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ANALYSIS OF DEFECTIVE QUALITY CONTROL OF POWDERED DRINKS USING THE SIX SIGMA METHOD ON MULTILANE MACHINES

Probokusumo[1], Aries Susanti[2], Sri Hartini[3]
Department of Industrial Engineering and Management, Faculty of Engineering, Diponegoro University
Jl. Prof. Sudarto No. 13, Tembalang, Kec. Tembalang,
Semarang City, Central Java
probokusumo@students.undip.ac.id, ariessusanty@lecturer.undip.ac.id, srihartini@lecturer.undip.ac.id

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ABSTRAK

This observation aims to identify the types of defects that occur in the powder packaging process at PT. XYZ as an effort to improve product quality. By doing this observation, the benefits obtained include being able to find out what problems cause disability and be able to overcome these defects from the suggestions given by observers. The multi lane machine is a packaging machine that is the object of observation because in the packaging process on this machine there are still many defective products produced. The method used in this observation is Six Sigma with the DMAIC approach which consists of the Define, Measure, Analyze, Improve, Control stages. The results of data processing show that the sigma level value is 4.10, which means that the quality control process carried out by the company has been running well. However, more intense control still needs to be needed to minimize the possibility of defects. The causative factors that cause leakage defects in the primary packaging of xyz powder include four factors, namely Human, Machine, Method and Material factors. Then from the four factors, suggestions for improvement are given.

Keywords: Multilane, quality control, six sigma, DMAIC

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Universitas Muslim Indonesia
Address :
Jl. Urip Sumoharjo Km. 5 (Kampus II UMI)
Makassar Sulawesi Selatan.
Email :
Jiem@umi.ac.id
Phone :
+6281341717729
+6281247526640

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I. INTRODUCTION

With the development of the times in this era of globalization, quality has become the main strategy in controlling the market. Products with high quality advantages will be the main key for companies to be able to meet consumer desires, so that business competition can be won. Therefore, companies are required to be able to achieve this quality. By providing guaranteed quality, consumers will both benefit from each other. Providing guaranteed quality to consumers makes producers will also be able to establish good relationships with consumers. Quality control is an effort made to maintain the quality or quality of the products produced to comply with the quality standards set by the company. (Assauri, 1998).

PT. XYZ is a company whose main production is powdered drinks, one of its products is xyz. The manufacture of xyz powder drink is carried out in Production Unit 2 (UP 2). In the packaging stage of making xyz powder drink, there are still many defects found. This results in losses for the company because with a product defect, the product cannot be marketed or must be reworked, which means this will increase costs. The packaging stage itself is divided into 3 stages, namely the primary, secondary and tertiary packaging stages. The main focus of research is on the primary packaging stage on multilane machines because at this stage the number of defective or reject products is still large compared to secondary and tertiary packaging.

Quality control is an important key for the company so that the quality of each product produced is maintained according to standards. The six sigma method is one way to improve and improve the quality of the company (Sirine & Kurniawati, 2017). The six sigma method is a quality improvement approach in order to achieve the target of 3.4 failures per one million opportunities (DPMO) in each production activity. Therefore, sig sigma can be interpreted as an effort made to achieve perfection (zero defect). (Sembiring, 2011).

The big classification of the sigma level based on the number of defects per one million opportunities can be seen in table 1.

Table 1. Relationship between Sigma and DPMO

Sigma	*Parts per Million*	Decsription
6 *Sigma*	3,4 *defects per million*	(world class industry)
5 *Sigma*	233 *defects per million*	
4 *Sigma*	6.210 *defects per million*	(US industry average)
3 *Sigma*	66.807 *defects per million*	
2 *Sigma*	308.537 *defects per million*	(Indonesian industry average)
1 *Sigma*	690.000 *defects per million*	(very uncompetitive)

From the problems above, the company must be able to find the factors that cause the rework process to cause rejects, and how to improve the reject products that occur in the primary packaging process, especially on the Multilane machine in order to survive the intense competition. Companies must still be able to maintain product quality according to standards. The possibility of waste from product defects produced must be as minimal as possible to reduce costs incurred. Quality control on defective products is vital to suppress the defective products produced and must be in accordance with company SOPs.

II. RESEARCH METHODOLOGY

Six Sigma uses statistical tools to identify several vital factors, the DMAIC Cycle is a key process for continuous improvement towards Six Sigma targets. DMAIC is carried out systematically based on science and facts (systematic, scientific, and fact based). The following are the stages in the DMAIC cycle and the steps that must be carried out at each stage:

1. Define

Define is a stage to identify problems that often occur (Kusumawati & Fitriyeni, 2017). Then after knowing the problem to be identified, the next step is to determine the key quality characteristics or Critical to Quality (CTQ) which is a description of consumer needs for xyz products and product packaging.

2. Measure

This stage is the stage of measurement or measure. At this stage, measurements of the value of DPO (Deffect per Opportunities), DPMO (Deffect per Million Opportunities) and sigma values are carried out for each type of defect in each package (Triadi, 2018). The sigma value obtained can also show the baseline

After getting the DPMO value, the sigma level value can be obtained for each type of disability. To get the sigma level value, it can be obtained from the DPMO conversion table to the sigma value or you can also use the Ms. Excel = *normsinv (1.000.000DPMO)/1.000.000)+1,5*..(3)

From the results of these calculations, it can be seen which type of disability is farthest from the six sigma level and then make a Pareto diagram of the defect to find out which type of disability is the most dominant.

3. Analyze

At this stage, an analysis of the main causes of problems that cause the performance of sigma in the process to decline is carried out. In addition to determining the factors that influence the type of dominant disability that occurs using a fishbone diagram.

4. Improve

This is the stage for selecting solutions and actions that need to be taken based on the analysis that has been done and hopes that these actions can improve the performance of Sigma. At this stage, it can be in the form of recommendations for improvement to minimize defects that occur.

5. Control

Control is the last stage in the six sigma method. At this stage, control of the process that has been improved is carried out. (Wahyani, Chobir, & Rahmanto, 2010).

performance of the company.

$$DPO = \frac{Total\ manufacturing\ defects}{Production\ quantity\ x\ CTQ} \text{...........(1)}$$

DPMO = DPO x 1.000.000 ....(2)

III. RESULTS AND DISCUSSION

The following are the stages of controlling six sigma on xyz products.

1. Define

PT. XYZ in its production process has set high quality standards and good management, but in the production process, precisely in the primary packaging, there are still many reject products in the primary packaging process.

The more rejected products are found, the more losses that must be borne because the product must be reworked or thrown into waste. The object that is the main focus of research is the primary packaging process on a multilane machine on shift 1. The types of defects (Critical to Quality) are grouped into 3 types:

a. Weight is a type of disability where the weight of the packaged xyz powder does not meet the established standards. Generally less weight or even too much.
b. Leaking is a type of defect where there are gaps or holes in the packaging due to several influencing factors, including cracking, comblong, tearing due to the sealing temperature being too hot or not hot enough.
c. Visual is a type of defect where in terms of the appearance of the packaging there is damage, namely the seal is not neat, and there are errors in packaging printing and it is not neat.

Tabel 2 packaging defect

Day	Unit	Good	Cacat			Total
			Leak	Weight	Visual	
1	Sachet	1646640	26864	0	0	1673504
2	Sachet	1763280	27423	830	0	1791533
3	Sachet	1833840	27555	0	0	1861395
4	Sachet	1519200	26678	170	0	1546048
5	Sachet	1949760	26879	0	0	1976639
6	Sachet	1977840	25368	160	0	2003368
7	Sachet	1197360	25366	360	0	1223086
8	Sachet	1647360	25346	0	700	1673406
9	Sachet	1756080	27353	240	0	1783673
10	Sachet	2077920	24591	1890	0	2104401
11	Sachet	1248480	21800	70	0	1270350
12	Sachet	1818720	7200	0	0	1825920
13	Sachet	1881360	23446	70	0	1904876
14	Sachet	1331280	23554	470	0	1355304
15	Sachet	1931760	24745	0	0	1956505
Total	**Sachet**	**25580880**	**364168**	**4260**	**700**	**25950008**

2. Measure

The next stage is to calculate the level of disability by calculating the value of DPO, DPMO, and sigma value according to equations (1), (2) and (3) to be able to determine the magnitude of the company's performance. The calculation of the DPMO value and the company's sigma value for 15 days in September-October 2020 in detail can be seen in table 3 below.

Table 3. Value of DPO, DPMO, and Value of Sigma

Day	Production	Leak	CTQ	DPO	DPMO	Level Sigma
1	1673504	26864	3	0,005	5350,800	4,05
2	1791533	28253	3	0,005	5256,673	4,06
3	1861395	27555	3	0,005	4934,471	4,08
4	1546048	26848	3	0,006	5788,416	4,02
5	1976639	26879	3	0,005	4532,737	4,11
6	2003368	25528	3	0,004	4247,432	4,13
7	1223086	25726	3	0,007	7011,293	3,96
8	1673406	26046	3	0,005	5188,270	4,06
9	1783673	27593	3	0,005	5156,496	4,07
10	2104401	26481	3	0,004	4194,582	4,14
11	1270350	21870	3	0,006	5738,576	4,03
12	1825920	7200	3	0,001	1314,406	4,51
13	1904876	23516	3	0,004	4115,097	4,14
14	1355304	24024	3	0,006	5908,577	4,02
15	1956505	24745	3	0,004	4215,851	4,13
Avg	**1730000,533**	**24608,53333**	**3**	**0,0048**	**4863578**	**4,10066667**

From table 3 above, it can be seen that the sigma value of the company is around 4.10. From the sigma value, it can be seen that the quality control process carried out by the company has been running well. However, more intense control is still needed to minimize the possibility of defects occurring again.

Process control chart

Control chart is used to monitor the activity of an ongoing process using graphical methods. So it can be known whether the process is within the limits of statistical control or not. The control chart that is in accordance with the data that has been obtained is a process control chart where the observations are that the number of samples taken is not the same. The results of the measurement of defective products from powder drinks produced are as follows:

Table 4. Calculation of Process Control Chart

Day	Production (ni)	Leak (Di)	Fraksi sampel (p)	Standar deviasi (p_bar)	UCL (Upper limit)	LCL (Lower limit)
1	1673504	26864	0,0161	0,00010	0,0184	0,0138
2	1791533	28253	0,0158	0,00009	0,0180	0,0135
3	1861395	27555	0,0148	0,00009	0,0170	0,0126
4	1546048	26848	0,0174	0,00009	0,0170	0,0126
5	1976639	26879	0,0136	0,00011	0,0198	0,0150
6	2003368	25528	0,0127	0,00008	0,0157	0,0115
7	1223086	25726	0,0210	0,00008	0,0148	0,0106
8	1673406	26046	0,0156	0,00013	0,0237	0,0183
9	1783673	27593	0,0155	0,00010	0,0179	0,0133
10	2104401	26481	0,0126	0,00009	0,0177	0,0132
11	1270350	21870	0,0172	0,00008	0,0146	0,0105
12	1825920	7200	0,0039	0,00012	0,0199	0,0146

13	1904876	23516	0,0123	0,00005	0,0062	0,0017
14	1355304	24024	0,0177	0,00008	0,0145	0,0102
15	1956505	24745	0,0126	0,00011	0,0203	0,0152
Total	**1730000,533**	**24608,53333**		**0,00008**	**0,0148**	**0,0105**

From the calculation results in table 4, the LCL and UCL value data can be presented in the process control chart. See figure 1. On the process control chart, the lower the line, the better. Because it shows that the proportion of defective products is getting lower.

Basically the lowest possible proportion of defective products a company expects. Many defective products are produced, which has a significant effect on the company's profits.

In Figure 4.2, if the proportion of defective products in a period is still between the upper limit (UCL) and the lower limit (LCL), it can be said that the proportion of defective products is still within the permissible limit.

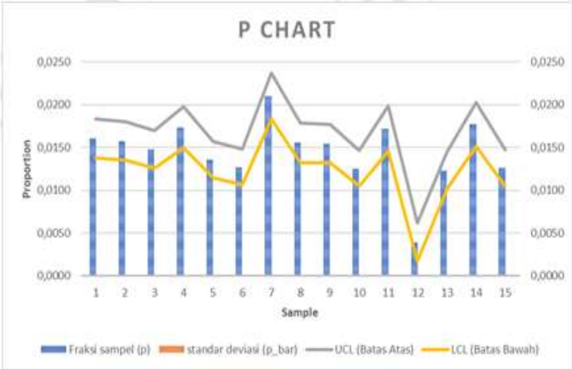

Figure 1. Defective product process control chart

On the control chart, it can be said that the data is from the same system. If we look at the distribution of the points around the center line, then the control chart can be said to be stable because the data has not yet formed a stationary pattern. However, on the process control chart above, there are indications of a high proportion of defects that are beyond the control limits. So it is necessary to improve so that the proportion of defects can be reduced to a minimum.

3. Analyze

The analysis stage is carried out to identify problems and find the source of the cause of quality problems. This stage consists of 2 steps, namely:

a. Process capability analysis

In this case, the defective product data is attribute data. So to get the value of the process capability is :

$$Cp = 1 - \bar{p}$$
$$Cp = 1 - 0{,}0146$$
$$Cp = 0{,}9854$$

This shows that in a number of products produced by PT. XYZ is able to produce good products or those that meet predetermined specifications of 98.54%. Thus, this also shows that the ability of the process to produce defective products is 1.46%. This value is not significant if the number of products produced is small. But PT. XYZ produces powdered beverage products in the amount of millions in one day. So that 1.46% is a significant influence on company profits.

Thus, if the management wants to improve the process capability to produce a suitable (non-defective) product based on the current stable process condition, the variation of the common causes attached to the process must be reduced.

b. Identify the cause of quality problems

Then for the sequence of defects for each type of disability in a row, which can be seen from table 5, From Table 5 above it can be seen that the order of the number of defects from the largest is leaking at 98.99%, weight by 1.2% and visual by 0.2. %. From this data, a Parreto diagram can be made as shown in Figure 2.

Table 5. Data on Pareto Chart Defects

No	Jenis Cacat	Jumlah Cacat	Percent	Percent Kumulatif
1	Bocor	364168	98,7%	98,7%
2	Berat	4260	1,2%	99,8%
3	Visual	700	0,2%	100,0%
Total		**369128**		

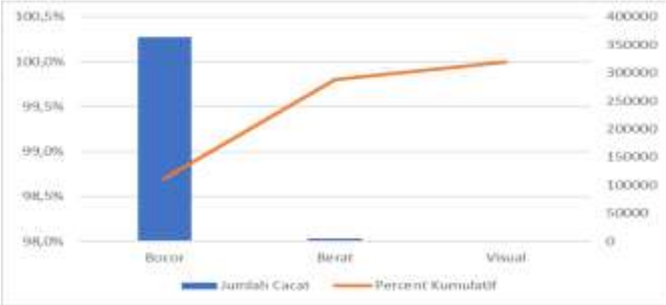

Figure 2. The Pareto Diagram of Disability

From the Pareto diagram it is clearly shown that the highest problem of 98.7% of all problems is caused by leaking defects. After knowing the types of internal defects from the results of the powder drink production process at PT. XYZ who owns the most significant number is leaking defects, then the source of the defects is identified which includes man, material, method, and machine factors. This can be illustrated in a causal diagram or fishbone obtained from the following interviews:

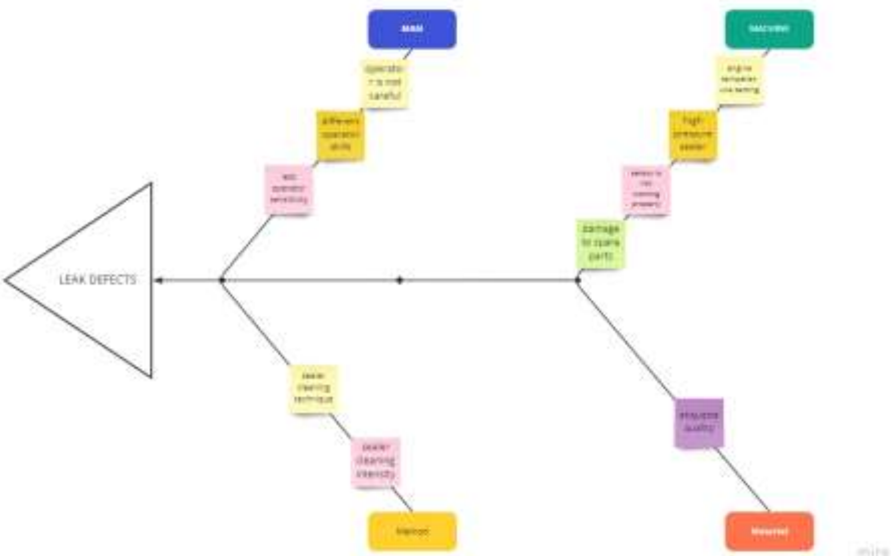

Figure 3. fishbone chart

Based on the research that has been done, there are 4 factors that cause leaking defects in the safety of the xyz powder drink. The explanation of the four factors that cause disability is as follows:

a) Human Factor

The human factor that causes leaking defects in xyz powder drink packaging is the operator's skill which is different for each individual where in setting up the machine the less skilled the operator is, the more rejects will occur. responsive in stopping the machine for resetting. The next thing that affects is the accuracy that is still minimal when a leak occurs and the accuracy of each individual operator is also different.

b.) Engine Factor

Machine factors that cause leaking defects in xyz powder drink packaging include the sealing temperature which is set too high or too low so that the pressing result is not good resulting in tearing or cracking of the product. Another thing that causes this type of defect is high pressure (Tension). unsuitable both vertically and horizontally. In addition, sensor errors can also cause pressing errors due to improper timing and result in the number of defective products increasing. Worn and damaged spare parts also have important roles in causing defects.

c.) Method

The method factor that causes leakage defects in xyz powder drink packaging is the first sealer itself. Because there is no schedule related to the intensity of sealer cleaning, sealers are often only cleaned when packaging damage occurs. In addition, the sealer cleaning technique is not correct where the brushing direction of the sealer does not match the type of sealer because the shape of the brush that is not suitable makes stains or dirt in the sealer still attached. This causes the sealer to quickly fail to work properly.

d.) Material

The material factor that causes leaking defects in the packaging of xyz powder drinks is the quality of the label used, this is due to the different distributors of the label used and because this has an impact on the quality of the label which is also slightly different, the machine settings are also different, if there is an error in the settings then the label will be damaged and result in leaking.

4. Improve

Improve is the stage where production improvement planning is carried out in the xyz primary packaging section using a Multi lane machine. The proposed method for improving the given method is based on the cause of the problem from the Analyze stage.

1) Human Element

a. Refresh machine training every 3 months for operators of old and new packaging packages so that they understand more about machines.

b. Carry out routine supervision every day and give a warning or direction if the operator makes a mistake.

c. Operators are expected to comply more with applicable SOPs.

2) Machine Element

a. Checking temperature, pressure and engine sensors regularly, especially when changing labels.

b.Conduct more intensive checks on machine spare parts when the machine is about to be run and when the machine makes a planned stop.

c. Replace spare parts that have started to wear out and don't wait until they are badly damaged first.

3) Method Element

a. Scheduling routine sealing cleaning every 1 hour so that the seal is not easily dirty because it does not only clean when the packaging has leaked because the seal is dirty.

b. Improving how to clean the sealer properly which is in accordance with the type of sealer and correctly and using a brush type that is more in line with the shape of the sealer, namely a thicker and stiffer brush so that cleaning can be carried out more optimally.

4) Material Element

a. Operators are expected to be more thorough and sensitive to the type of etiquette used and to set the machine accordingly.

IV. Conclusion

Based on the results of the discussion, the following conclusions can be drawn:

1. There are 3 types of defects in the primary packaging process, namely severe, leaking, and visual defects.
2. It can be seen from the results of calculations with the six sigma method obtained an average sigma of 4.10 so that it can be concluded that PT. XYZ is in good condition but quality control still needs to be done so that defects can be minimized.
3. From the results of observations, it can be seen that the causal factors that cause leakage defects in primary packaging consist of four factors, human factors, machines, methods, materials. Then suggestions/suggestions are given.

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