on problems related to quality (Quality). The 7 (seven) basic QC tools were first introduced by Kaoru Ishikawa in 1968. The seven tools are check sheets, pareto diagrams, histograms, stratification, control charts, scatter diagrams, and fishbone diagrams (Palupi et al., 2022).

3. RESULT AND DISCUSSION

The types of defects in 800ml bottles at PT EFG are grouped into six characteristic types of defects. The following table is data on the characteristics of these defect attributes:

Table 1. Defective Attribute Characteristics of 800m Bottle

Characteristics of the damage	Description
Stress Crack	Deformation
Seam Split	Breaks in the handle or body connection
Contamination	Fish eye, scrap
Cap Leaker	Leaked at aluminium foil
Other	dented, pinched by machine, etc

From the various bottle defect data collected from the production department and the finish goods warehouse, an analysis will be carried out using the seven tools method to analyse the data and find the source of the cause of damage to 800ml packaging bottles that occur at PT EFG.

3.1 Check Sheet

Check sheets are tools that are often used in the manufacturing industry to collect data on the production process which is then processed into information and results that are useful in decision making(Dahda, 2023).

Table 2. 800ml Bottle Defect Data Check Sheet Year 2022

Month	Bottle usage (units)	Types of Defect					Total Defect	% Total Defect
		Stress Crack	Seam Split	Contamination	Cap Leaker	Other		
January	1.653.278	-	-	38	-	-	38	0,0023
February	1.739.383	4	-	34	-	5	43	0,0025
March	1.657.108	4	1	44	-	-	49	0,0030
April	1.954.067	5	-	52	-	-	57	0,0029
May	1.622.062	3	-	37	-	-	40	0,0025
June	2.072.536	-	-	76	-	5	81	0,0039
July	1.312.632	-	-	32	-	6	38	0,0029
August	1.131.192	-	-	33	-	-	33	0,0029
September	2.034.808	-	-	49	-	7	56	0,0028
October	1.846.205	-	-	33	-	8	41	0,0022
Total	16.841.831	16	1	428	0	31	476	

Source: PT. EFG

The most defects occurred in June, which was 0.0039 per cent. Defects in June have exceeded the maximum tolerance limit set by the company which is 0.003 per cent of the total bottle usage.

3.2 Pareto Diagram

A Pareto diagram is a bar graph that shows problems in order of the number of occurrences. The order starts from the number of problems that occur the most to the least (Mulyono & Jefva Septio, 2022).

Table 3. Categories and Frequency of 800ml Bottle Defects

Characteristic Attributes	Types of defect	Number of defect	Defect Accumulate	% number of Defect	% Defect Accumulate
Contamination	Fish Eye	325	325	68	68
	Hole	33	358	7	75
	Clefts	25	383	5	80
	Folds	23	406	5	85
	Scrap	22	428	5	90
Stress Crack	Severe dents	16	444	3	93
Seam Split	Joint ruptures	1	445	0	93
Cap Leaker	Cap Leaker	0	445	0	93
Others	Others	31	476	7	100

Sumber: PT. EFG

The table above is then visualised into a Pareto diagram. It appears that the most frequent defect type frequency is the defect type with contamination attribute characteristics with fish eye problem items.

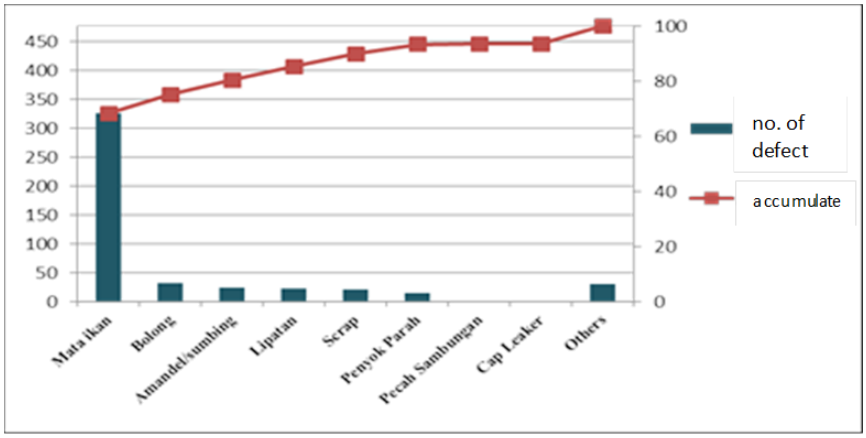

Figure 1. Pareto diagram of defect type

3.3 Stratification

Stratification is an attempt to break down or classify problems into smaller groups or similar groups (Laili & Kurniawan, 2023).

Table 4. Stratification of 800ml Bottle Leaks

Types of defect	No. of defect	% of defect	% of defect accumulate
Fish Eye	325	76	76
Hole	33	8	84
Severe	25	6	89
Folds	23	5	95
Scrap	22	5	100
Total	428	100	100

Source: PT. EFG

The 800ml bottle is stratified into five defect types which possess contamination attribute characteristics.

3.4 Histogram Diagram

A histogram is a graphical display to visually show the distribution of data or how often different values occur in a data set (Laili & Kurniawan, 2023).

Table 5. Defect Data of Contamination Sub-Attribute

Month	Scrap	Hole	Fish Eye	Folds	Severe	Total
January	-	3	32	-	3	38
February	-	2	29	3	-	34
March	5	2	30	3	4	44
April	2	3	41	2	4	52
May	1	4	26	3	2	37
June	2	2	64	5	3	76
July	3	3	21	1	4	32
August	2	5	23	1	2	33
September	4	3	36	3	3	49
October	3	5	23	2	-	33
Total	**22**	**33**	**325**	**23**	**25**	**428**

Source: PT. EFG

Table 4 is then actualised into a histogram diagram to make it easier to read the data.

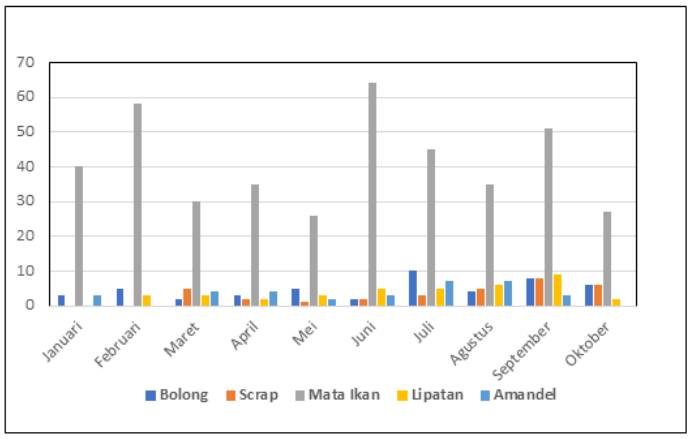

Figure 2. Histogram of Contamination Sub-Attribute Damage

In Figure 3. above, it is clear that the most frequent type of leak is the fish-eye leak type and with the highest amount of damage in each month.

3.5 Control Chart

Control chart or control map is a tool that is graphically used to monitor and evaluate whether a process activity is in statistical quality control or not so that it can solve problems and produce quality improvements (Dahda, 2023). The calculations used to find the average number of defects or p-bar, percentage of defects (p), Upper Centre Limit (UCL), and Lower Centre Limit (LCL) are as follows(Dahda, 2023).

a. Calculating the p-bar:

$$\bar{p} = \frac{\sum np}{\sum n} = \frac{Number\ of\ defect}{Number\ of\ production}$$

b. Calculate the percentage (p) of the number of defects:

$$p = \frac{np}{n}$$

c. Calculate Upper Center Limit (UCL):

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

d. Calculate Lower Center Limit (UCL):

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

The results of calculating the p-chart control map from January to October 2022 are shown in the table below.

Table 6. P-chart Control Map Calculation

Month	Bottle usage (units)	No. of defect	% defect	$\bar{P}$	UCL	LCL
January	1.653.278	38	0,000023	0,000028	0,000040	0,000016
February	1.739.383	43	0,000025	0,000028	0,000040	0,000016
March	1.657.108	49	0,000030	0,000028	0,000040	0,000016
April	1.954.067	57	0,000029	0,000028	0,000039	0,000017
May	1.622.062	40	0,000025	0,000028	0,000040	0,000016
June	2.072.536	81	0,000039	0,000028	0,000039	0,000017
July	1.312.632	38	0,000029	0,000028	0,000042	0,000014
August	1.131.192	33	0,000029	0,000028	0,000043	0,000013
September	2.034.808	56	0,000028	0,000028	0,000039	0,000017
Octoberr	1.846.205	41	0,000022	0,000028	0,000040	0,000016
Total	16.841.831	476				

Source: PT. EFG

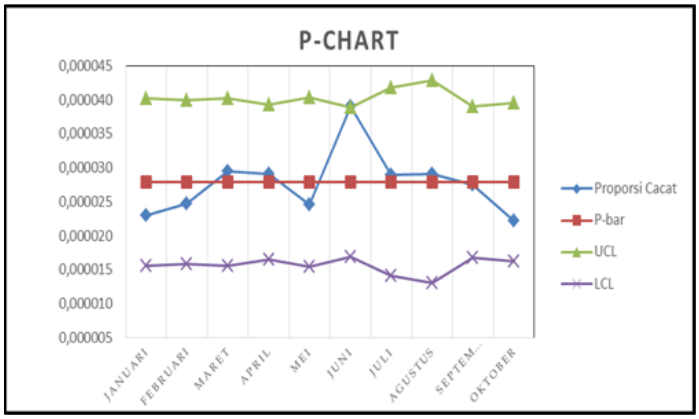

Figure 3. P-Chart of expected Bottle Damage

From the control map, it can be seen that in June the number of defects is outside the control limits, so it is necessary to make corrections / improvements as a standard for the future, so the results are as shown below, namely by eliminating the number of defects in June.

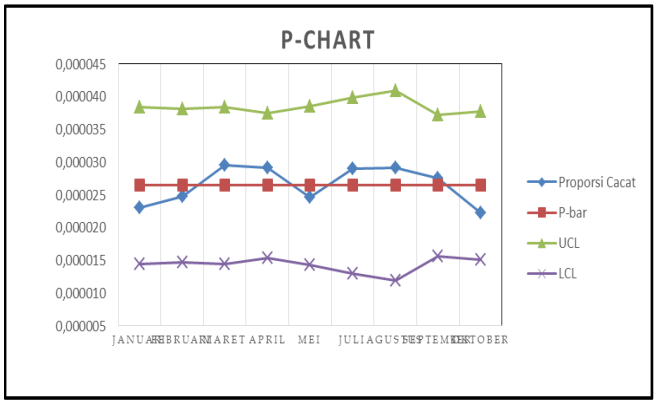

Figure 4. P-Chart of expected Bottle Damage

In addition, a control map of the incoming bottle inspection in June was made to determine whether or not the bottle leak control process or leak test performed by PT.EFG was still within the required limits. Below are the data during the check carried out by the Quality Control Operator at the time of incoming 800ml bottles using a Leak Tester / Led Light Table machine, which is a glass table in which 18 watts x 4 LED lights are installed.

Table 7. Leak Tester Incoming Data

No	Bottle usage (units)	No of. ANSI sampling	No. of defect	% defect	$\bar{P}$	UCL	LCL
1	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
2	36.000	500	1	0,0020	0,0012	0,0059	-0,0035
3	34.000	315	0	0,0000	0,0012	0,0071	-0,0047
4	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
5	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
6	36.000	500	1	0,0020	0,0012	0,0059	-0,0035
7	34.000	315	3	0,0095	0,0012	0,0071	-0,0047
8	36.000	500	1	0,0020	0,0012	0,0059	-0,0035
9	34.000	315	1	0,0032	0,0012	0,0059	-0,0047
10	36.000	500	0	0,0000	0,0012	0,0071	-0,0035
11	36.000	500	1	0,0020	0,0012	0,0059	-0,0035
12	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
13	36.000	500	1	0,0020	0,0012	0,0059	-0,0035
14	35.000	500	2	0,0040	0,0012	0,0059	-0,0035
15	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
16	36.000	500	1	0,0020	0,0012	0,0059	-0,0035
17	35.000	500	1	0,0020	0,0012	0,0059	-0,0035
18	36.000	500	1	0,0020	0,0012	0,0059	-0,0035
19	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
20	34.000	315	0	0,0000	0,0012	0,0071	-0,0047
21	34.000	315	3	0,0095	0,0012	0,0071	-0,0047
22	36.000	500	1	0,0020	0,0012	0,0059	-0,0035
23	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
24	34.000	315	0	0,0000	0,0012	0,0071	-0,0047
25	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
26	36.000	500	1	0,0020	0,0012	0,0059	-0,0035
27	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
28	36.000	500	0	0,0000	0,0012	0,0059	-0,0035
29	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
30	36.000	500	1	0,0020	0,0012	0,0059	-0,0035
31	36.000	500	4	0,0080	0,0012	0,0059	-0,0035
32	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
33	36.000	500	1	0,0020	0,0012	0,0059	-0,0035
34	35.000	500	1	0,0020	0,0012	0,0059	-0,0035
35	34.000	315	0	0,0000	0,0012	0,0071	-0,0047
36	36.000	500	1	0,0020	0,0012	0,0059	-0,0035
37	35.000	500	1	0,0020	0,0012	0,0059	-0,0035
38	36.000	500	0	0,0000	0,0012	0,0059	-0,0035
39	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
40	34.000	315	1	0,0032	0,0012	0,0071	-0,0047
Total	1.396.000	34.000	41				

Source: PT. EFG

The control diagram of the above calculation data is shown in the following figure.

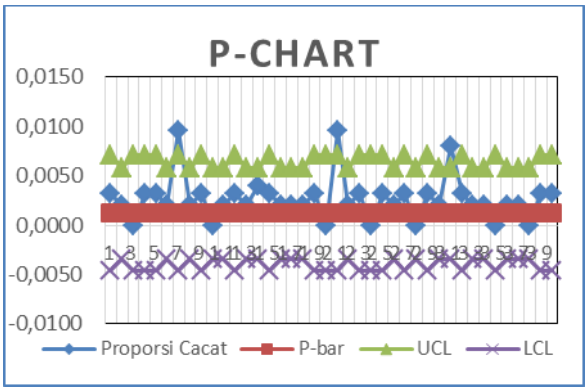

Figure 5. Incoming Leak Test P-Chart Current condition

From the diagram above, it is necessary to make corrections / improvements by eliminating samples that are out of control, this needs to be done so that it can be used as a reference in the next control process.

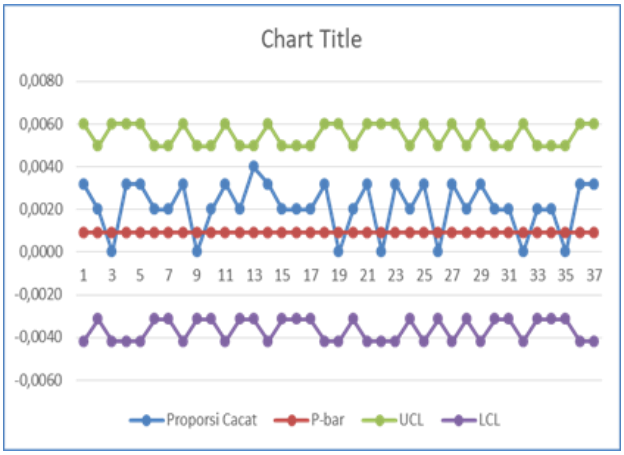

Figure 6. Incoming Leak Test P-Chart Expected condition

3.6 Scatter Diagram

A scatter diagram is a graph that displays the relationship between two variables whether the relationship between the two variables is strong or not and determines the type of relationship (Susetyo et al., 2019). The scatterplot is used in this research to determine the correlation between variables. The variable on the X axis is the number of defects from January to October 2022 and the variable on the Y axis is the amount of production. The scatterplot can be displayed as shown in the following figure.

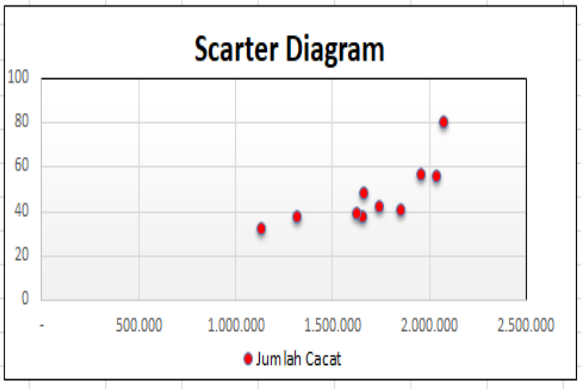

Figure 7. Scatter Diagram of 800ml bottle damage

3.7 Fishbone Diagram

A cause-and-effect diagram is a tool used to identify and show the relationship between cause and effect in order to find the root cause of a problem, because it looks like a fishbone(Susetyo et al., 2019).

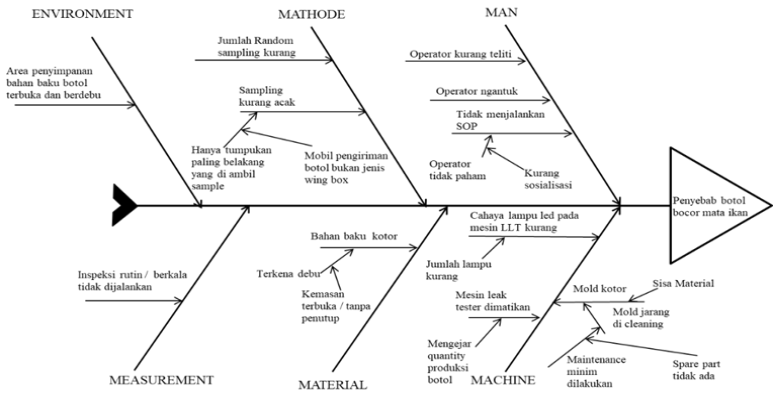

Figure 8. Fishbone Diagram of the cause and effect of damage to 800ml bottles

The following is a description of the factors that cause leakage in the form of fish eye leaks in 800ml bottles:

1) Human Factor (Man)
   Operators are less careful in checking, the final check before being packed into plastic bags is not carried out by the supplier. When checking the bottle comes, the operator or analyst does not carry out the standard operation procedure (SOP) properly and correctly.
2) Equipment Factor (Machine)
   - The led light on the leak test machine / Led Light Table is not bright enough, so the analyst cannot see the leaking fish eye on the bottle.
   - The leak tester machine at the supplier is not able to detect every bottle produced, which causes the leaking bottles to not be detected and sent to PT EFG.
   - The moulds are dirty due to infrequent cleaning, leftover material, minimal maintenance, and unavailability of spare parts. This causes the bottles to be moulded in less than perfect condition and leak fish eyes.
3) Method factor
   Sampling is less random, only the rearmost pile in the car body is taken for the sample. The amount of random sampling is also not much so that there are still defective bottles that escape.
4) Material Factors
   Raw materials are dirty and dusty. Caused by open packaging so that it is easily mixed with dust and dirt.
5) Environment Factor
   The raw material storage warehouse area at the supplier is open and dusty.
6) Measurement Factor
   Regular and periodic inspection of the quality of the bottles

From the improvement steps taken, it was possible to reduce the number of bottle leaks with the characteristics of the fish eye type subattribute. The results of the reduction in the number of bottle leaks are shown in the table below.

Table 8. Comparison of Leakage before and after analysis with Seven Tools

Month	Usage bottle (units)		No. of bottle defect		% of bottle defect		balance
	2022	2023	2022	2023	2022	2023	
January	1.653.278	1.834.372	38	34	0,0023	0,0019	-0,0004
February	1.739.383	1.439.837	34	14	0,0020	0,0010	-0,0010
March	1.657.108	2.490.399	44	15	0,0027	0,0006	-0,0021
April	1.954.067	1.367.292	52	32	0,0027	0,0023	-0,0003
May	1.622.062	1.539.728	37	18	0,0023	0,0012	-0,0011
June	2.072.536	1.415.095	76	37	0,0037	0,0026	-0,0011
July	1.312.632	1.078.960	32	18	0,0024	0,0017	-0,0008
Total	12.011.066	11.165.683	31.3	168			

Source: PT. EFG

A comparison diagram of leakage before and after the implementation of the Seven Tools method is shown in the following figure.

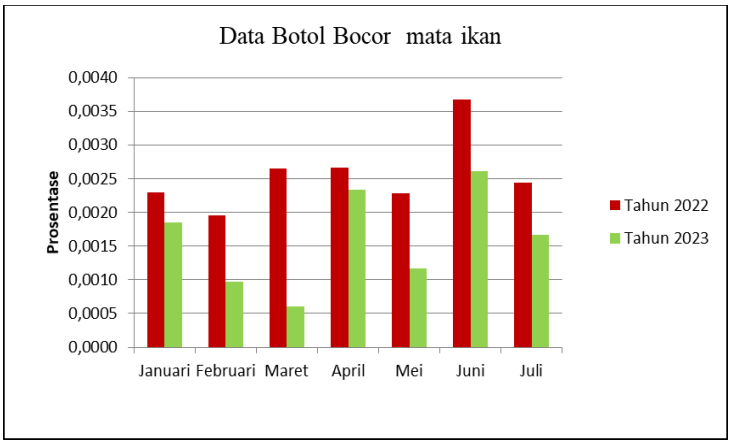

Figure 9. Comparison chart of leakage before and after implementation of Seven Tools

4. CONCLUSION

1) Common type of defect is fish eye, caused by the production process at the supplier, the mould is rarely cleaned, there is residual material from the previous product stuck to the mould, the plastic beans are dirty and dusty, the leak tester machine in the production line is damaged. The LED light table machine, which is used to check for leaks on entry, was unable to detect fish eye defects due to insufficient lighting.
2) It is necessary to increase the light on the LED light table, discuss with the supplier to jointly determine the improvement steps.

5. ACKNOWLEDGMENTS (Optional)

This research can be carried out well with the help of various parties, for which the researcher would like to thank the Research and Management Centre (RMC) of Global University Jakarta and PT EFG for their good cooperation in this research.

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