SITEKIN: Jurnal Sains, Teknologi dan Industri, Vol. 21, No. 1, December 2023, pp.131 - 137
ISSN 2407-0939 print/ISSN 2721-2041 online

Analysis Of Quality Control of Defects In 500 Ml Plastic Bottle Products Using Fault Tree Analysis and FMEA Methods At PT. Berlina Tbk Pandaan

Adimas Syarifuddin[1], Achmad Misbah[2]
[1,2] Universitas Yudharta Pasuruan
Jl. Yudharta No.7, Kembangkuning, Sengonagun, Kec. Purwosari, Pasuruan, Jawa Timur 67162
Email: adimassyarifuddin87@gmail.com

ABSTRACT

Industrial company PT. Berlina Tbk. currently engaged in manufacturing processing of plastic pellets into plastic packaging products. From the data the author has obtained for 1 month from 21 August to 22 September 2022, the production process at PT. Berlina Tbk. has a bottle product defect in 500 ml plastic packaging quality. From 21 August to 22 September 2023, this production resulted in 6,421 (2%) defects from the total machine production of 287,897 (100%) 500 ml plastic bottles. This study uses a qualitative descriptive method by conducting field research activities (field research), observations, and interviews and by studying books, journals, literature, and other references related to this research. The analysis used in this study is the FTA analysis (Fault Tree Analysis) and the FMEA method (Failure Mode and Effect Analysis). From the research to overcome and reduce the three most significant types of defects using the FTA (Fault Tree Analysis) method, it was found that the causes were influenced by several elements, such as workforce, machines, and materials. With the discovery of the most extensive defect, the researcher has made a proposal based on the RPN (Risk Priority Number), which is then analyzed using the FMEA (Failure Mode And Effect Analysis) method, namely the submission for dirty material defects by checking in the storage room for raw materials, then the type of dirty oil defect by checking on the compressor air section so that during the blowing process it avoids dirty oil. The proposal from the last researcher is a type of folded defect to periodically check the cutting temperature to see if there is a shorted thermocouple.

Keywords: *Quality, 500 ml plastic packaging, FTA, FMEA*

Introduction

The industrial sector in the modern era has a significant role in production. In addition to competing on price, the service from each company to the customer must be of the best quality in the production process. Profits are obtained if it has high competitiveness and resilience [1]. As an industrial company, the quality of its products plays an essential role as the key to the success of its production. Both are company performance criteria that play a significant role for profit-oriented companies [2].

According to [3], products within the company consist of 3 elements: input, process and output. Input in the industrial world is defined as raw materials or materials and human labor and the information needed. The process is the processing of raw goods into finished or semi-finished goods. Output is also defined as finished goods according to company standards and can be used [4]. According to [5], quality control is a process control activity that characterizes product quality, compares with specifications or requirements and takes appropriate measures if there is a difference between actual and standard performance.

From the data the author has obtained for 1 month from 21 August to 22 September 2022, the production process at PT. Berlina Tbk. has a bottle product defect in 500 ml plastic packaging quality. From 21 August to 22 September 2023, this production resulted in defects of 6,421 (2%) of the total machine production of 287,897 (100%) 500 ml plastic bottles. The imperfections in these products include condensation, dirty oil, snap grips, dirty material, deformation, sharp lines, and folds. Therefore, several steps were carried out to repair this defect to optimize the target for the 500 ml plastic packaging product. To overcome the problem of product defects, the methods researchers use is FMEA (Failure Mode and Effect Analysis) and FTA (Fault Tree Analysis). So, a technique that can define, identify, reduce, and even eliminate damage due to problems from the production process is the FMEA (Failure Mode and Effect Analysis) method. The method for analyzing failures in the production system is looking for aspects and finding the root causes that often occur in product defects in the production process. To find out the root cause of the defect problem and how to solve the 500 ml plastic bottle defect problem in detail, efforts were made using the FMEA (Failure Mode and Effect Analysis) and FTA (Fault Tree Analysis) methods [6][7].

Research Methods

According to [6], the research method uses descriptive qualitative research methods by finding and obtaining data through direct field research, observation, interviews and using literature, books, journals and other references related to this research. There are two ways of collecting data in this study: observation and interviews. Then, the results are processed and analyzed using FTA (Fault Tree Analysis) and FMEA (Failure Mode And Effect) analysis to determine the RPN (Risk Priority Number) value [8].

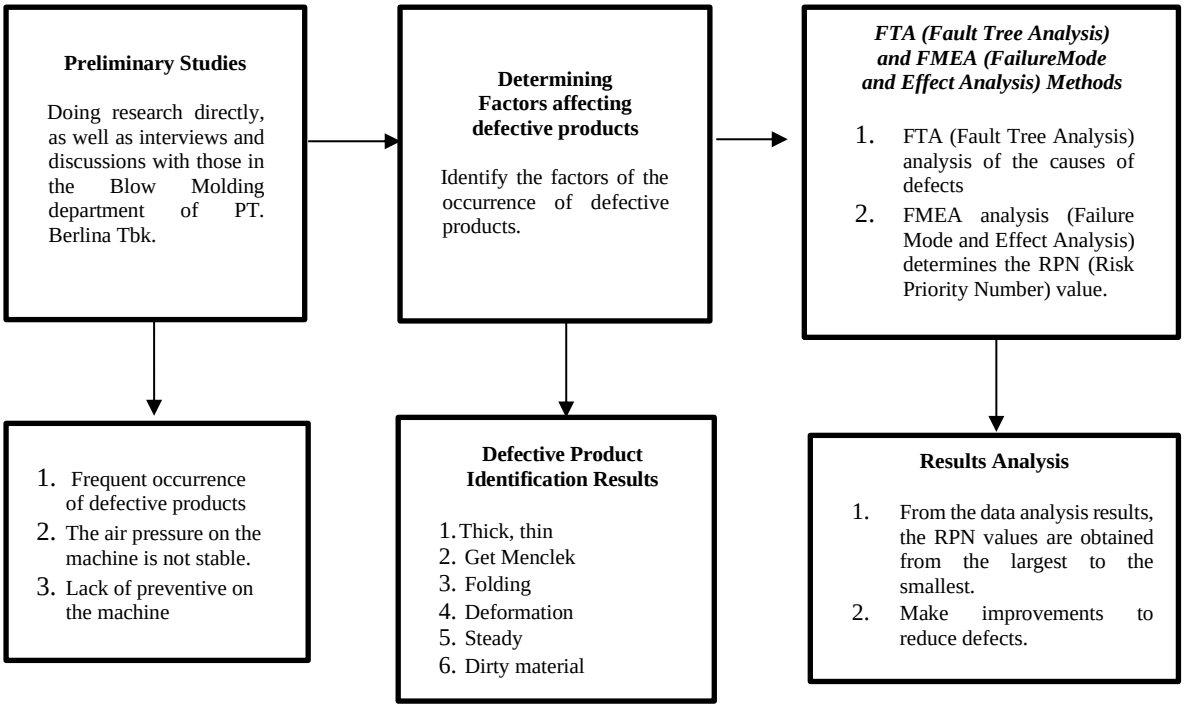

Figure 1. Flowchart Research

Results and Discussion

From data collection using observation, interviews and literature studies conducted by researchers, in broad outline, namely company data and data analysis. As follows :

Table 1. Production Total Data and 500 ml Bottle Defect Data. August 21st to September 22nd

No	Date	Total Production	Total Defect
1	21 – 08 – 2022	9.912	160
2	22 – 08 – 2022	8.400	170
3	23 – 08 – 2022	7.392	150
4	24 – 08 – 2022	7.056	220
5	25 – 08 – 2022	5.208	340
6	26 – 08 – 2022	8.064	250
7	27 – 08 – 2022	3.488	120
8	28 – 08 – 2022	8.400	280
10	30 – 08 – 2022	9.408	200
11	31 – 08 – 2022	10.416	190
12	01 – 09 – 2022	9.912	230
13	02 – 09 – 2022	10.584	190
14	03 – 09 – 2022	10.416	220
15	04 – 09 – 2022	10.248	180
16	05 – 09 – 2022	6.216	200
17	06 – 09 – 2022	10.080	160

18	07 – 09 – 2022	9.744	260
19	08 – 09 – 2022	9.576	200
20	09 – 09 – 2022	10.080	190
21	10 – 09 – 2022	8.064	170
22	11 – 09 – 2022	4.827	350
23	12 – 09 – 2022	7.560	300
24	13 – 09 – 2022	8.400	200
25	14 – 09 – 2022	10.080	195
26	15 – 09 – 2022	10.416	145
27	16 – 09 – 2022	10.584	180
28	17 – 09 – 2022	10.920	165
29	18 – 09 – 2022	8.400	210
30	19 – 09 – 2022	10.752	180
31	20 – 09 – 2022	6.384	240
32	21 – 09 – 2022	9.774	190
33	22 – 09 – 2022	10.080	166
	Total	**287.897**	**6.421**

Source: Company Internal Data

Table 2. Data on the total production of 500 ml Plastic Bottles. 21 August to 22 September 2022

No	**Date**	**Shift**		
		1	**2**	**3**
1	21 – 08 – 2022	2.520	3.864	3.528
2	22 – 08 – 2022	2.856	2.016	3.528
3	23 – 08 – 2022	3.192	3.528	4.560
4	24 – 08 – 2022	3.024	1.512	2.352
5	25 – 08 – 2022	1.680	504	3.024
6	26 – 08 – 2022	2.856	3.192	2.016
7	27 – 08 – 2022	4.864	1.176	2.312
8	28 – 08 – 2022	3.192	3.360	1.848
10	30 – 08 – 2022	3.360	1.344	2.352
11	31 – 08 – 2022	2.520	3.528	3.360
12	01 – 09 – 2022	3.192	3.528	3.696
13	02 – 09 – 2022	3.864	2.856	3.192
14	03 – 09 – 2022	3.528	3.528	3.528
15	04 – 09 – 2022	3.696	3.528	3.360
16	05 – 09 – 2022	3.528	3.696	3.024
17	06 – 09 – 2022	2.016	3.192	1.008
18	07 – 09 – 2022	2.856	3.528	3.696
19	08 – 09 – 2022	3.192	3.528	3.024
20	09 – 09 – 2022	3.024	3.024	3.528
21	10 – 09 – 2022	3.360	3.024	3.696
22	11 – 09 – 2022	3.528	3.258	1.008
23	12 – 09 – 2022	672	3.840	315
24	13 – 09 – 2022	3.840	1.680	2.040
25	14 – 09 – 2022	2.688	2.520	3.192
26	15 – 09 – 2022	3.360	3.360	3.360
27	16 – 09 – 2022	3.528	3.528	3.360
28	17 – 09 – 2022	3.696	3.360	3.528
29	18 – 09 – 2022	3.696	3.696	3.528
30	19 – 09 – 2022	3.696	1.680	3.024
31	20 – 09 – 2022	3.696	3.528	3.528
32	21 – 09 – 2022	2.016	1.512	2.856
33	22 – 09 – 2022	2.856	3.192	3.696
	Total	**3.360**	**3.192**	**3.528**

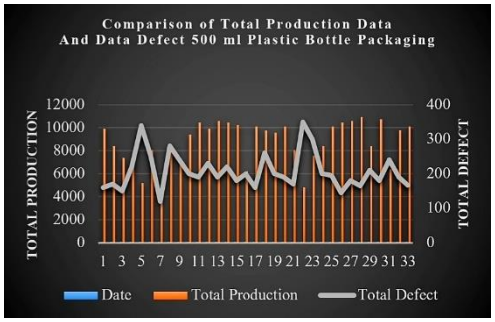

Figure 2. Comparison of Total Production Data and Data on 500 ml Plastic Bottle Packaging Defects from 21 August to 22 September 2022.

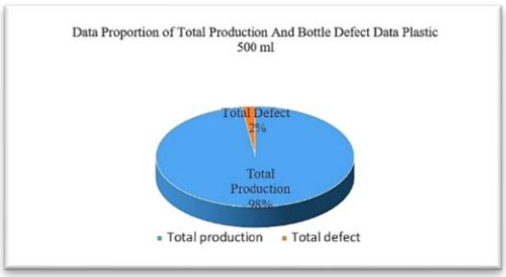

Figure 3. Proportion of Total Production Data and 500 ml Plastic Bottle Defect Data. For 1 Month From 21 August to 22 September 2022

From processing the data presented in the pie chart, based on data on defects in 500 ml plastic packaging bottles for 1 month from 21 August to 22 September 2022, it reached 2% of total production for 1 month.

Table 3. Data on Defects in 500 ml Plastic Bottles for 1 Month From 21 August to 22 September 2022

Defect Type	Amount Defect	Percentage (%)	Accumulation (%)
Gross Materials	2015	30%	30%
Dirty Oli	1210	18%	49%
Folding	990	15%	64%
Condensation	925	14%	78%
Sharp Line	600	9%	87%
Deformation	440	7%	93%
Snap Gripis	430	7%	100%
Total *Defect*	**6610**	-	-

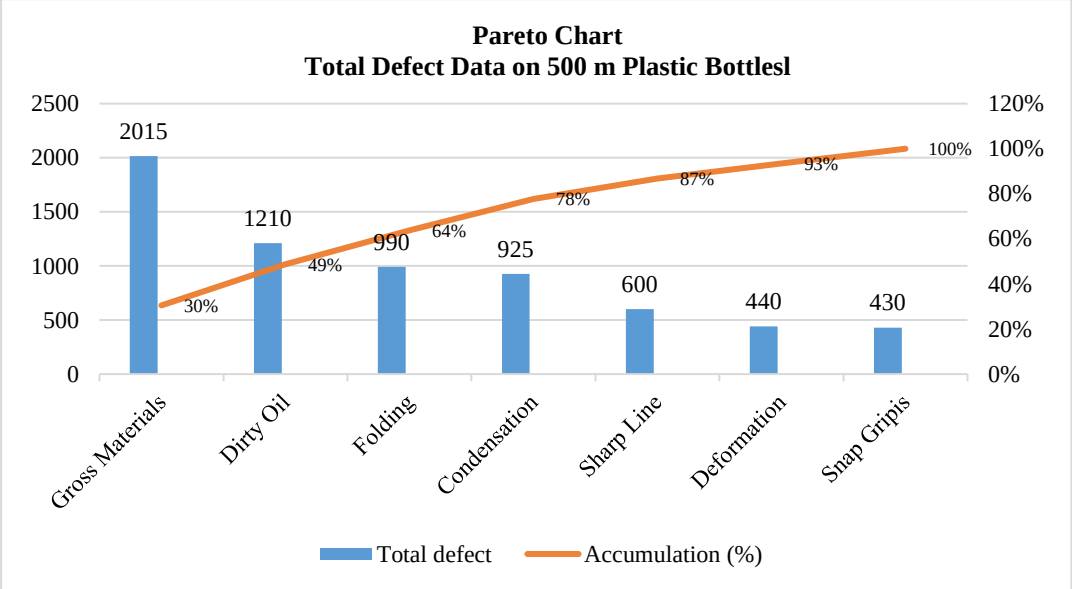

Figure 4. Pareto Chart Data for Total Defects in 500 ml Plastic Bottles for 1 Month From 21 August to 22 September 2022

Analysis FTA (Fault Tree Analysis)

According to [6] and [9], the use of the Fault Mode and Effect Analysis (FMEA) method to find priorities for repairing defective products and the Fault Tree Analysis (FTA) method to find the root of the problem as a basis for proposing improvements to the company's production process. Several types of defects were taken to be examined. The RPN calculation on the FMEA method yields a value of 288 for ghosting defects with dirty and shriveled contents. Analysis of gross material defects, contaminated oil, and folding using the FTA (Fault Tree Analysis) method for 500 ml plastic bottle products. This analysis was carried out with the aim of obtaining information about what elements are the cause of the occurrence of the 3 types of defects with the largest value.

1. Factors causing the problem of the Gross Material defect in the 500ml Plastic Bottle product at PT.
2. Factors causing the problem of the Dirty Oil defect in the 500ml Plastic Bottle product at PT.
3. Factors causing the problem of folding defects in 500ml plastic bottle products at PT.

By classifying data, [10] and [11] describe it into units, synthesizing, compiling into patterns, choosing which ones are significant and what will be learned, and making conclusions. So that they are easily understood by oneself and others, that has been done using FTA (Fault Tree Analysis), it has been determined that several factors are causing material, oil, and folding defects, as follows.

1. Man Factor.
   Humans are actors in this scenario as selectors, operators, and other roles, and the human factor is one of the factors actively participating. Many factors could have contributed to this, including a lack of initiative by the electorate, who failed to communicate the issue to the operator and waited to address it. In contrast, the operator worked on other topics.
2. Engine Factor
   The machine factor is one of the essential factors because the machine is a tool used to carry out production activities. This is influenced by several reasons: the temperature is too high, and the temperature is not according to the protocol.
3. Material Facto
   The material factor is one of the essential factors because the material is the primary raw material that will be used to manufacture a product. This is influenced by a reason: the type of plastic pellets is unsuitable due to the different melting rates of the plastic pellets.

Analysis FMEA (Failure Mode and Effect Analysis)

According to [12] and [13], the RPN (Risk Priority Number) value is determined using data from FMEA (Failure Mode and Effect Analysis) analysis in order from largest to smallest. Following are the findings of an FMEA (Failure Mode and Effect investigation) investigation into errors in 500 ml plastic bottle packaging related to material, oil impurities, and folding:

1. From the FMEA (Failure Mode and Effect Analysis) Analysis, the Gross defect of the 500ml plastic bottle product material has the most significant RPN (Risk Priority Number) value, namely, the liv Cavity diameter section is not evenly distributed or worn out with an RPN (Risk Priority Number) value of 432.
2. From the Analysis of the FMEA (Failure Mode and Effect Analysis), Defective dirty oil in a 500ml plastic bottle product has the most significant RPN (Risk Priority Number) value. Namely, there is oil in the Blue Core with an RPN (Risk Priority Number) Value of 384
3. From The Analysis FMEA (Failure Mode and Effect Analysis) Analysis, the defect of folding a 500ml plastic bottle product has the largest RPN (Risk Priority Number) Value, namely, the thermos Couple is not installed property with an RPN (Risk Priority Number) value of 280.

Based on the RPN (Risk Priority Number) findings, FMEA Analysis (Failure Mode and Effect Analysis). Therefore, research results [14] and [15] present a model of the functional relationships between three RPN factors – incidence, detection, and severity – to clarify how and why each element is used in RPN calculations. Some of the results described from the model are useful for researchers and practitioners. Further improvements are made to minimize these deficiencies from developing the largest RPN (Risk Priority Number) value.

Table 4. Proposed Improvements

Type Defect	Potential Causal Factors	Proposed Improvements
Dirty Material	The Diameter of the liv is uneven or worn	With regular maintenance, Cavity and Mold
Dirty oil	The air in the compressor is dirty, and the blue core has oil	Carry out routine maintenance activities on the compressor so that the air supply is clean, and the blue center is free of oil
Folding	*Thermos Couple has* not installed the property.	Carry periodic checking of thermos Couple on set up or change of bottle type production so that the temperature is stable on the monitor.

Source: Researcher Data Processing

Conclusion

From the research results on 500 ml plastic bottle packaging products at PT. Berlina Tbk. So, it can be concluded that the Pareto chart, referred to as the 80/20 principle, means 80% of the effect and 20% of the cause. From this principle, 3 types of defects are the main centers that must be emphasized because they reach 80% in cumulative percentage, namely 30% gross material defect, 13% folding defect, and 28% gross oil defect. Based on the analysis made by researchers using the FTA (Fault Tree Analysis) method, it was found that the elements are dirty oil, dirty material, and folding in 500ml plastic bottle packaging product at PT Berlina Tbk. Namely Man, Material, and Machine.Regarding the proposed improvement from the researcher to repair the gross material, dirty oil and folding defects based on the largest RPN (Risk Priority Number) from the FMEA (Failure Mode and Effect Analysis) method observations,

After understanding the proposed improvements above, the next thing that must be carried out is the 5W+1H analysis by paying attention to what needs to be repaired, such as defects in material dirt, oil, and folding. As follows: Based on the 5W + 1H analysis for improving material gross defects, namely by regularly maintaining in the living cavity and mold. It is using the mold shop department to repair the parts of the residing holes that are not balanced. Based on the 5W + 1H analysis, to improve the dirty oil defect by maintaining it to supply clean air and blue core, avoid oil by using a compressor to clean housing and blue center. Based on the 5W + 1H analysis for repairing folding defects, namely by checking the thermos couple when setting up or changing the production of bottle types so that the temperature is shown on the monitor.

Acknowledge

I express my deepest gratitude to all parties involved in this research, especially Father KH. M. Sholeh Bahrudin as Caretaker of Ngalah Islamic Boarding School and Darut Taqwa Foundation. Mr. Dr. Kholid Murtadlo, ME as Chancellor of Yudharta University Pasuruan. Mr. Achmad Misbah, ST., MT., as the Advisory Lecturer, has taken the time to guide, direct, and encourage the authors in preparing the proposal to completion and all parties who have helped perfect this research.

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