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Defect Analysis of Packaging Bottle Products Using Six Sigma and Kaizen Methods at PT. XYZ

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A B S T R A C T

PT XYZ is a company engaged in manufacturing plastic packaging. The company produces various forms of packaging, one of which is cosmetic bottle packaging. Meanwhile, based on the problems of the production process, various types of product defects such as black spots, leaks, and oil dirt are often found. The company produces the most defective products in 30ml cosmetic bottle products, with a percentage of 3% to 4% of the total production. Based on the above problems, this study aims to determine the level of defects and the sigma value of product quality. In addition, provide suggestions for improvement to reduce the level of product defects at PT XYZ. The methods used are Six sigma and Kaizen. The Six Sigma stages include define, measure, analyze, and improve. The improve stage is assisted by the Kaizen Five M Checklist and Kaizen Five Step Plan. The improve stage is assisted by the Kaizen Five M Checklist and Kaizen Five Step Plan. Based on the results of research with the six sigma method, the percentage of black spot defects is 74%, leaking is 14.1%, and dirty oil is 11.9%. the proposed improvements given are providing 5S training and SOP refreshment, sorting reject products before grinding, cleaning the machine and production area at the end of each shift, replacing blowpin threads and bolts, and others.

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1. INTRODUCTION

Competition in the business world and companies can be influenced by the level of productivity, price, and quality of the products produced. Only companies that have high enough competitiveness are able to survive in their business to increase profits. In order to maintain the consistency of product quality in accordance with the demands of market needs, it is necessary to analyze the quality of the products produced (Rumampuk & Yuliawati, 2019). An adequate level of product quality is one way to attract buyers to use the products that have been offered by each company or industry (Rofieq and Septiari, 2021). According to Mulia and Rochmuljati (2021), quality is a quantity used in making judgments, good or bad of a product or service in meeting

consumer needs (Rohkma and Aryanny, 2023). Quality is one of the components that functions as capital and a tough tool for every industry so that it can survive and be superior to compete in every era (Indrawansyah and Cahyana, 2019). In 2018, the Ministry of Industry (Ministry of Industry of the Republic of Indonesia) noted that the number of industries engaged in plastic packaging reached 925 companies with a workforce of 37,327 and a total production of 4.68 million tons. One of the companies engaged in the industry is PT. XYZ.

PT XYZ is a company engaged in manufacturing plastic packaging. The company produces various forms of packaging, one of which is cosmetic bottle packaging. The company is committed to becoming a leading plastic company by providing the best service to customers and interested parties. So that the company's products must have high quality. However, this company has obstacles in realizing this desire. The phenomenon that occurs at PT XYZ, in the production process is often found various types of product defects such as black spots, leaks, and dirty oil. The company produces the most defective products in 30ml cosmetic bottle products, with a percentage of 3% to 4% of the total production. Based on the above problems, this study aims to determine the level of defects and the sigma value of product quality. In addition, provide suggestions for improvement to reduce the level of product defects at PT XYZ. In dealing with these problems, it is not enough just to analyze the factors that cause defects without continuous improvement. So a quality control tool is needed to reduce the number of product defects and towards zero defects. The methods proposed by the researcher are Six Sigma and Kaizen.

Six sigma is a quality improvement tool based on the use of data and statistics. The basic principle of Six Sigma is to improve product quality by improving the process, so that the process carried out can produce good products and can satisfy consumers (Soemahadiwidjojo, 2017). Kaizen is a method that means "continuous improvement" which comes from Japanese. The application of Kaizen in the company is continuous improvement by involving all employees, from the top level of management, to the lower level. Kaizen has a function to improve space utilization, product quality, production capacity, and others (Bukhori and Assidiqi, 2020). The Six Sigma and Kaizen methods were used in the study Hairiyah et al., (2020). In the study, the Six Sigma and Kaizen methods were able to increase the sigma value in the plastic castok production process from 3.4 sigma to 3.8 sigma. Likewise, research conducted by Rumampuk and Yuliawati (2019), Six Sigma and Kaizen methods were able to increase the sigma value of bread products from 2.24 to 2.38 sigma. Based on the results of the two studies, it shows positive changes using the Six Sigma and Kaizen methods, so it is hoped that the Six Sigma and Kaizen methods can provide suggestions for improvements that can reduce the percentage of defects at PT XYZ.

2. LITERATURE REVIEW

Quality is the overall characteristic of an item that can support its ability to provide satisfaction of predetermined needs. So quality focuses on the ability to produce a good item at a competitive price, besides that quality is able to correct defects in the products produced (Effendi, 2021). According to Amrina et al (2020), Quality is one of the characteristics of a good or service that must be achieved by a company by making continuous improvements, because this will be taken into consideration by consumers. So, every company must always review the quality level of the products and services it produces (Fathurohman et al., 2023). Quality is an important component in every process, here is the importance of quality for companies: (1) Good reputation of the company. Quality is a perspective on new goods produced by a company, worker activities, and relationships with suppliers. (2) Product capability. Groups, organizations, or companies that create products that can cause damage or accidents will be punished by the court. So that the products produced must be ensured to have sufficient reliability. (3) Global involvement. Quality is a matter of international concern. Goods and services that compete internationally must meet global expectations for quality, design, and price (Rochmah, 2022). Quality control is one of the activities of verifying the products produced to ensure that the results

obtained by a business unit meet or match expectations, and conduct a review if the results obtained do not match or do not meet the desired. This is done to maintain the best possible quality stability (Supardi and Dharmanto, 2020). Quality control is a way that companies must do to maintain the quality of the goods or services they produce, so that they can satisfy consumers. Quality control is divided into three types, namely raw material quality control, process quality control, and final product quality control. The three types of quality control are closely related and support each other (Wirawati, 2019).

The Six Sigma approach is used to identify matters related to error resolution and product rework that can cost money, time, reduce revenue, and lose consumer confidence. For companies that produce physical products, the results of implementing six sigma are able to reduce production defects in improving the quality of the benefits of using six sigma, namely increasing effectiveness, process efficiency, company profits, and reducing costs incurred, encouraging employee initiatives to actively participate in contributing to the company, increasing understanding related to customers, what factors affect customer satisfaction. (Soemahadiwidjojo, 2017). In the six sigma method there are two types of cycles, namely DMAIC and DMADV. **DMAIC.** This cycle consists of 5 stages, namely, define, measure, analyze, improve, and control. (i) Define, is the first stage used to identify problems. In addition, this stage is a planning step in improving quality from one process to the next. (ii) Measure, is the second stage by determining CTQ, collecting and processing data. (iii) Analyze, is the third stage that carries out the process of analyzing and examining each production activity and the data that has been obtained. (iv) Improve, is the fourth stage as a step in formulating improvement proposals used to solve quality problems that occur. (v) Control, is the last stage by doing or implementing the proposed improvements that have been made previously. At this stage control is carried out, to determine the success rate of improvement (Yuswandi et al., 2021).

DMADV. This cycle consists of five stages: define, measure, analyze, design, and verify. This cycle is used to create items that did not exist before, or items that are still in the existing process that have been tried to be optimized and still do not meet the desired goals (Soemahadiwidjojo, 2017)

According to Krishnan and Prasath (2013), the Six Sigma method is a statistically relevant modified scale for a process. The method has an accuracy of up to 99.9997 percent. Six Sigma is a method used to improve the entire process that is the main problem. Six Sigma is intended as a quality "toolbox" and management tool to solve problems that focus on various continuous improvement activities (Utomo, 2020). According to Gupta et al., (2018), Six Sigma which has 5 stages namely define, measure, analyze, improve, and control or commonly referred to as DMAIC, is one approach that is able to direct various industries or companies to focus more on the process of developing products and services produced appropriately. Six Sigma is able to identify and eliminate product defects that cannot meet consumer needs, which affect system performance (Herlambang, 2020). Kaizen is a method that means "continuous improvement" which comes from Japanese. The kaizen principle assumes that life should make continuous improvement efforts. Kaizen has a function to improve space utilization, product quality, production capacity, and others (Bukhori & Assidiqi, 2020). Kaizen is a work culture. Kaizen has become one of the working cultures that originated in Japan, so this method can be used as a step for continuous improvement. The focus of kaizen is not on how it is managed, but on the processes used to promote sustainable improvement (Syahputra & Aisyah, 2022).

In its application, Kaizen has several tools such as kaizen five step plan and kaizen five m checklist. Kaizen five step plan is one of the efforts in improving work culture with predetermined SOPs. The 5S concept with kaizen seeks to humanize work by eliminating non-valuable activities, thus making the job easier and employees more productive. Kaizen five m checklist is a tool used to identify problems so that it can describe opportunities and improvements using a checklist with a 5-factor approach, namely man, machine, material, methods, and environment (Hasan et

al., 2023). The Six Sigma and Kaizen methods were used in the study Hairiyah et al., (2020). In the study, the six sigma and kaizen methods were able to increase the sigma value in the plastic castok production process from 3.4 sigma to 3.8 sigma. Likewise, research conducted by Rumampuk and Yuliawati (2019), six sigma and kaizen methods were able to increase the sigma value of bread products from 2.24 to 2.38 sigma.

3. RESEARCH METHOD

This research, in solving its problems with the six sigma and kaizen methods, uses the following steps (Figure 1). This research was conducted at PT.XYZ. This research begins with a field survey, then formulates the problems and research objectives. After that, data collection is carried out, including data on the amount of production, data on the type and amount of product defects. The first step is the define stage, at this stage the identification of the object and the objectives to be achieved is carried out. In this study, the object of research is focused on 30ml cosmetic bottles. The second step is the measure stage, at this stage determining Critical to Quality (CTQ), control charts, and calculating DPO, DPMO, and Sigma values. The third step is the analyze stage, at this stage the analysis of the previously calculated data is carried out and analyzes the root cause of the problem using a fishbone diagram. The fourth step is the improve stage, at this stage an improvement analysis is carried out using the Kaizen five m checklist and the Kaizen Five Step Plan. In this study, the control stage was not carried out because the improvement stage was only limited to improvement recommendation.

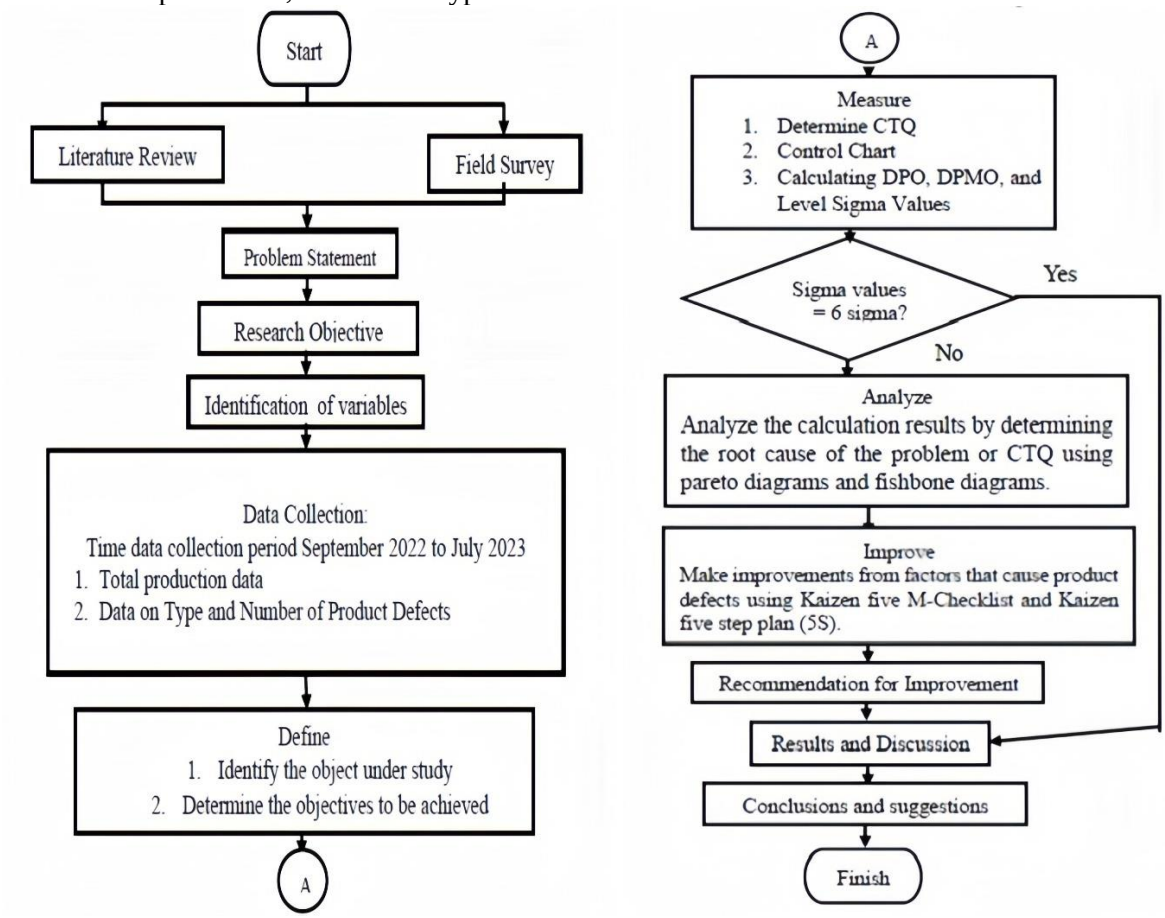

Figure 1. Problem solving flow chart

4. RESULT AND DISCUSSION

4.1. Define Stage

The problem faced by the company is the large number of defective products produced. The company produces the most defective products in 30ml cosmetic bottle products, so the object

of this research will be focused on these products. Based on the identification of the research object, the objectives that the researcher wants to achieve are to determine the level of defects and the sigma value of product quality and to provide suggestions for improvements that the company can consider to improve the level of product defects.

4.2. Measure Stage

At this stage, the data used can be seen in Table 1.

Table 1. Production data, types and number of product defects from September 2022 to July 2022

No	Month	Product Defect Type			Total defect	Total prod.
		Black spot	Leaking	Dirty oil		
1	Sep-22	24.605	6.308	5.320	36.233	1.398.600
2	Okt-22	62.431	1.550	2.284	66.265	2.279.717
3	Nov-22	15.206	5.179	1.592	21.977	1.340.929
4	Dec-22	20.818	7.270	5.606	33.694	1.138.050
5	Jan-23	26.196	1.930	8.107	36.233	1.019.750
6	Feb-23	34.205	8.218	7.242	49.665	2.288.350
7	Mar-23	39.935	6.160	1.480	47.575	1.571.240
8	Apr-23	38.277	5.635	3.410	47.322	1.440.660
9	May-23	25.085	4.609	5.298	34.992	1.299.700
10	Jun-23	16.913	6.735	6.008	29.656	1.162.400
11	Jul-23	19.294	7.826	5.415	32.535	1.275.000
Total		**322.965**	**61.420**	**51.762**	**436.147**	**16.214.369**

a. Determine Critical to Quality

1. Black spots

Black spot defects are defects that are usually found on the surface of the bottle.

2. Leaking

Leaking defects are defects that are often found in bottle products when the product leak testing process is carried out.

3. Dirty Oil

Dirty oil defects are defects characterized by dirty or oil stains on the surface of bottled products.

b. Control chart

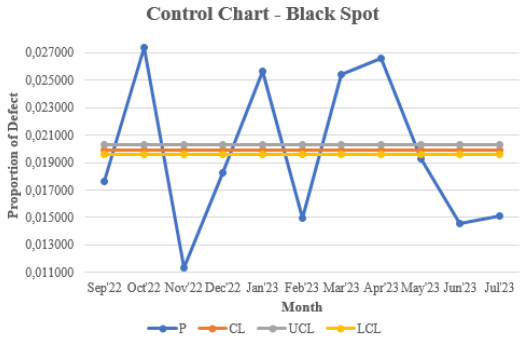

Figure 2. Control chart black spot
Source: data processing

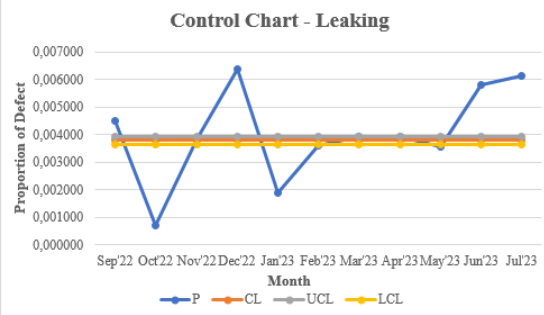

Figure 3. Control chart leaking
Source: data processing

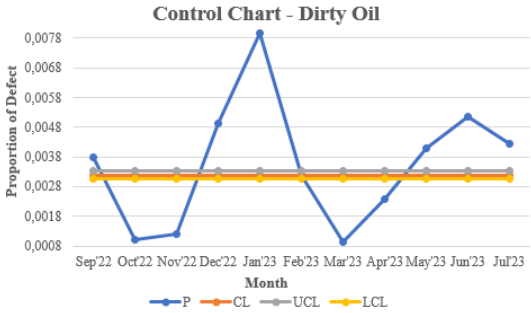

Figure 4. Control chart dirty oil
Source: data processing

Based on Figure 1, 2 and 3, it can be seen that there are still many data that are on the control limit. This shows that there are types of defects that are outside the control limits, so it is necessary to conduct an analysis to determine the cause of the defects.

c. Calculating DPO, DPMO, and Sigma Values

calculation of DPO, DPMO, and Sigma values for September 2022 using the following formula:

$$\text{DPO} = \frac{total\ defect}{total\ production \times CTQ} = \frac{36.233}{1.398{,}600 \times 3} = 0{,}00863554$$

$$\text{DPMO} = DPO \times 1.000.000 = 8.635{,}54$$

$$\text{Sigma Level} = NORMSINV\left(\frac{(1.000.000 - DPMO}{1.000.000}\right) + 1{,}5 = NORMSINV\left(\frac{(1.000.000 - 8.635{,}54}{1.000.000}\right) + 1{,}5 = 3{,}88\ Sigma.$$

As for the results of the recapitulation of the calculation of DPO, DPMO, and Sigma Value can be seen in Table 2.

Table 2. Calculating DPO, DPMO, and sigma values

No	Month	Total Prod.	Total defect	ctq	DPO	DPMO	Sigma value
1	Sep-22	1,398,600	36,233	3	0.0087	8,635.54	3.88
2	Oct-22	2,279,717	66,265	3	0.0097	9,689.07	3.84
3	Nov-22	1,340,929	21,977	3	0.0055	5,463.13	4.05
4	Dec-22	1,138,050	33,694	3	0.0099	9,868.93	3.83
5	Jan-23	1,019,750	36,233	3	0.0118	11,843.75	3.76

6	Feb-23	2,288,350	49,665	3	0.0072	7,234.47	3.95
7	Mar-23	1,571,240	47,575	3	0.0101	10,092.88	3.82
8	Apr-23	1,440,660	47,322	3	0.0109	10,949.15	3.79
9	May-23	1,299,700	34,992	3	0.0090	8,974.38	3.87
10	Jun-23	1,162,400	29,656	3	0.0085	8,504.24	3.89
11	Jul-23	1,275,000	32,535	3	0.0085	8,505.88	3.89
Total		**16,214,396**	**449,517**		**0.0998**	**99,761.42**	**42.56**

Based on the data in Table 2. shows that the sigma level in September 2022 to July 2023 for 30ml cosmetic bottle products is less than 6-sigma, so proceed to the analyze stage to analyze and determine the cause of the product defect.

4.3. Analyze Stage

a. Pareto diagram

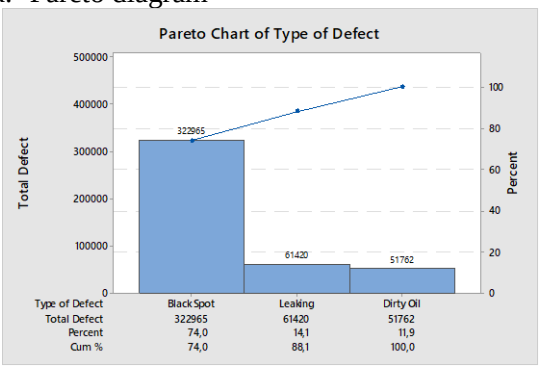

Figure 5. Pareto chart

Based on the figure above, it can be seen that the type of defect that has a dominant contribution to the decline in the quality of cosmetic bottle products is Black Spots with a percentage of (74%), followed by Leaking defects with a percentage of (14.1%), then followed by Dirty Oil defects with a percentage of (11.9%).

b. Fishbone diagram

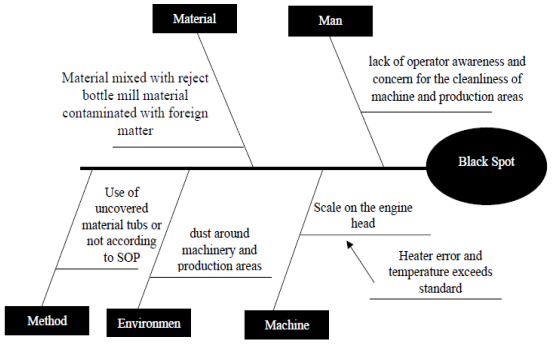

Figure 6. Fishbone diagram black spot

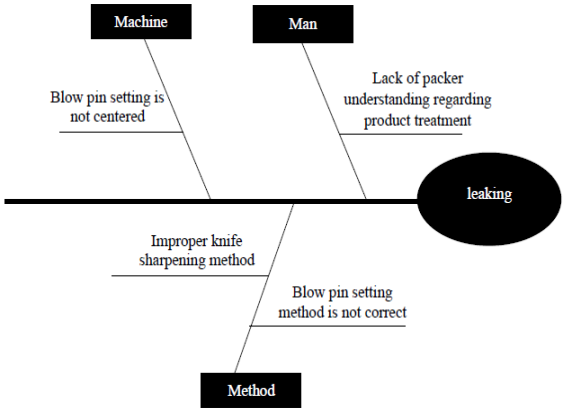

Figure 7. Fishbone diagram leaking

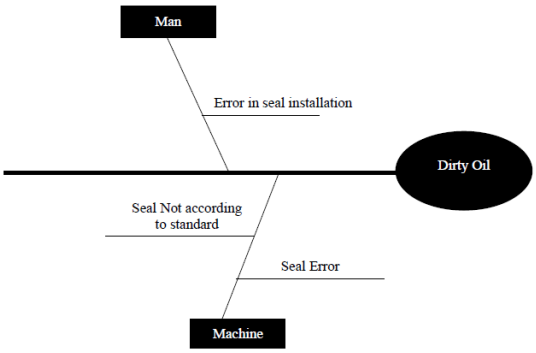

Figure 8. Fishbone diagram dirty oil

Based on Figures 6-8, the factors causing product defects can be identified. The types of product defects include black spots, leaks, and dirty oil. Black spot defects are caused by 5 factors, namely in terms of humans due to the lack of awareness and concern of operators for the cleanliness of the machine and production area, in terms of material because the material is mixed with reject bottle mill material contaminated with foreign objects, in terms of methods due to the use of material tubs that are not closed or not according to the SOP, in terms of machinery due to the presence of crust on the machine head, in terms of the environment because there is dust around the machine and production area. Leaking defects are caused by 3 factors, namely in terms of humans due to lack of understanding of packers related to product treatment, in terms of methods due to improper blowpin setting methods and improper knife sharpening methods, in terms of machines due to setting the blow pin not centered. Dirty oil defects are caused by two factors, namely in terms of humans due to errors in seal installation and in terms of machines because the seals error and not according to standard.

4.4. Improve Stage

At this stage, an analysis of proposed improvements is carried out based on the results of analyzing the causes of defects in the fishbone diagram using Kaizen.

a. Kaizen Five M Checklist

Based on the results of the fishbone diagram, further analysis is carried out using the Kaizen Five M checklist. This method focuses on five key factors in each process including people, methods, materials, machines and the environment. The following results of the kaizen five m checklist analysis can be seen in Table 3-5.

Table 3. Black spot defect analysis with Kaizen Five M checklist

No	Problem Factors	Root cause	Impact of the problem	Proposed improvements
1	Man	Lack of operator awareness and concern for the cleanliness of the machine and production area	Causes materials or products to be contaminated with foreign objects	Provide training related to 5S (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke)
2	Method	Use of material tanks that are not closed or not according to SOP	Materials contaminated with dust and other foreign matter	Provide a covered material bin
3	Material	Material mixed with reject bottle mill material contaminated with foreign matter	The appearance of black spots on the product produced	Sorting reject products before grinding
4	Machine	Scale on the engine head	Scale can be mixed into the melted material.	Conduct regular heater checks
5	environ ment	dust around machinery and production areas	Materials or products may be contaminated with dust	Cleaning machine and production areas at the end of each shift

Table 4. Leaking defect analysis with Kaizen Five M checklist

No	Problem Factors	Root cause	Impact of the problem	proposed improvements
1	Man	lack of packer understanding regarding product treatment	Product treatment by packer is not perfect	1. Provide SOP refreshment. 2. Supervise workers' SOP
2	Method	1. setting blow pin method is not correct 2. knife sharpening method is not correct	1. blow pin not center 2. blunt knife	1. Melakukan refreshment training 2. Melakukan pengecekan ketajaman pisau
3	Machine	Setting blow pin not center	Bottle mouth thickness is not the same	1. Periodically check the position of the blow pin 2. Replacement of blow pin threads and bolts

Table 5. Dirty oil defect analysis with Kaizen Five M checklist

No	Problem Factors	Root cause	Impact of the problem	Proposed improvements
1	Man	Error in seal installation	Seal leaked	1. Providing strict sanctions if mistakes occur repeatedly 2. Post the machine setting procedure in the area around the machine.
2	Machine	The seals used are faulty and not up to standard	Piston leak	Replace seals that meet the standard

b. Kaizen Five Step Plan

After analyzing improvements with the kaizen five m checklist, then analyze the proposed improvements with the Kaizen Five Step Plan.

Table 6. Proposed improvements using the Kaizen five step plan

Problem	Kaizen Five Step Plan				
	Seiri (sorting)	Seiton (structuring)	Seiri (cleaning)	Seiketsu (maintenance)	Shitsuke (habituation)
Man: 1. Lack of operator awareness and concern for the cleanliness of the machine and production area 2. lack of packer understanding regarding product treatment 3. Error in seal installation		Post the machine setting procedure in the area around the machine.		Provide SOP refreshment	1. Provide training related to 5S (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke) 2. Supervise workers' SOP 3. Providing strict sanctions if mistakes occur repeatedly
Method: 1. Use of material tanks that are not closed or not according to SOP 2. setting blow pin method is not correct 3. knife sharpening method is not correct			Provide a covered material bin		Conducting refreshment training
Material:	Sorting reject				

Problem	Kaizen Five Step Plan				
	Seiri (sorting)	Seiton (structuring)	Seiri (cleaning)	Seiketsu (maintenance)	Shitsuke (habituation)
1. Material mixed with reject bottle mill material contaminate with foreign matter	products before grinding				
Machine:					
1. heater eror				1. Conduct regular heater checks	
2. Setting blow pin not center				2. Perform standard seal replacement	
3. The seal used is faulty and does not meet the standard				3. Periodically check the position of the blow pin	
				4. Replacement of blow pin threads and bolts	
Environment:					
1. Dust around the machine and production area			Cleaning machine and production areas at the end of each shift		

4.5. Improvement Recommendation

Based on the results of the Kaizen Analysis, improvement recommendations to reduce the level of defects given by researchers include the following:

1. Seiri (sorting); (a) Performing sorting of reject products before grinding
2. Seiton (structuring); (a) Putting machine setting procedures in the area around the machine, (b) Provide a closed material bin
3. Seiso (cleaning); (a) Cleaning the machine area at the end of each shift
4. Seiketsu (maintenance); (a) Provide SOP refreshment, (b) Perform routine heater checks, (c) Replace seals that meet the standard, (d) Checking the position of the blow pin regularly, (e) Replacement of blow pin threads and bolts
5. Shitsuke (habituation); (a) Provide training related to 5S (seiri, seiton, seiso, seiketsu, and shitsuke), (b) Supervising workers' SOPs, (c) Giving strict sanctions if mistakes occur repeatedly, (d) Conducting refreshment training

5. CONCLUSION

Based on the results of the study, it can be concluded that the level of defects in 30ml cosmetic bottle products from highest to lowest in order is Black Spots with a percentage of (74.0%), followed by Leaking defects with a percentage of (14.1%), then followed by Dirty Oil defects with a percentage of (11.9%). Based on the calculation of DPO, DPMO, and Sigma Value of 30ml cosmetic bottle products from September 2022 to July 2023, the average sigma value is 3.86 sigma. Improvement recommendations given to reduce each type of defect, namely for Black Spot Defects, include provide training related to 5S (Seiri, Seiton, Seiso, Seiketsu, and Shitsuke), provide a closed material bin, sorting reject products before grinding, conducting routine heater checks, cleaning the machine area at the end of each shift. For leaking Defects, among others, provide SOP (Standard Operating Procedure) refreshment, supervising worker SOPs, conduct refreshment training, checking the position of the blow pin regularly, and replacement of blow pin threads and bolts. For Dirty Oil Defects, among others giving strict sanctions if mistakes occur repeatedly, stick the machine setting procedure in the area around the machine, and replacing seals that meet the standard. Future research is expected to find more sources related to Six Sigma and Kaizen methods. in addition, it is hoped that further research can use both methods and be combined with other methods, one of which is FMEA.

REFERENCES

Bukhori, N. D., & Assidiqi, A. F. (2020). *Pedoman Manajemen Industri di PT. SEM INDONESIA: Smart Earmuff* (1st ed.). AFA GROUP.

Effendi, U. (2021). *Implikasi Iklan Brosur, Kualitas Produk, dan Citra Merek*. Yayasan Barcode.

Fathurohman, D. M., Dewi, I. N., & Firman. (2023). Quality Improvement to Reduce Paper Bags Defects Using DMAIC

Method in Cement Industry. *IJIEM (Indonesian Journal of Industrial Engineering & Management)*, *IV*(3), 624-631. doi:10.22441/ijiem.v4i3.22041

Hairiyah, N., Amalia, R. R., & Nugroho, I. K. (2020). Penerapan Six Sigma dan Kaizen Untuk Memperbaiki Kualitas Roti di UD. CJ Bakery *Jurnal Teknologi & Industri Hasil Pertanian*, *25*(1), 35. https://doi.org/10.23960/jtihp.v25i1.35-43

Hasan, M., Permatasari, R., Alamsyahbana, M., Hamid, D., Supriadi, B., Sitohang, A., Dai, S., Januardin, & Alfiana. (2023). *Manajemen UMKM Berkelanjutan*. Media Sains Indonesia.

Herlambang, H. (2020). Six Sigma Implementation in Connector and Terminals Manufacturing Company : A Case Study. *IJIEM - Indonesian Journal of Industrial Engineering and Management*, *1*(1), 1. https://doi.org/10.22441/ijiem.v1i1.9305

Indrawansyah, I., & Cahyana, B. J. (2019). Analisa Kualitas Proses Produksi Cacat Uji Bocor Wafer dengan menggunakan Metode Six Sigma serta Kaizen sebagai Upaya. *Prosiding Seminar Nasional Sains Dan Teknologi*, 1–8.

Rochmah, S. (2022). *Buku Ajar Manajemen Operasi 1* (M. Nasrudin (ed.); 1st ed., pp. 52–53). Penerbit NEM.

Rofieq, M., & Septiari, R. (2021). Penerapan Seven Tools dalam Pengendalian Kualitas Botol Plastik Kemasan 60 ML. *Journal of Industrial View*, *03*, 23–34. : https://doi.org/10.26905/jiv.v3i1.5720

Rohkma, A. N., & Aryanny, E. (2023). Analisa Tingkat Kecacatan Bata Beton Ringan Dengan Metode Seven Tools dan FMEA di CV. XYZ - Mojokerto. *Jurnal Kendali Teknik Dan Sains*, *1*(3). https://doi.org/https://doi.org/10.59581/jkts-widyakarya.v1i3.

Rumampuk, N. I., & Yuliawati, E. (2019). Analisa Pengendalian Kualitas Produk Kastok Plastik Menggunakan Metode Six Sigma Dan Pendekatan Kaizen. *Seminar Nasional Sains Dan Teknologi Terapan VII*, 143–150.

Syahputra, M. J., & Aisyah, S. (2022). Kaizen Method Implementation in Industries: Literature Review and Research Issues. *IJIEM (Indonesian Journal of Industrial Engineering & Management)*, *III*(2), 116-130. doi:https://dx.doi.org/10.22441/ijiem.v3i2

Soemahadiwidjojo, A. T. (2017). *Six Sigma Metode Pengukuran Kinerjs Perusahaan Berbasis Statistik* (1st ed.). RAIH ASA SUKSES.

Supardi, & Dharmanto, A. (2020). Analisis Statistical Quality Control pada Pengendalian Kualitas Produk Kuliner. *JIMFE (Jurnal Ilmiah Manajemen Fakultas Ekonomi)*, *6*(2), 199–210. https://doi.org/https://doi.org/10.34203/jimfe.v6i2.2622

Utomo, U. (2020). A Systematic Literature Review of Six Sigma Implementation in Services Industries. *IJIEM - Indonesian Journal of Industrial Engineering and Management*, *1*(1), 45. https://doi.org/10.22441/ijiem.v1i1.8846

Wirawati, S. M. (2019). Analisis Pengendalian Kualitas Kemasan Botol Plastik dengan Metode Statistical Process Control (SPC) di PT. Sinar Sosro KPB Pandeglang. *Jurnal InTent*, *2*(1), 94–102. https://ejournal.lppm-unbaja.ac.id/index.php/intent/article/view/524. https://doi.org/10.47080/intent.v2i1.524

Yuswandi, D., Anindya, D., & Dwicahyani, R. (2021). Pengendalian Kualitas Produk Cacat Hollow Alumunium Menggunakan Metode Six Sigma dengan Tahapan DMAIC (Studi Kasus di PT. XYZ Surabaya). *Prosiding SENASTITAN: Seminar Nasional Teknologi Industri Berkelanjutan*, *1*(1), 421.