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Quality control of plastic sack products using the DMAIC method at PT. XYZ

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ABSTRACT

PT. XYZ is a company engaged in the production of plastic sacks which are used for various industrial purposes. There are several types of defects in plastic sacks, namely, torn sacks, inappropriate sack brands, and slanted seams. This research aims to determine the level of product defects, factors causing product defects and provide suggestions for improvements to the production process at PT. XYZ. This research uses the six sigma method through the DMAIC stages (Define, Measure, Analyze, Improve and Control). Based on research results, the defect rate for plastic sack products was 2.72%, while the average level was 3.9 sigma. There are several factors that cause defects in plastic sack products, namely human factors, machines, work methods and materials. Proposed improvements to improve product quality at PT. XYZ there are several factors that must be improved, namely, humans are carrying out training and directing employees to follow SOPs, machines are making continuous maintenance schedules according to machine capacity so that they are always in good condition, work method factors the company must make additional SOPs so that work method problems are reduced. In the future, material is tightening the process of checking the inspection of threads that are not good properly.

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1. INTRODUCTION

Competition in both service and manufacturing industries is not only in the scale of the company and its human resources, but also in the quality of the products produced. Quality is very important for a company, where the quality produced is determined by certain values and characteristics. A successful production is said to be of good quality if it can meet the desires and even exceed customer expectations (Fadhilah & Wahyudi, 2022; Mouelhi et al., 2020; Zhang et al., 2022).

Quality products are a measure of the company's success and also a guarantee for the company that must be given to customers so that they are loyal and avoid various bad complaints after using the products they buy so that this will indirectly provide business benefits for the producer (Alzoubi et al., 2022; Farid et al., 2022; Lina, 2022).

PT. XYZ is a manufacturing company that produces various plastic sack products such as rice sacks, fertilizer, flour, feed and various other types of sacks according to customer requests. PT. XYZ has a vision of becoming a company known for its good quality in accordance with the company's vision and mission so that it can compete with other companies.

In the production process, this company really pays attention to the quality of the products produced, however, defects or even damage still occur. In the production results, problems were found, namely the level of product defects exceeded the company's standard limits and several types of product defects were found, namely torn sacks, slanted seams and inappropriate brand prints. The factors that influence the cause of high product defects are human factors, machines, materials and how they work (Hong et al., 2020; Nugraha et al., 2022; Sgarbossa et al., 2020).

Problems that occur if not resolved will cause continuous losses for the company. For this reason, problems that occur in the production process require immediate action, namely looking for factors causing product defects and identifying the type of defect and making continuous improvements to the quality of the company's products using the DMAIC model (Bahauddin & Arya, 2020).

2. RESEARCH METHOD

The method used refers to principles which include define, measure, analyze, improve and control (DMAIC). This method is used to anticipate the occurrence of defects or errors by using measurable and structured steps. Based on existing data, several stages can be carried out as follows: (Gaspersz, 2002; Kossiakoff et al., 2020)

Define

The define stage is a way to get solutions for improvements in the production process by determining the type of defect in a product and researchers must know the ongoing production process.

Measure

The measure stage is the second step in the DMAIC stage which will continue from the define stage. The aim of six sigma is to develop the production process continuously so that it reaches 6 sigma (3.4 DPMO) by knowing the company's current sigma value.

Analyze

The analysis stage is the third stage of DMAIC which aims to identify factors that influence the production process.

Improve

The repair stage is the stage used to repair defects in plastic sack products from three types of defects. Improvement proposals formulate the root of the problem that is the cause of production defects.

Controls

The final stage of DMAIC is the control stage. The control stage aims to ensure that the improvements made in the improve stage are more effective.

3. RESULTS AND DISCUSSIONS

3.1 Data Collection

The data collected in this research is data on the production of plastic sack products. There are several types of defects, namely torn sacks, inappropriate brand prints and slanted seams obtained from the company. The following is data on production results and product defects in the following table:

Table 1. Production results and production defects

No	Month	Total product (sheet)	Types of defects (sheets)			Total defects (sheets)
			Torn sack	Brand print does not match	Oblique seam	
1	March-22	725,645	9,876	7,034	3,456	20,366
2	April-22	790,678	9,876	6,980	3,354	20,210
3	May-22	754,369	10,765	7,685	3,098	21,548
4	June-22	704,598	8,965	6,785	2,987	18,737

5	July-22	765,432	7,985	5,789	3,345	17,119
6	August-22	756,478	10,980	6,543	3,245	20,768
7	September-22	689,654	9,876	7,890	3,901	21,667
8	October-22	705,467	10,156	6,789	4,004	20,949
9	November-22	679,866	9,875	5,678	4,080	19,633
10	December-22	723,458	8,976	5,345	4,009	18,330
11	January-23	675,433	7,900	4,679	3,870	16,449
12	February-23	667,845	9,876	5,007	3,943	18,826
	total	8,638,923	115.106	76,204	43,292	234,602

3.2 Analysis and Discussion

In the DMAIC method there are several stages of problem solving as follows:

Define

Table 2. CTQ description of plastic sack products

CTQ	Picture	Description
Bag torn		Errors during the plastic sack assembly process there are problems in th machine and lack of control against the machine by the operator so that t plastic sacks torn.
Print brand no in accordance		An error occurred when printing the sack brand so that the plastic sack mold did not match both the brand and the expected position of the mold.
Stitching crooked		Errors when sewing plastic sacks are caused by the operator's lack attention when sewing plastic sacks so that the position of the sack seam crooked.

The define stage is a way to improve the production process by determining the type of defect in a plastic sack product and researchers must know the production process that is currently operating. Previously, researchers had to know consumer needs (Irwanto et al., 2020).

Next, data was collected to observe the number of defects for the three types of CTQ that occurred in plastic sack products. The number of defects in each CTQ is in the following table:

Table 3. Number of disabilities in each CTQ

Critical To Quality (CTQ)	Number of sheets)
Torn sack	115.106
The sack brand print does not match	76,204
Oblique seam	43,292
Total	234,602

Measure

Measure is a measurement stage which consists of three stages, namely the six sigma value calculation stage, control chart analysis and Pareto diagram analysis stage (Bakti & Kartika, 2020)

Calculation of sigma value

Sigma is a level that shows a measure of the level of variation in defective products by converting the value from DPMO to sigma level. Calculation of the sigma value of plastic sack production using the following formula:

a) Calculate DPU (Defect Per Unit)

$$DPU = \frac{Total\ defects}{Total\ production} \quad (1)$$

b) Calculate DPO (Defects Per Opportunities)

$$DPO = \frac{Total\ defects}{Total\ production\ X\ Number\ of\ defect\ types} \quad (2)$$

c) Calculate DPMO (Defects Per Million Opportunities

$$DPMO = x\ 1{,}000{,}000 \frac{Total\ defects}{Total\ produksi\ X\ Number\ of\ defect\ types} \quad (3)$$

d) Sigma level = Norm. S. Inv (1,000,000 – DPMO/1,000,000) + 1.5

Table 4. DPMO and sigma level calculation results

Month	Production Amount	Number of Defects	CTQ	DPU	DPO	DPMO	Sigma
March-22	725,645	20,366	3	0.028	0.009	9,355	3.9
April-22	790,678	20,210	3	0.026	0.009	8,520	3.9
May-22	754,369	21,548	3	0.029	0.010	9,521	3.8
June-22	704,598	18,737	3	0.027	0.009	8,864	3.9
July-22	765,432	17,119	3	0.022	0.007	7,455	3.9
August-22	756,478	20,768	3	0.027	0.009	9,151	3.9
September-22	689,654	21,667	3	0.031	0.010	10,472	3.8
October-22	705,467	20,949	3	0.030	0.010	9,898	3.8
November-22	679,866	19,633	3	0.029	0.010	9,626	3.8
December-22	723,458	18,330	3	0.025	0.008	8,446	3.9
January-23	675,433	16,449	3	0.024	0.008	8.118	3.9
February 23	667,845	18,826	3	0.028	0.009	9,396	3.8
Average	719,910.25	18175.67	3	0.025	0.008	8,435.33	3.9
Total	8,638,923	234,602	-	-	-	108,824	-

Based on the DPMO calculation results in the table above, the production results of plastic sacks from March 2022 to February 2023 with an average of 8,435 are at an average level of 3.9 sig ma, indicating that defects are 8,435 for one million production.

1. Control chart

A control chart is a graphic method used to evaluate whether the product is within statistical quality control limits or not. The steps in creating a control chart are: (Baldah, 2020).

Calculate the percentage of product defects or product nonconformities to determine the level of defect in plastic sack products by using the following formula:

$$P = x\ 100\% \frac{x}{n} \quad (4)$$

Information: P = Percentage of production defects, x = total defects in plastic sack production, n = Number of production

Table 5. Calculation Results of Product Defect Percentage

Month	Total product (sheet)	Torn sack	Types of defects (sheets)	Italic print	Total defects (sheets)	Percentage (%)	Standard limit (%).

			Sack brand print does not match				
March-22	725,645	9,876	7,034	3,456	20,366	2.81	1.7
April-22	790,678	9,876	6,980	3,354	20,210	2.56	1.7
May-22	754,369	10,765	7,685	3,098	21,548	2.86	1.7
June-22	704,598	8,965	6,785	2,987	18,737	2.66	1.7
July-22	765,432	7,985	5,789	3,345	17,119	2.24	1.7
August-22	756,478	10,980	6,543	3,245	20,768	2.75	1.7
Sept-22	689,654	9,876	7,890	3,901	21,667	3.14	1.7
October-22	705,467	10,156	6,789	4,004	20,949	2.97	1.7
November-22	679,866	9,875	5,678	4,080	19,633	2.89	1.7
December-22	723,458	8,976	5,345	4,009	18,330	2.53	1.7
January-23	675,433	7,900	4,679	3,870	16,449	2.44	1.7
February-23	667845	9,876	5,007	3,943	18,826	2.82	1.7
Total	8,638,923	115.106	76,204	43,292	234,602	2.72	1.7

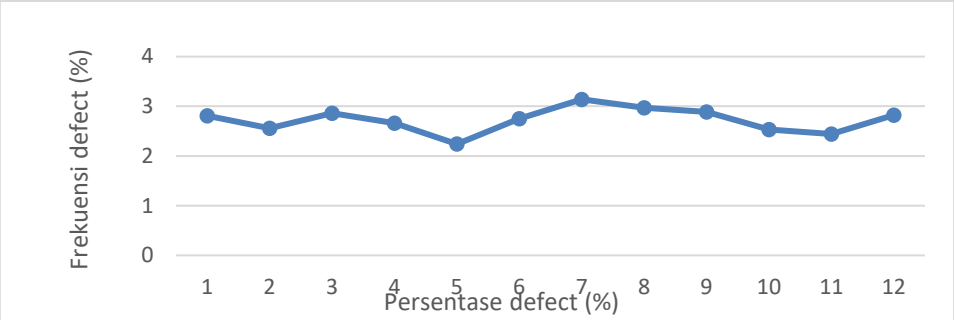

Figure 1. Control map p (chart)

From the picture above, it can be seen that the percentage of defects above the defect frequency of 1.7% indicates that the level of defects in plastic sack products exceeds the company's standard limit, namely 1.7%, so it can be said that the results of the production process are not good or indicate there are problems (Nabila & Rochmoeljati, 2020).

2. Pareto Chart

After knowing the data regarding the types of product defects that occur, a Pareto diagram is created to determine the most dominant types of defects. To calculate the percentage of each product defect, use the following formula:

$$\text{Percentage of defects} = X\ 100\% \frac{type\ of\ disability}{Total\ defects} \quad (5)$$

Table 6. Recapitulation of cumulative disability percentage calculation

CTQ Type	Number of defects	Percentage (%)	Cumulative (%)
Torn Sack	11.5106	49.06	49.06
Brand Print Inappropriate	76,204	32.48	81.54
Oblique Stitching	43,942	18.73	100

Next, describe the results of the cumulative defect percentage in the form of a Paerot diagram as follows:

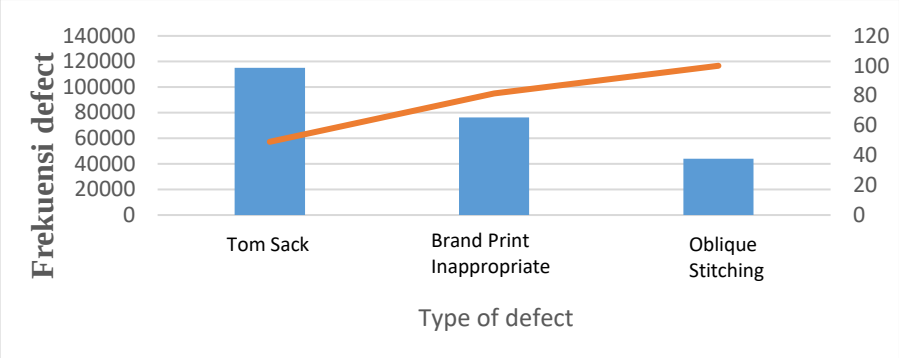

Figure 2. Pareto diagram of plastic sack product defects

From the picture above it can be seen that the most dominant type of defect is the torn sack defect, so next the researcher will look for the root cause of defects in plastic sack products using a fishbone diagram (Qothrunnada et al., 2022).

1. Analyze

The analysis stage is the third stage of DMAIC which aims to identify factors that cause defects. To find out the cause of the sack being torn, an analysis was carried out using a fishbone diagram.

The cause and effect diagram for the type of defect in torn sacks is found to be the problem, namely: a) machine factor where the performance of the cilculator room machine decreases due to lack of machine maintenance, resulting in sacks being torn, b) work method factors where employees often operate machines on an automatic basis, c) the workforce is less focused and pays less attention to machines, d) The material factor is that the quality of the bag is not good, so it breaks easily when assembling the sack in the cilculator room machine, causing the sack to tear.

2. Improve

The repair stage is a stage used to repair defects in plastic sack products from the three types of defects. Improvement techniques used to improve the plastic sack production process using the 5W + 1H method.

5. Control

The final stage of the DMAIC method is the control stage. The control stage aims to ensure that the improvements made in the improve stage have been carried out. The control of proposed improvements carried out in the improvement stage is as follows: (Widyarto et al., 2019)

a. Man

Proposed action:

- Conduct training to employees regarding work SOPs.
- Conduct discipline training for employees.
- Holding outreach about the importance of quality in every plastic sack production process.

Controls:

- Increase supervision of employee training regarding Operation Systems and Procedures (SOP).
- Supervise employees during production process activities.

b. Machine

Proposed action:

- Carry out continuous care and maintenance.
- Create a maintenance schedule and carry it out periodically

Controls:

- Supervise machines that are operating continuously

- Carry out strict maintenance supervision

c. Working method
   Proposed action:
   - Explains how to operate an automatic machine.
   - Create additional SOPs so that automatic-based machine setup problems do not recur.

   controls:
   - Supervise employees when setting up automatic machines

d. Material
   Proposed Improvements:
   - Check the thread strands before they go to the supplier to see if the quality is good.

   Controls:
   - Monitoring and evaluating the quality of raw materials from Suppliers when the goods arrive.
   - Supervision of the material inspection checking process is more thorough.

3.3 Recommendations for Improvement

Based on the results of the analysis from this research using the DMAIC method, recommendations for improvement are as follows:

1. Conduct training to operators on Operation Systems and Procedures (SOP) so that errors in the production process can be minimized so that the company's target production defect rate is achieved, namely 1.7% and below.
2. Based on the analysis of the causes and effects of production defects, especially in humans, where operator negligence and errors in carrying out production process activities, companies should increase motivation so that these problems do not happen again.
3. After the company provides motivation to the operator, the next step is to increase supervision and if the operator does the same thing, the company should provide sanctions to the operator.
4. Continuously improve machine maintenance so that the machine can be ensured to be in good condition.
5. To increase accuracy in work methods, especially in running automatic machines, there should be a special operator to operate them.
6. Improving the quality of the material, namely the thread strands, both thickness, strength, thread tension so that they don't break when assembling the plastic sacks.

4. CONCLUSION

Based on the results of research analysis using the DMAIC method at PT. XYZ can be concluded as follows: There are several factors that cause defects in plastic sack production, namely, human factors, machines, work methods and materials. Proposed improvements to improve product quality are: a. Humans, namely carrying out training and directing employees to follow systems and procedures (SOP). b. The machine means making a continuous maintenance schedule according to the machine's capacity so that it is always in good condition. c. The work method factor is that the company must create additional operating systems and procedures (SOP) so that work method problems will be better in the future. d. Material, namely tightening the process of checking the inspection of bad threads carefully before entering the plastic assembly process.

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